भा.कृ.अनु.प.
I.C.A.R.

भारतीय मृदा एवं जल संरक्षण संस्थान
IISWC
ISO 9001:2015

ICAR-IISWC

Annual Report

2018-19

ICAR-Indian Institute of Soil and Water Conservation

218-Kaulagarh Road, Dehra Dun-248 195, Uttarakhand

भा.कृ.अनु.प.
I.C.A.R.

ISO 9001:2015

Annual Report

2018-19

ICAR-Indian Institute of Soil and Water Conservation
218-Kaulagarh Road, Dehra Dun-248 195, Uttarakhand

Published by

Dr. P.R. Ojasvi
Director (acting)

Compilation and Layout
Matish Chandra

Graphics and Technical Support
Amit Chauhan

Secretarial Assistance
Meenakshi Pant

Cover Page
Peach based agri-horticulture land use system established in degraded lands in Shivalik foothills near Chandigarh (UT).

Designed and Printed at:
Apna Janmat, Dehra Dun

ICAR-IISWC and Research Centres

Hqr. Dehra Dun
ICAR-Indian Institute of Soil and Water Conservation
218, Kaulagarh Road, Dehra Dun - 248 195 (Uttarakhand
Tel. : (O) : 91-135-2758564 (R) : 91-135-2754968, Fax : 91-135-2754213, 2753386
E-mail : directorsoilcons@gmail.com / projasvi@gmail.com, Website : www.cswcrtiweb.org

Agra

Indian Institute of Soil &
Water Conservation
Research Centre, Chhaleser,
Agra - 282 006 (U.P.)
Tel. : (O) 0562- 6544599;
(R) 91-9837017725
E mail : agra.cswcrti@gmail.com
skdubeyagra@gmail.com

Bellary

Indian Institute of Soil &
Water Conservation
Research Centre,
Bellary - 583 104 (Karnataka)
Tel. : (O) 08392- 242164; (R) 242534
Fax : 08392- 242665
E-mail : soilcons2bly@gmail.com
slpatil64@gmail.com

Chandigarh

Indian Institute of Soil &
Water Conservation
Research Centre,
Sector 27-A, Madhya Marg,
Chandigarh - 160 019
Tel. : (O) 0172-2650783, 2659365; (R) 2651226
Fax : 0172- 2650783
E-mail : soilcons_chd@yahoo.com
v_k_bhatt2001@yahoo.co.in

Datia

Indian Institute of Soil &
Water Conservation
Research Centre,
Datia - 475 661 (M.P.)
Tel. : (O) 07522- 237229, 237372; (R) 237373
Fax : 07522- 400993
E-mail : hocdatia.iiswc@gmail.com
rsyadav@icar.org.in

Kota

Indian Institute of Soil &
Water Conservation
Research Centre, Dadwara
Kota - 324 002 (Rajasthan)
Tel. : (O) 0744-2462642; (R) 2461239
Fax : 0744- 2460853
E-mail : rajivesingh@gmail.com
head@cswcrtikota.res.in

Koraput

Indian Institute of Soil &
Water Conservation
Research Centre, Post Box No. 12,
Sunabeda - 763 002 Distt. Koraput (Orissa)
Tel. : (O) 06853- 220125; (R) 220126
Fax : 06853- 220124
E-mail : cswcrtikoraput@rediffmail.com
madhupmd@gmail.com

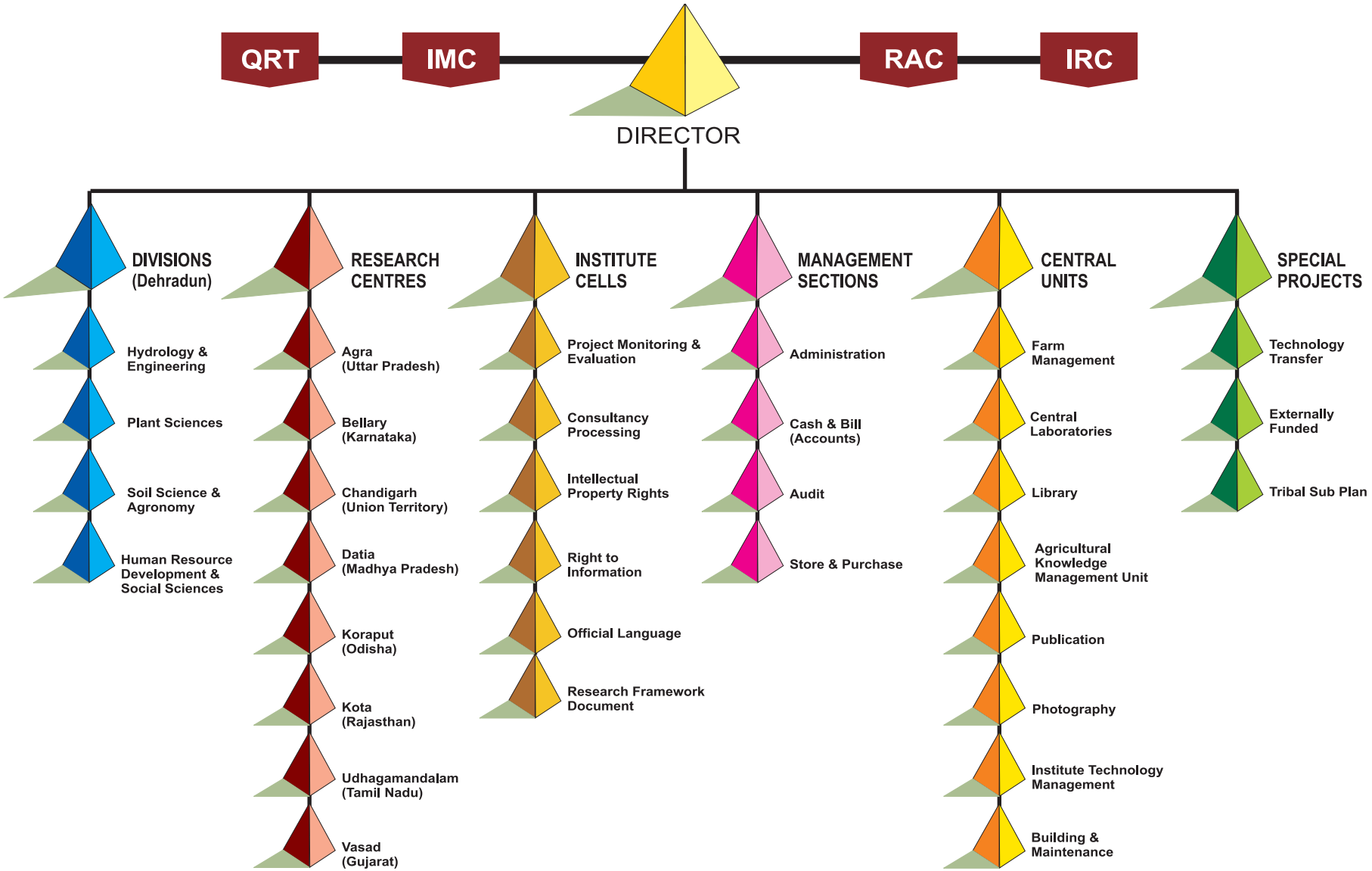
Udhagamandalam

Indian Institute of Soil &
Water Conservation
Research Centre,
Ree's Corner, P.O. Fernhill,
Udhagamandalam - 643 004 (The Nilgiris)
Tel. : (O) 0423- 2443992; (R) 2444093
Fax : 0423-2446757
E-mail : cscooty@gmail.com
opskhola@gmail.com

Vasad

Indian Institute of Soil &
Water Conservation
Research Centre,
Vasad (W. Rly) -388 306 (Gujarat)
Tel. : (O) 02692- 274226; (R) 0265-2750260
Fax : 02692- 274806
E-mail : cswcrtivsd@yahoo.co.in
pr_bhatnagar@yahoo.com

ORGANISATIONAL SETUP



Preface

It is a matter of great honour to present the accomplishments of Indian Institute of Soil and Water Conservation during the year 2018-19 on research, extension, training and related activities. In fact this provides an huge opportunity to highlight the achievements of this premier Institute under NRM division of ICAR. This Annual Report presents a summary of progress of research activities of the Institute under different thematic areas.

Among various research achievements I would like to lay emphasis upon the techniques that have a far reaching impact with regards to soil and water conservation as well as suastainable production from degraded lands. On the basis of long term studies conducted at the Institute, design of trench intensity has been standardised with respect to runoff trapping efficiency from degraded watershed. These experiments revealed that trenches with 60% or 80% runoff trapping capacity would result in better restoration of degraded lands. Infact the trenching technology recorded a positive effect on all resource conservation parameters under different agro-ecological regions across the country. The In-situ moisture conservation technique (V-shaped micro catchment) demonstrated under aonla based agro forestry system in red soils of Bundelkhand can be a effective tool with regards to soil erosion, nutrition loss, rainwater conservation and yield potential of intercrop as well as aonla fruit.

Institute's Research and Development efforts got major thrust/strength/impetus from well structured, well defined and time bound projects targeting specific group. The crucial financial support comes from in-house budget as well as from externally funded projects. The institute constantly strives to diversify its area of action. In this regard, apart from undertaking consultancy projects supported by various organisations a number of extension and training activities in collaboration with external agencies were also conceived and implemented.

I am also happy to put on record that the Institute conducted a wide range of activities to fulfill the objectives of 'Swachch Bharat Mission' programme at Head Quartes as well as at its Regional Centres.

The research findings of the Institute were documented in 96 peer reviewed papers published in international and national research journals. Also, 77 research papers were presented at international and national conferences apart from publication of 11 books and 40 book chapters.

I wish to place on record my thanks to ICAR Head Quarters and members of Board of Management, Chairman and members of RAC for their unconditional support and invaluable guidance. Thanks are also due to the respective theme leaders and all the staff members for their efforts in bringing out this report. I hope that this annual report will be a useful piece of information to all stake holders. Ideas to bring improvements and to make it more appealing are welcome.

(P.R. Ojasvi)

Contents

EXECUTIVE SUMMARY

Indian Institute of Soil and Water Conservation(IISWC) is one of the premier institute under NRM Division of ICAR, engaged in research and developmental activities related to Soil & Water Conservation and Watershed Management. Also, the Instititute actively participates in a variety of programmes in association with SAUs, State,Central Government and International organisations and has developed a strong bond with the farming community. Some of the salient features of different activities accomplished,undertaken during the year are summarised as follows.

Inventory and Data Base of Erosion Status Using Modern Tools and Procedures

Application of high resolution geo-spatial data on topography, LULC, and rainfall erosivity on soil erosion fluxes, besides improving erosion estimates, underlines the fact that stream bank and other mass erosion processes contribute significantly to total sediment load of hilly streams. The data recorded indicate that more widespread erosion takes place with high moisture levels, the rain factors (intensity) are not as important.

Studies undertaken on comprehensive assessment of climate change implication on watershed development component of WDC-PMKSY indicated that this study may help in the calculation of net irrigation water requirement and understanding the behaviour of weather parameter on reference evapo-transpiration. Also the results may help in planning of efficient water management and ultimately in increasing the efficiency of available water.

Soil Erosion Process Modelling and Climate Change Studies

Under inter-institutional and interdisciplinary project National Mission on Sustaining Himalayan Ecosystem (NMSHE), the climate change projection data of all districts of IHR, for RCP 8.5, year 2050, RCP 4.5, and year 2030 has been compiled. Also, a new empirical auto regressive relationship have been developed to predict the water temperature from air temperature on a daily basis which accurately works based on a unique coefficient that innately differentiate between running and stagnant water condition in a storage structure.

In temperate mountainous ecosystem of Western Ghats the data recorded for Nitrogen in *Shola* forest soils, phosphorous in agricultural soils, and Potassium in agricultural soils were found to be enormously high. With regards to land uses, availability of Nitrogen was found to be sufficient in all the land uses whereas sufficient Phosphorous was available in all the land uses but in *Shola* forest and pure acacia. Similarly sufficient availability of Potassium was recorded in all the land uses except in eucalyptus + acacia, pure acacia , and Grass land .

Soil Carbon Dynamics and Erosion Productivity Studies

The studies undertaken to quantify the impact of erosion on crop productivity, and soil and nutrient losses on red soils of Bundelkhand region suggested that erosion losses increased with increasing slope gradient. Grain yield of sorghum followed trend contrary to runoff, soil, organic carbon and clay content losses. In general, irrespective of application of fertiliser the Sorghum grain yield recorded higher values at lower slope (0.50 %) as compared to yield from plot having higher slope (3.50 %).

The results of experiments conducted with regards to assessment of the vegetation and SOC recovery potentials of abandoned shifting cultivated sites in Central Eastern Ghats indicated that in all the clusters (under study), there was a positive relationship between soil organic carbon (SOC) and fallow duration however, the rate of recovery varied. After the fallow period, the gain in SOC stocks was found to be slow in the initial years. The vegetation establishment on shifting cultivated lands in all five locations caused significant SOC stock build-up.

Resource Conservation Measures for Arable Lands

Studies conducted on interaction effects of different tillage practices and cropping sequences with crop residue management practices indicated that amongst all the treatments, the lowest runoff and soil loss was recorded in zero tillage maize with *in-situ* green manuring of sunnhemp with 15 cm tall crop residues. The highest maize grain yield was recorded in conventional tilled pure maize and pure wheat crops with 5 cm tall crop residues, while the highest system productivity was recorded in conventional tilled maize +cowpea-pea-wheat with crop cutting at 15 cm height.

Evaluation of conservation tillage based *Arundo donax* mats for resource conservation and enhancing cropping intensity on sloping crop lands revealed that by placing *Arundo donax* mats in zero-tilled maize crop at 0.5 meter vertical interval, marked reduction in runoff and soil loss can be achieved as compared to zero tilled maize crop grown without placing erosion controlling mat. Also with the application of this conservation technique, most of the rain water gets stored into soil profile which can be used to raise catch crop in between rain fed maize-wheat crops without having any adverse effect on wheat crop yield.

Experiments conducted on effect of varying water regimes on Zn and N dynamics and rice productivity in saline Vertisols indicated that the water saving practices are potent tool to maintain yield as equivalent to traditional practices apart from saving water under water scarce situations that prevails in Tungabhadra command area.

The results of long term experiment on *In-situ* moisture conservation practices under aonla [*Phyllanthus emblica* (Indian gooseberry)] based agro-forestry system for sustainable production in red soils of Bundelkhand clearly establishes the supremacy of various innovative rain water harvesting practices over farmer's practice of aonla planting with regards to conservation as well as production parameters.

Studies on conservation tillage systems for enhancing productivity and resource-use efficiency in rainfed area of South-Eastern Rajasthan indicates that the residue retention is beneficial in reduction of conservation parameters in the range of 10-15% as compared to no residue retention. Also, the residue retention demonstrated marked improvement in yield parameters however the effect was more pronounced in Rabi season as compared to *Kharif.*

Evaluation of effect of cover crops and reduced tillage for enhancing productivity and soil health in rainfed farming system in the hilly area revealed that initially the tillage effect was not that noticeable. However, after fourth year of experimentation, yields of potato (rainy season) and carrot (winter) under reduced tillage were found to be higher. Also, the incorporation of cover crop has positive impact on yield potential of potato as well as that of carrot. In addition, higher soil moisture was recorded under reduced tillage and cover crops.

Resource Conservation Measures for Non-Arable Lands

Studies conducted on improvised soil working techniques under rainfed conditions of North-Western Himalayas for enhancing tree establishment indicated that adoption of modified sub-surface planting has positive impact on survival rate (agri-horticulture). Also it can provide protection against abiotic stresses in surface layer during dry spell and prolonged low temperature and frost prevalent during winter season.

The data generated under long term experiment on traditional minor millet based agroforestry systems under recommended agri-silvicultural practices of North Western Himalayas revealed that the conservation of natural resources under different land uses was markedly evident in multipurpose trees (MPTs), native millet crops and tree crop combinations. The data obtained clearly established the effectiveness of tree crop combinations in reducing the run off. However, reduction in yield of finger millet and barnyard millet under *Grewia optiva* and *Morus alba* was recorded, indicating strong tree crop interaction.

The studies conducted under collaborative project funded by International Network for Bamboo and Rattan (INBAR) State Forest Department, Uttarakhand revealed that with the incorporation of different bamboo species there was marked improvement in soil physical properties. Also, a reduction in soil organic carbon, nitrogen and potassium was recorded for all the species under trial.

The data collected for evaluation of promising fruit species with different moisture conservation practices in red soils of Bundelkhand region indicated that under sunhemp treatment, growth parameters of fruit plants, custard apple, pomegranate and lemon, were markedly better as compared to control. However, with regards to soil moisture the percent soil moisture depletion per day was lowest in case of plastic mulch (0.86% in custard apple to 1.26 % in pomegranate).Studies conducted in Eastern Ghats high land region of Odisha indicated the importance of on cover crops under cashew and mango plantation. The data generated clearly underlines the positive impact of cover crops on soil health parameters. Soil conservation efficiency of cover crops varied between 24.9-76.6% for mango and between 24.2-53.2 % for cashew as compared to control. At the same time above ground dry biomass production of cover crops was in the range of 1.5 and 16.6 t/ha/yr which contributed total NPK nutrients of 290 to 1041 kg/ha to soil.

Hydrological Behaviour of Land uses and Management Practices

Hydrologic systems analysis in sub-humid catchment of Eastern Ghat high land region of Odisha, across multiple spatial scales indicated that both, unit area runoff and sediment yield declined with the increase in plot length. With regards to resource conservation parameters, highest values were obtained for fallow land use whereas scrub with small pebbles recorded the lowest. The collected data indicated that scrub and forest land use required 20.5mm rainfall to produce runoff whereas under fallow only 6.0mm rain fall was sufficient.

Water Harvesting, Groundwater Recharge and Management

Under the project implemented by a consortium of seven Institutions covering a country wide study on different aspects of RWH, rainwater harvesting potential at the design rainfall of 75% probability, the criteria used in semi-arid regions for estimating runoff volume, has been worked out for nine states (Bihar, UP, Rajasthan, Maharashtra, Telangana, AP, Kerala, Karnataka and Tamilnadu). This data can be directly used for various decision making related to harvestable runoff volume, size of structure and its design. Also a system of solar powered micro irrigation system is being standardised for efficient utilisation of harvested water in different agro-ecological zone of the country.

Irrigation with Yamuna river water was found to be quite promising in wheat crop in an stretch of about 200 Km from Agra to Etawah district of Uttar Pradesh. The assessment of effect of irrigation with Yamuna river water on grain and straw yield as well as yield attributes of wheat crop revealed that number of plants/m^2, ears/m^2, length of ears, plant height and yield were higher in comparison to crop irrigated with groundwater. The significant increase in mean grain (30%) and straw yield (42%) of wheat crop was observed on irrigation with Yamuna water over the irrigation with groundwater.

Rehabilitation of Areas Affected by Mass Erosion

The studies conducted in Yamuna ravines to assess the impact of different trenching densities on survival and growth of seedlings and to quantify resources conservation clearly establish the efficacy of trenches having 80% runoff trapping potential towards resource conservation parameters. However, with regards to annual increment in the planted seedlings the impact of trenches having 60% runoff trapping potential was found to be markedly better. As a matter of fact the trenching intensity has recorded a positive effect on resource conservation parameters under different agro-climatic regions across the country.

Participatory Technology Dissemination and Adoption

Evaluation of farmer's knowledge, vulnerability and adapting capacity under changing climatic scenario underlines the fact that majority of the farmers across the country are aware of the impending challenges with regards to changes in the temperature, rainfall, wind velocity etc.

Training on Soil and Water Conservation

During the year 2018-19, two batches of regular four month training courses on “Soil & Water Conservation and Watershed Management” were conducted at Institute Head Quarters DehraDun. In all 43 participants attended the training programme. Up to 31 March 2019, a total of 2956 officers have been trained at institute Head Quarters DehraDun and its Regional Research Centers.

01 INTRODUCTION

Historical Back Ground

The Indian Institute of Soil and Water Conservation (formerly known as Central & Soil Water Conservation Research and Training Institute) was established on 1st April, 1974 with Headquarters at DehraDun by combining Soil and Water Conservation Research, Demonstration and Training Centers established in 1950's at DehraDun, Kota, Bellary, Udhagamandalam, Vasad, Agra and Chandigarh. Research centers were initially established by the Government of India and transferred to the Indian Council of Agricultural Research (ICAR) on 1st October, 1967. Subsequently two new Research Centers were established, one at Datia in Madhya Pradesh (18th September, 1986) to tackle soil and water conservation issues of Bundelkhand region and another at Koraput in Orissa (31st January, 1992) to address the ill effects of shifting cultivation. The Institute and its Research Centers, since inception, have focused primarily on evolving strategies for controlling land degradation (by adopting watershed approach), targeting area specific problems (such as ravines, landslides, mine spoils and torrents), demonstration of technologies for popularisation and imparting training besides developing technologies for water harvesting and recycling.

In the year 1956, experimental watersheds were set-up for generating watershed-based protection and production technologies. From the year 1974 onward, the Institute pioneered in operationalising the watershed concept through four Operational Research Projects at Sukhomajri (Haryana), Nada (Chandigarh), Fakot (Tehri-Garhwal in Uttarakhand), and G.R. Halli (Chitradurga, Karnataka). On realising, tremendous tangible and intangible, benefits from these watersheds, the ICAR developed 47 model watersheds in sixteen states in collaboration with State Agricultural Universities and State Agriculture Departments. Encouraged with the success of the model watersheds, the Ministry of Agriculture conceived a mega project entitled "National Watershed Development Programme for Rainfed Areas" (NWDPRA) for resource conservation and sustainable agricultural development in 29 states during 1991. Subsequently, the focus of watershed development programmes shifted towards community participation besides biophysical aspects to achieve sustainability in production systems. Success of the watershed management programmes generated a lot of interest among different stake holders and attracted many international agencies, like World Bank, ICIMOD, EEC, DANIDA, KfW Germany, SIDA and Swiss Development Corporation, for support, collaboration and funding. The research and training experience of the Institutes and its Research Centers is being put to good use by the Ministries of Agriculture, Rural Development, Environment & Forests, NRAA and various Central and State departments for capacity developmental programmes.

Land Degradation Scenario

India is blessed with vast natural resources but increasing pressure on land is disturbing the natural balance between the soil formation and soil depleting processes resulting in serious problems of land degradation which is threatening the national food security. As per the harmonized database on land degradation, about 120.72 m ha (36.70%) is suffering from various forms of land degradation on arable (104.19 m ha) and non-arable (16.53 m ha) lands out of the total geographical area of 329 M ha. In the degraded arable land, water erosion is the chief contributor (73.27 m ha) followed by chemical degradation (17.45 m ha), wind erosion (12.40 m ha) and physical degradation (1.07 m ha). Also, water erosion (9.30 m ha) and chemical degradation (7.23 m ha) are two major factors for land degradation in open forest areas. Land degradation through specific problems affects 17.96 m ha area comprising 8.53 m ha waterlogged, 5.50 m ha saline soils including coastal sandy area, 3.97 m ha ravines and gullies, 1.73 m ha shifting cultivation and 2.73 m ha riverine areas and torrents. Denudation of forest land in various watersheds has resulted in recurring floods, *chaos* and torrents besides there are serious issues of landslides, silting of rivers and reservoirs. The annual production loss in major rain fed crops due to erosion in the country has been assessed as 15.7% of total production of cereals, oilseeds and pulses. These losses can be prevented or minimised by adopting appropriate SWC strategies on arable and non-arable lands following the concept of participatory integrated watershed management.

01 INTRODUCTION

Historical Back Ground

The Indian Institute of Soil and Water Conservation (formerly known as Central & Soil Water Conservation Research and Training Institute) was established on 1st April, 1974 with Headquarters at DehraDun by combining Soil and Water Conservation Research, Demonstration and Training Centers established in 1950's at DehraDun, Kota, Bellary, Udhagamandalam, Vasad, Agra and Chandigarh. Research centers were initially established by the Government of India and transferred to the Indian Council of Agricultural Research (ICAR) on 1st October, 1967. Subsequently two new Research Centers were established, one at Datia in Madhya Pradesh (18th September, 1986) to tackle soil and water conservation issues of Bundelkhand region and another at Koraput in Orissa (31st January, 1992) to address the ill effects of shifting cultivation. The Institute and its Research Centers, since inception, have focused primarily on evolving strategies for controlling land degradation (by adopting watershed approach), targeting area specific problems (such as ravines, landslides, mine spoils and torrents), demonstration of technologies for popularisation and imparting training besides developing technologies for water harvesting and recycling.

In the year 1956, experimental watersheds were set-up for generating watershed-based protection and production technologies. From the year 1974 onward, the Institute pioneered in operationalising the watershed concept through four Operational Research Projects at Sukhomajri (Haryana), Nada (Chandigarh), Fakot (Tehri-Garhwal in Uttarakhand), and G.R. Halli (Chitradurga, Karnataka). On realising, tremendous tangible and intangible, benefits from these watersheds, the ICAR developed 47 model watersheds in sixteen states in collaboration with State Agricultural Universities and State Agriculture Departments. Encouraged with the success of the model watersheds, the Ministry of Agriculture conceived a mega project entitled "National Watershed Development Programme for Rainfed Areas" (NWDPRA) for resource conservation and sustainable agricultural development in 29 states during 1991. Subsequently, the focus of watershed development programmes shifted towards community participation besides biophysical aspects to achieve sustainability in production systems. Success of the watershed management programmes generated a lot of interest among different stake holders and attracted many international agencies, like World Bank, ICIMOD, EEC, DANIDA, KfW Germany, SIDA and Swiss Development Corporation, for support, collaboration and funding. The research and training experience of the Institutes and its Research Centers is being put to good use by the Ministries of Agriculture, Rural Development, Environment & Forests, NRAA and various Central and State departments for capacity developmental programmes.

Land Degradation Scenario

India is blessed with vast natural resources but increasing pressure on land is disturbing the natural balance between the soil formation and soil depleting processes resulting in serious problems of land degradation which is threatening the national food security. As per the harmonized database on land degradation, about 120.72 m ha (36.70%) is suffering from various forms of land degradation on arable (104.19 m ha) and non-arable (16.53 m ha) lands out of the total geographical area of 329 M ha. In the degraded arable land, water erosion is the chief contributor (73.27 m ha) followed by chemical degradation (17.45 m ha), wind erosion (12.40 m ha) and physical degradation (1.07 m ha). Also, water erosion (9.30 m ha) and chemical degradation (7.23 m ha) are two major factors for land degradation in open forest areas. Land degradation through specific problems affects 17.96 m ha area comprising 8.53 m ha waterlogged, 5.50 m ha saline soils including coastal sandy area, 3.97 m ha ravines and gullies, 1.73 m ha shifting cultivation and 2.73 m ha riverine areas and torrents. Denudation of forest land in various watersheds has resulted in recurring floods, *chaos* and torrents besides there are serious issues of landslides, silting of rivers and reservoirs. The annual production loss in major rain fed crops due to erosion in the country has been assessed as 15.7% of total production of cereals, oilseeds and pulses. These losses can be prevented or minimised by adopting appropriate SWC strategies on arable and non-arable lands following the concept of participatory integrated watershed management.

Mandate

- Research for management of land degradation in a primary production systems and rehabilitation of degraded lands in different agro-ecological regions of the country.
- Co-ordinate research network for developing location-specific technologies in the area of soil and water conservation.
- Centre for training in research methodologies and updated technology in soil and water conservation and watershed management.

Presentation of Research Progress

The research progress for the year 2018-19 is being presented in a programme mode as per the advice of Research Advisory Committee of the Institute and as recommended by ICAR committee. Accordingly, the research activities were rationally divided into six programmes and 13 sub-programmes. For meaningful and logical comparison of research findings within a research programme/project, the order of presentation is as per agro-climatic regions, viz; hill region (DehraDun, Chandigarh, Udhagamandalam Centres), ravine region (Agra, Kota, Vasad), Bundelkhand region (Datia), black soil semi-arid region (Bellary) and shifting cultivation-lateritic soil region (Koraput). The research programmes and Programme Leaders are as follows:

Research programme	Project Leaders
P-1 : Water erosion appraisal in different agro-ecological regions.	Dr. P.R. Ojasvi
P-2 : Conservation measures for sustainable production systems.	Dr. N.K. Sharma (Arable) Dr. Harsh Mehta (Non-arable)
P-3 : Watershed hydrology for conservation planning.	Dr. D.R. Sena
P-4 : Rehabilitation of areas affected by mass erosion.	Dr. Ambrish Kumar
P-5 : Integrated watershed management for socio-economic growth and policy advocacy.	Dr. Pradeep Dogra
P-6 : Human resource development and technology transfer.	Dr. Bankey Bihari

Organisational Set-up

The information on organizational set-up had been presented through a chart in the beginning of the report.

Important Events

Union Minister of Agriculture & Farmer's Welfare Visited Research Centre Vasad

Shri Radha Mohan Singh Ji, Hon'ble Union Minister of Agriculture & Farmers' Welfare visited Research Centre, Vasad on September 10, 2018. Hon'ble Union Minister had a fruitful interaction with the staff members on various issues and enquired about center's activities and their impact. Dr. P.R. Bhatnagar, Head made a presentation about the ongoing research projects at the Research Centre. A visit to the Research Farm located on NH- 8 was also arranged.

Institute Celebrates 45th Annual Day

The ICAR-IISWC, DehraDun celebrated its 45th Annual Day on April 7, 2018. Sh. Subodh Uniyal, Hon'ble Minister of Agriculture & Horticulture, Uttarakhand graced the occasion as Chief Guest. Dr. P.K. Mishra, Director highlighted the achievements of the Institute. The Hon'ble Chief Guest congratulated the Institute for its good work at field level and underlined importance of soil and water conservation in agriculture, the main livelihood of rural Uttarakhand. Highlighting, Uttarakhand state's present agricultural scenario

with migration as the prime problem, he emphasised on Community Farming and "*Chak Bandi*" as solution to the problem. He further stressed upon importance of organic farming and horticulture for State's farmer. Farmers of Utpalta, Hattal-Sainj, Kalsi, and Langha villages and Raipur Block collaborating with Institue in various projects were felicitated on the occassion. The farmers expressed their heartfelt gratitude for various soil and water conservation interventions and watershed development works under taken by the institute.

ICAR Governing Body Member Visited IISWC

Shri Suresh Chandel ji, Ex-Member of Parliament and Hon'ble Member of ICAR Governing Body visited the institute during May 3-4, 2018 and took stock of the research, extension, training and administrative activities. He interacted with the Director, Chief Administrative Officer, Senior Finance & Accounts Officer and other administrative staff, wherein important issues were discussed. The Hon'ble Member also visited Research Farm and expressed his contentment about efforts, being made to address soil and water conservation problems.

Secretary (DARE) & Director General (ICAR) Visited Research Centre Chandigarh

Dr Trilochan Mohapatra, Hon'ble Secretary (DARE) & Director General (ICAR), visited Research Centre, Chandigarh on September 9, 2018. He was accompanied by Dr K. Alagusundaram, Deputy Director General (Engg & NRM), ICAR. Dr Trilochan Mohapatra showed keen interest in Center's research activities and asked for its major achievements. He was apprised of developed technologies and success stories. Hon'ble Secretary lauded the achievements of the centre and also enquired about ongoing research projects. He also emphasised on making short technology brochures, which should be able to impress the stakeholders by brief look.

Annual IRC Meeting-2018 of Institute Held

The annual Institute Research Committee (IRC) Meeting was held at DehraDun during April 23-28, 2018. Dr. P.K. Mishra, in his opening address emphasised upon hard work with new ideas and technologies to focus on land degradation and its restoration. During the week long deliberations, progress of seventy seven ongoing projects,including four core projects and twelve externally funded projects, were presented and discussed. Seven new project proposals, recommended by the Research Advisory Comittee (RAC) and six observational trials, were also presented. Dr. P.K. Mishra gave a presentation on "Paradigm Shift in Addressing Land Degradation and Restoration Issues in the Context of IPBES (Inter-governmental Platform on Bio-diversity and Eco-system Services) Conceptual Framework".

Quinquennial Review Team visited Research Centre Vasad and Datia

The Quinquennial Review Team (QRT) for ICAR-IISWC visited Research Centre Vasad and Datia to review activities in various domains. The QRT took stock of infrastructure and staff position at the Centres. The team visited the ongoing experiments at research farms and held extensive discussions on objective, methodology and findings. The Quinquennial Review Team appreciated the well maintained experiments and suggested to record all possible parameters required to support output from the treatments. Field visits were conducted to Transfer-of-Technology and externally funded project sites followed by meeting with the farmers. The team appreciated the works undertaken at farmer's fields. The QRT Chairman, Dr. Pratap Narain, ex-VC, SKRAU, Bikaner and ex-Director, CAZRI, Jodhpur in his remarks appreciated the research work being carried out at the centres, and suggested that the three ravine centres along with Datia centre may work on an interlinked frame of research programme in order to avoid duplicity.

Plantation Drive under Mission Rispana to Rishiparna

ICAR-IISWC, DehraDun actively participated in plantation drive under Mission Rispana to Rishiparna for reviving the dying Rispana river, whose upper region continues to provide drinking water to DehraDun. In this programme, staff members including Scientists, Technical Officer, Officer Trainees (118 batch of regular training), skilled supporting staff and contractual staff actively participated. About 300 pits were dug on May 19, 2018 in the allotted block No. 37 in upper catchment of Rispana river at village Karwana in Rajpur Block.

International Yoga Day Celebrated

Fourth International Yoga Day was celebrated at IISWC, DehraDun, and its Research Centres on June 21, 2018. Under the theme “Yoga for Harmony and Peace”, Hon'ble Prime Minister Shri Narendra Modi ji led thousands of volunteers to perform yoga asanas at a function organised at Forest Research Institute campus, DehraDun. ICAR- IISWC staff members actively participated in the programme. Addressing the gathering, the Hon'ble Prime Minister said that Uttarakhand has been a centre for yoga for several decades. Yoga has now become the biggest mass movement across the Globe in quest for good health and well-being, which is crucial for creation of a peaceful world. Hon'ble Prime Minister urged people to practice yoga to lead a healthy life. A yoga camp was organised at institute campus during June 8-12, 2018. At the Research Centres, yoga instructors sensitised participants about yoga and its various health benefits.

Capacity building programme on Participatory Integrated Watershed Management conducted

A twelve days capacity building programme on “Participatory Integrated Watershed Management” for

Nadi Veeras of Rally for Rivers -Isha Foundation was organised during 09-20 July 2018 at IISWC Regional Centre Udhagamandalam. This programme aims at training Nadi Veeras of Rally for Rivers to improve their knowledge and skills in planning and implementing soil and water conservation activities through watershed concept.

The training module consists of lectures on site selection and design of soil conservation structures, drainage line treatments, water harvesting and recharge structures, application of GIS in watershed management and benchmark survey for watershed planning. Besides the lectures, the trainees were involved in field exercises/ hands on practice of design and cost estimation of various soil and water conservation, drainage line and water harvesting structures. The trainees also surveyed and prepared detailed project report for Kappathorai watershed.

World Soil Day celebrated:

World Soil Day was celebrated at IISWC, Head Quarters, Dehra Dun and its research centres on fifth December 2018. Shri Subodh Uniyal, Hon, ble Minister, Government of Uttarakhand was the chief guest at the programme organised at the Institute Head Quarter Dehra Dun. Shri Harbansh Kapoor, MLA, DehraDun Cantonment., Shri. Gauri Shankar, Director Agriculture, Uttarakhand, Shri R.C.Srivastav, Director, Horticulture, Uttarakhand and Shri Vijay Devrani, Chief Agriculture Officer, Uttarakhand also graced the occasion. This year the theme for World Soil Day was "*Be the solution to soil Pollution*" and the programme began with the Oath Taking Ceremony. Dr. P.R. Ojasvi, acting Director extended warm welcome to the chief guest; dignitaries and greeted the participants on the occasion and elaborated upon various programmes being conducted by the Institute across the country. The Chief Guest in his address highlighted the importance of soil health card and encouraged the farmers to diversify and adopt integrated farming in order to double their income. Sh. Harbans Kapoor indicated the importance of utilizing proper fertilizer recommendations for increasing farmer's income and highlighted the great role which the Institute has to play in achieving it. The farmers present shared their experience with regards to application of soil health card.

National Conference of Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR – 2019) organised

Indian Association of Soil and Water Conservationists, DehraDun in collaboration with ICAR –IISWC,

Research Centre, Koraput organised three days National Conference of Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR – 2019) from 6th -8th February, 2019 at HAL, Sunabeda. During the conference, apart from research deliberations, more than 400 leading and innovative farmers from Eastern states of Bihar, Chhattisgarh, Jharkhand, Odisha and West Bengal, practicing soil and water conservation measures, were felicitated. Along with exhibition stall display of various departments, tour of the research farm, that has different technology related to farming, was also conducted for visiting farmers.

National Conference of SCSI on Farmers' Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact organised

Twenty eighth National Conference of Soil Conservation Society of India on Farmers' Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact was jointly organised by SCSI, ICAR – IISWC, Research Centre, Udhagamandalam and Tamil Nadu State Chapter of SCSI during 31st January to 02nd February 2019 at Udhagamandalam, Tamil Nadu. The conference was inaugurated by the Thiru. Banwarilal Purohit, Hon'ble Governor of Tamil Nadu. Dr. M. R. Srinivasan, Former Chairman Atomic Energy Commission was the guest of honour. Dr. R.C. Agrawal, Registrar General, Protection of Plant Varieties and Former's Rights Authority, New Delhi delivered the Key note address. Dr Suraj Bhan, President, SCSI, New Delhi welcomed the gatherings and briefed about SCSI activities. On the occasion, Hon'ble Governor felicitated twenty seven scientists, farmers and students for their outstanding contribution in the field of soil and water conservation. The three days conference had a total of ten technical sessions and from each theme, recommendations were derived for developing Farmers' Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact in the present scenario. The valedictory function, on 02nd February 2019, was chaired by Dr. N. Kumar, Vice Chancellor, TNAU, Coimbatore. Dr. K. Alagusundaram, DDG (Agril. Eng & NRM), ICAR- New Delhi was the guest of honour. Sh. C. Paulrasu, IAS, Executive Director, Tea Board of India, Coonoor; Dr. A. Arunachalam, ADG (International Relations), ICAR, New Delhi; Dr. P.R. Ojasvi, Director, ICAR-IISWC, DehraDun and Dr. E.B. Chakurkar, Director, ICAR- CCARI, Goa also addressed the august gathering on the occasion.

Training for Technical Officers of ICAR Institutes

Training Programme on Motivation, Positive Thinking and Communication Skills or Technical Officers (T-5 and above) was conducted during 13 -19 March 2019. The week long training was sponsored by ICAR-NAAS, Hyderabad. A total number of twenty four (24) technical officers, including five (05) women from different ICAR institutes, participated.

Important Publication

- Annual Report 2017-18, ICAR-Indian Institute of Soil and Water Conservation, DehraDun.
- Adhikary, P.P; Hombegowda, H.C; Barman, D; and Madhu, M (2018) Soil and onsite nutrient conservation potential of aromatic grasses at field scale under a shifting cultivated degraded catchment in Eastern Ghats, India. International Journal of Sediment Research 33(3):340-350.
- Dash, Ch. J; Adhikary, P.P; Das, N.K; Alam, N.M; Mandal, U and Mishra, P.K (2018) Comparison of rainfall kinetic energy –intensity relationships for Eastern Ghats Highland region of India. Natural Hazards 93:547–558.
- Dash, Ch. J;, Adhikary, P.P; Madhu, M; Mukhopadhyay, S; Singh, S.K; Mishra P.K (2018) Assessment of spatial changes in forest cover and deforestation rate in Eastern Ghats Highlands of Odisha. Journal of Environmental Biology 39(2):196-203.
- Jakhar, P; Rana, K.S; Dass, A; Choudhary, A.K; Choudhary, M; Adhikary, P.P and Maharana, J (2018) Resource conservation practices in maize-mustard cropping system: Impact on energy, soil carbon and nutrient dynamics. Journal of Environmental Biology 39(4):440-446.
- Kurothe, R.S., Singh, H.B., Tiwari, S.P., Pande, V.C., Bagdi, G.L., Sena, D.R., Vishwakarma, A.K., Kumar, G., Rao, B.K. (2018). 60 Years of Research on Soil and Water Conservation in Gujarat. ICAR-Indian Institute of Soil & Water Conservation, Research Centre, Vasad 388306. 190 p.
- Manivannan, S; Khola, O.P.S; Kannan, K; Choudhury, P.K and Thilagam, V.K (2018) Efficacy of open weave jute geo-textiles in controlling soil erosion and its impact on hill slope stabilization. Indian Journal of Agricultural Sciences 88(5):679–84.
- Mehta, H; Rajkumar; Dar, M.A; Juyal, G.P; Patra, S; Dobhal, S; Rathore, A.C; Kaushal, R; Mishra, P.K (2018) Effect of geojute technique on density, diversity and carbon stock of plant species in landslide site of North West Himalaya. Journal of Mountain Science 15(9):1961-1971.
- Mitra, Soumita; Sarkar, S.K; Raja, P; Biswas, J.K; Murugan, K (2018) Dissolved trace elements in Hooghly (Ganges) River Estuary, India: Risk assessment and implications for management. Marine Pollution Bulletin DOI 10.1016/j.marpolbul.2018.05.057.
- Panwar, P; Pal, S; Bhatt, V.K; Prasad, R; Tiwari, A.K and Patra, S (2018) Topo sequential agroforestry based land use system for soil and water conservation in sloping lands. Range Management and Agroforestry. 39(1):93-96.
- Raja, P; Bhaskar, B.P; Surendran, U; Rajan, K; Sarkar, S.K; Malpe, D.B and Nagaraju M.S.S (2018) Pedogenesis of spatially associated red and black soils in Purna valley from semi arid region of Central India. Chemical Geology 483:174-190.
- Ramesha, M.N; Jhenkhar, M; Holscher, D; Patil, S.L and Hombe Gowda, H.C (2018) Essentiality of fast-growing tree species in Krushi Aranya Prothsaha Yojane. Current Science 114(8):1595.
- Shankar, M; Green, S.M; Mishra, P.K; Snöälv, J.T.C; Sharma, N.K; Karthikeyan, K; Somasundaram, J; Kadam, D.M; Dinesh, D; Kumar, Suresh; Kasthuri, T.V and Quine T.A (2018) Nationwide soil erosion assessment in India using radioisotope tracers 137Cs and 210Pb: The need for fallout mapping. Current Science 115 (3):388–390.
- Sarkar, A; Biswas, D.R; Datta, S.C; Roy, T; Pravash, C. Moharana; Biswas, S.S and Ghosh, A (2018) Polymer coated novel controlled release rock phosphate formulations for improving phosphorus use efficiency by wheat in an Inceptisol. Soil and Tillage Research. DOI: 10.1016/j.still.2018.02.009.
- Manivannan, S; Thilagam, V.K; Kannan, B; and Thiyagarajan, G (2018) Integrated Watershed Management (in Tamil), Thannambikai Publication, Coimbatore, ISBN 978-93-87314-60-3. 262p.
- Madhu, M; Hombegowda, H.C; Meena, M.K and Barla, G.W (2018) Shifting cultivation in Odisha state - Issues and Challenges. ICAR-IISWC Research Centre, Koraput, Odisha, India. PP-02/KR/E-2016, 33p.
- Adhikary, P.P; Hombe Gowda, H.C; and Madhu, M (2018) Alley cropping for resource conservation in degraded highlands of Eastern Ghats of India. ICAR-IISWC Reseach Centre, Koraput, TB-06/KR/E-2018, 8p.
- Manivannan, S., Thilagam V.K; and Khola, O.P.S (2018) Training Manual on Participatory Integrated Watershed Management. ICAR-IISWC Research Centre, Udhagamandalam, The Nilgiris, Tamil Nadu, 230 p.
- Manivannan, S; Thilagam V.K and Khola O.P.S (2018) Training Manual on Soil and Water Conservation and Watershed Management for B.Tech Students. ICAR-IISWC Research Centre, Udhagamandalam, The Nilgiris, Tamil Nadu.

- Narayan, D (2018) Bundelkhand Mein Prakirtik Sansadhan Sanrakchan Evum Tikau Utpadan Hetu Chana + Sarson ki Antaphasli Kheti (in Hindi). Technical brochure.
- Narayan, D (2018) Bundelkhand Mein Rain-gun Duara Sinchai Se Jal Ki Bachat Evum Jal Upyog Chhamta Mein Viradhdi (in Hindi). Technical brochure.
- Pande, V.C; Bhatnagar, P.R; Raj Kumar; Dinesh, D; Kumar, G (2018) Mahi Ravine Ecosystem - Farmers Perception, Services & Incentives for Management. ICAR-IISWC, Reseach Centre, Vasad 388306 (Anand), Gujarat, TB-03/V/E-2018, 40p.
- Patil, S.L; Biswas, H; Morade, A.S; Naik, B.S; Ojasvi, P.R; Dupdal, R; Kumar, S; Prabhavathi, M; Dogra, P and Shrimali S.S (2018) Land Resource Inventory (LRI) Recommendations at work: Monitoring and Evaluation Experience: Sujala III, Karnataka Watershed Development Project II.

Important Meetings

- 50th meeting of Institute Management Committee was held on29/01/2019 at the Institute Head Quarters, Dehra Dun.

Training Programme

During the year 2018-19, two batches (118th & 119th Batches) of regular four months Certificate Courses on Soil and Water Conservation and Watershed Management were conducted at Institute Head Quarters, Dehra Dun. A total number of forty three (43) officers, including fourteen women, attended the training programme. Up to March 2019, 2956 officers have been trained at Head Quarters., Dehra Dun and its regional centers [Bellary, Kota and Udhagamandalam].

Resource Generation

During 2018-19, revenue worth ₹ 235.85 lakhs was generated. Highest revenue was generated through the sale of farm produce (₹97.70 lakhs) followed by internal resource generation activities *viz.* training & consultancy (₹24.47 lakhs) and lab analysis (₹1.99 lakhs). It is attributed to efficient management of resources at Research Farms, organisation of short-term courses, analytical testing fee and undertaking a number of consultancy projects. The details of institute unified budget are as under.

Unified Budget [IISWC, DehraDun and its Eight Research Centres]	Funds	₹ **5918.00** lakhs
	Expenditure	₹ **5895.52** lakhs

Staff Position

The strength of sanctioned staff as on 31.3.2019 including filled and vacant positions is given as follows:

Category	Sanctioned	In position				Vacant
		Total	SC	ST	OBC	
RMP	01	--	--	--	--	--
Head/ Pr. Scientist	12	04	--	--	--	08
Sr. Scientist	24	19	--	01	02	05
Scientist	90	74	10	06	17	16
Administrative	83	62	10	06	04	21
Technical	150	124	23	09	16	26
Supporting	228	136	21	06	21	92
Total	**588**	**419**	**64**	**28**	**60**	**169**

02 RESEARCH ACHIEVEMENTS

P-1: WATER EROSION APPRAISAL IN DIFFERENT AGRO- ECOLOGICAL REGION

1.1: Inventory and Database of Erosion Status using Modern Tools and Procedures

Assessment of soil erosion fluxes of Uttarakhand (P.R. Ojasvi-Dehra Dun)

Study on soil erosion fluxes is undertaken by employing high resolution geo-spatial data on topography, LULC, and rainfall erosivity. Besides hill slope erosion, contribution from stream bank and other major erosion processes are being estimated for the Uttarakhand State. Estimation of potential erosion rate with 30 m resolution data showed that 21.6% area of Uttarakhand is under >10 t ha^{-1} yr^{-1} rate as compared to previous estimate of 55.6%. Besides improving erosion estimates this also shows that stream bank and other mass erosion processes contribute significantly to total sediment load of hilly streams. Two main processes of bank erosion are direct shear and bank slips due to undercutting. The former is directly controlled by river flow conditions and the latter mainly by soil moisture conditions. More widespread erosion takes place with high moisture levels; low banks of silty material also appear to enhance erosion because the whole height of the bank is more frequently wetted. The rain factors (intensity) are not as important. The area vulnerable to bank erosion have been identified in Almas watershed by applying stream power function model (Fig. 1). The quantification of stream bank erosion will be attempted by considering above mentioned factors. Stream bank erosion is the dominant source of sediment in many river systems, and sediment loads may increase by 10 to 15 times in comparison with normal sediment load of the stream.

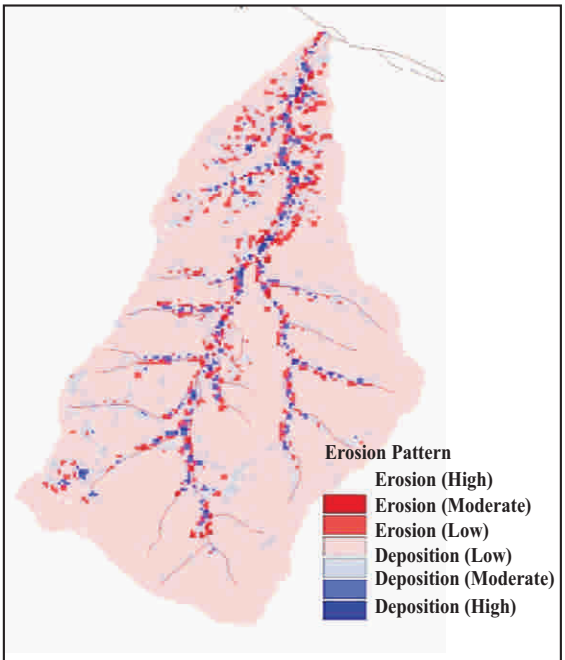


Fig. 1 : Stream bank erosion affected areas (along the stream)

An evaluation of a novel approach to use the Fallout Radionuclide (FRN) Caesium-137 (137 Cs) in National-scale soil erosion assessment in India (M. Shankar, Deepak Singh, P.P. Adhikary, Kasthurithilagam, Rajeev Ranjan and D. Dinesh-Dehra Dun)

Project was approved during IRC-2017-18. In this project we have to complete International Collaboration Formality by making MoU between ICAR-IISWC, DehraDun and University of Exeter, UK, for carrying out the project activities. We did field work to select appropriate field for measuring In-situ Caesium-137 in Koraput, Odisha (Photo.1) and DehraDun Uttarakhand. Other centres Co-PI also requested and did field survey to identify the field.

Photo 1 : Field work at Koraput, Odisha.

Impact of land use land cover changes on soil erosion susceptibility in Bundelkhand region using remote sensing and GIS technique (R. Ranjan, M. Pramanik and R.S. Yadav-Datia)

The project was initiated in the year 2015-16 with the objective to quantify the spatio-temporal variability in land use - land cover changes, estimation of soil erosion and to prepare suggestive treatment plan/map for vulnerable area of Bundelkhand region with remote sensing and GIS. The land use land cover map for Bundelkhand region (District map Fig.2) was prepared for the year 2003 and 2016 using Landsat ETM+ image (30 m spatial resolution) and DEM map (ASTER, 30m resolution) with stream network has been prepared with ArcGIS (Fig.3). LS factor map has been generated from DEM for bundelkhand region using the concept developed by Desmet and Govers, 1996. Soil erodibility map for Bundelkhand region has been generated based on the study conducted by Adhikary et al. 2014 (Fig.4).

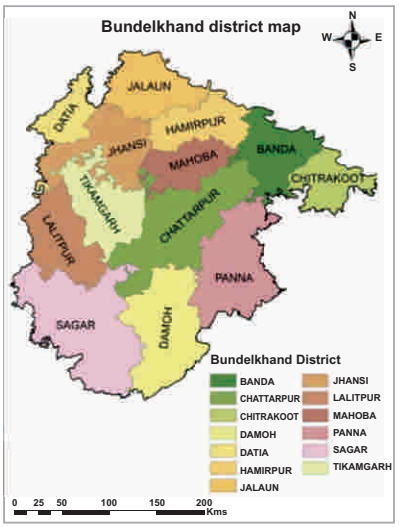


Fig 2 : District map of Bundelkhand region

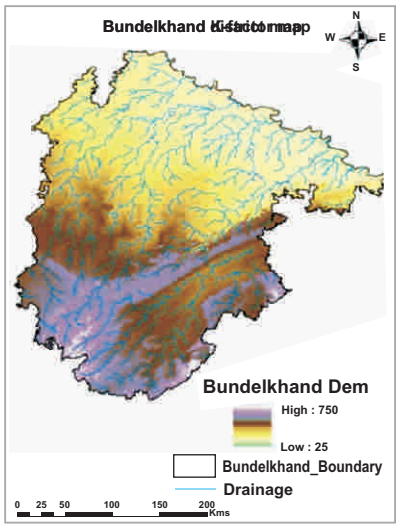


Fig. 3 : DEM map with stream network

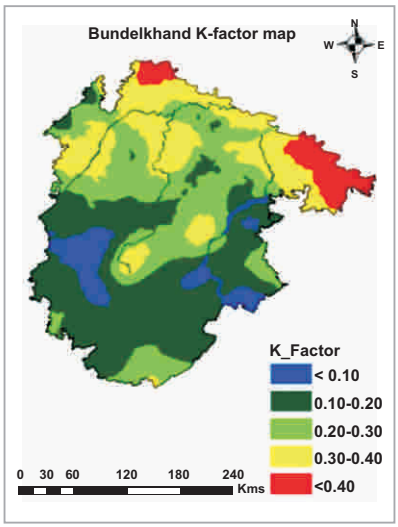


Fig. 4 : Soil erodibility map for Bundelkhand region

Fig. 5 : Stop dams monitored in Jhansi district, U.P.

For assessing the impact of NRM structures, constructed under Bundelkhand package, three stop-dams (of village Javan, Dugara and Dondiga) of Jhansi (Fig. 5) were monitored. A detailed questionnaire was prepared to assess the impact on productivity, water availability and socio-economic conditions of the beneficiary farmers. It was observed that the site selected for checkdam construction at Dugara and Dondiga was perfect but at Jawan, it was constructed near an old check dam on the same stream. The size of the checkdam was almost perfect and there were no sluice gates. The technical observation of stopdams is given in Table 1. About 50- 60 % listed beneficiary responded positive in increase in water availability, ground water recharge, and increase in production after the construction of checkdams. The farmers response about the stopdams is given in Table 2.

Table 1 : Technical observation about the identified stop dams

Parameters	Javan	Dugara	Dondiga
Site selection	×	√	√
Oversized	×	×	√
Sluice gate	×	×	×
Water storage created	√ / ×	√ / ×	√ / ×

*no of beneficiary farmers interacted

Table 2 : Farmers responses about the stop dams

Parameters	Javan (n=10)	Dugara (n=10)	Dondiga (n=10)
Participation in construction	Nil	Nil	Nil
Water availability	5	6	6
Ground water recharge	5	6	6
Benefit derived	5	6	6
Production increase	5	6	6
Suffice to safeguard drought	No	No	No

Regionalization of erosivity density and identification of hot-spot of erosion risk under different agro-ecological regions of India (Ch. J.P. Dash and S.S. Shrimali-Koraput)

Soil erosion models, USLE or RUSLE, have widely been used for predicting soil erosion. Among all factors used within USLE or RUSLE, the erosive force of rainfall (rainfall erosivity: R-factor) is particularly important. Accurate assessment of R-factor requires long term pluviograph data, which is a concern in many places and leads to development of some simplified functions/models correlating the R-factor with readily available rainfall data. As rainfall and *R*-factor vary spatio-temporally and sufficient length of record is needed to obtain reliable average value of R-factor, to address this issue, the erosivity density (ED) concept was came in to picture. Therefore, in this project, emphasis is given to develop R-factor and rainfall relationships for different agro-ecological region of India along with identification of erosion risk prone area based on rainfall and ED. The

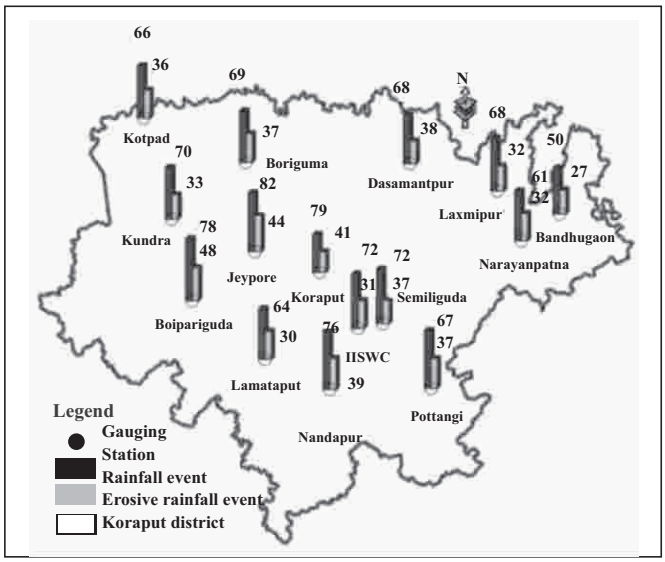


Fig.6. : Locations of meteorological stations along with rainfall and erosive rainfall events in Koraput district

pluviograph data having rainfall more than 12.6 mm collected from all the research centre of IISWC, including Head quarter DehraDun, and used to calculate the single storm R-factor. The sum of events R-factor occurring in a 24 h period is considered "daily erosivity". The sum of daily R-factor calculated in a month is considered "monthly erosivity". The sum of monthly R-factor calculated in a year is considered "annual erosivity". The R-factor was related with respective rainfall amount, and best fit-model was developed. Erosivity Density (ED) was calculated by dividing R-factor with rainfall. The data of Koraput Centre (1994-2017) has been analyzed (Fig.6).

R- factor was correlated daily, monthly and annual rainfall, and the spatial variability of *R*-factor was mapped. The results showed that, power regression models predicted satisfactorily the daily, monthly and annual *R*-factor, of which annual *R*-factor model performed best (model efficiency: 0.93) (Table 3). Mean monsoon season *R*-factor was 15.6 and 10.0 times higher than the pre- and post-monsoon season *R*-factor. Annual *R*-factor values ranged from 3040-10127 MJ mm ha^{-1} h^{-1} $year^{-1}$, with a standard deviation of 1981 MJ mm ha^{-1} h^{-1} $year^{-1}$ (Fig 7). Rainfall intensity was positively correlated with erosivity density and numerical value of rainfall intensity was almost double of the erosivity density value (Fig 8). When rainfall intensity were high (18-30 mm hr^{-1}) and very high (> 30 mm hr^{-1}), ED values were observed to be more than 9 MJ ha^{-1} h^{-1} and 15 MJ ha^{-1} h^{-1}respectively. The monthly ED was found to be more than 3.0 MJ ha^{-1} h^{-1} for all the months of the year except February (Fig 9). For four months (November-December-January-March), the ED values ranged from 3.2 to 3.8 MJ ha^{-1} h^{-1}, and this was because of the predominance of low intensity rainfall events. Starting from April to August, ED values showed an increasing trend. Both July and August months were having highest ED (5.4 MJ ha^{-1} h^{-1}), followed by September (5.2 MJ ha^{-1} h^{-1}) and June (5.1 MJ ha^{-1} h^{-1}). Months having high ED values indicated that the rainfall was characterized by high intensity events of short duration. In term of erosivity, June, July, August and September were more critical months due to higher *R*-factor, combined with intense rainfall.

Table 3 : Best- fit models for rainfall and R-factor and their prediction statistics

Relationship between	Type of equation	Model	ME MJ mm ha^{-1} h^{-1}	R^2	RMSE MJ mm ha^{-1} h^{-1}	E_f
R_e and P_e	Power	$R_e=0.295xP_e^{1.769}$	0.09	0.659	168.5	0.69
R_d and P_d	Power	$R_d=0.208xP_d^{1.850}$	5.62	0.650	176.3	0.61
R_m and P_m	Power	$R_e=2.686xP_m^{1.119}$	9.02	0.815	290.1	0.86
R_a and P_a	Power	$R_a=0.008xP_a^{1.887}$	10.7	0.841	387.9	0.93

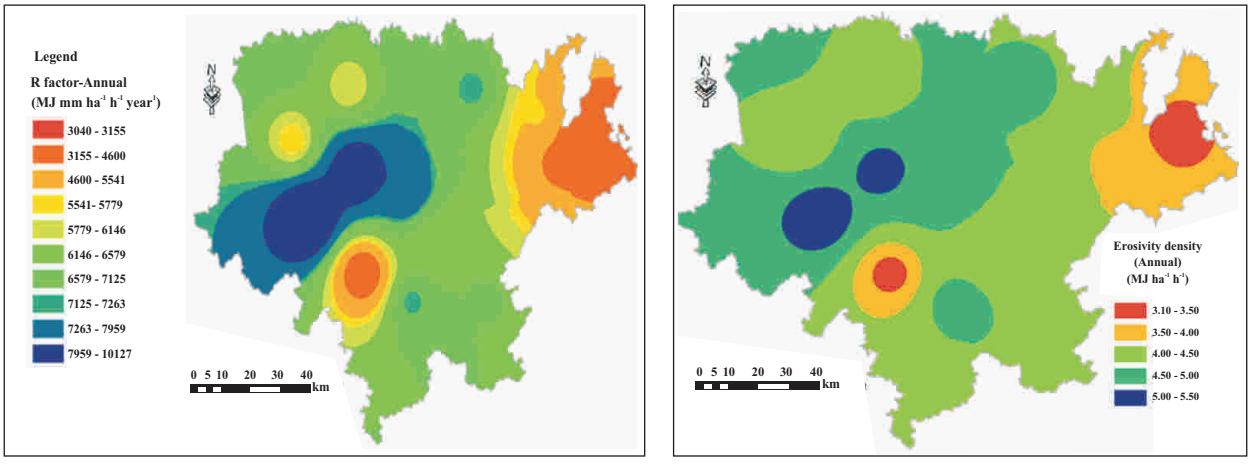


Fig. 7. : Annual Erosivity (A) and Erosivity density (B) map of Koraput

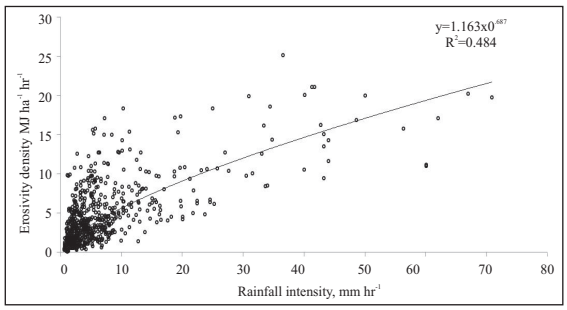


Fig. 8 : Relationship between rainfall intensity and ED

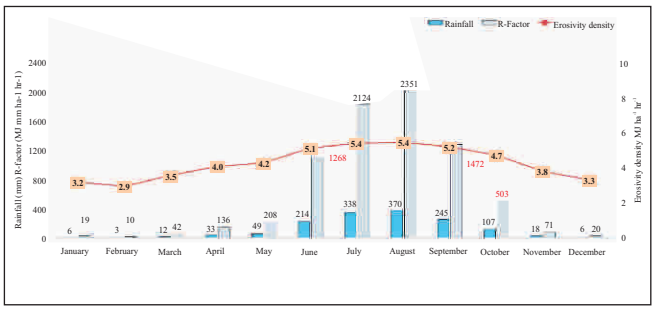


Fig. 9 : Variation of monthly rainfall, *R*-factor and ED

Comprehensive assessment of climate change implication on watershed development component of WDC-PMKSY(D. R.Sena, Uday Mandal, Gopal Kumar, Ramanjeet Singh, M. Shankar and Pradeep Dogra-Dehra Dun)

For analysing the influence of topographic, land use land cover and soil, SWAT model was applied in the Mahanadi basin. Digital elevation model of ASTER (30 m resolution), Land use Land cover from NRSC and Soil data from (https://soilgrids.org) website was utilized to generate the watershed and hydrological response units (HRU). Stream flow line was digitized using Google earth interface and was used in stream burning process. Soil parameters such as Soil organic carbon, bulk density, clay, sand, silt, soil pH and cation exchange capacity which are downloaded from (https://soilgrids.org) website are pre-processed by using ArcGIS and all parameters value came to mapping unit. SAXTON-RAWLS equation is used forsoil water characteristics such as available water capacity and saturated hydraulic conductivity to create final soil database for SWAT model. LULC map is clip from NRSC Landuse Land cover for this basin. Automatic watershed delineation process was followed and generated 144 sub-basins. Hydrological response units (2148) were generated based on threshold value 15:15:10 for land use, soil and slope respectively (Fig 10). In this study, IMD gridded (0.25 degree) daily weather parameter (precipitation, temperature, solar radiation, humidity and wind speed) was used from 1988 to 2004. Slope map was created from ASTER DEM which shows most of the area coming under 2-8 % slope (41% of total basin area). SWAT model is simulated from 1988 to 2004. Runoff data of 15 gauging stations were downloaded from the Water Resource Information System (WRIS) web portal and processed for using calibration (1990 to 1998) and validation (1999 to 2004) process by SUFI-2 algorithm of SWAT-CUP. Model calibration and validation will be done after sensitivity analysis by using SUFI-2 to optimize the output so that it matched the observed discharge, available at different gauging station of river basin. The statistical indices such as R^2 and NSE shown in Fig.11indicate that there is a good agreement between observed and simulated monthly stream flow during calibration and validation period. Comparison of simulated stream flow for Future Periods (2010-2039 (2030s), 2040-2069 (2060s) and 2070-2099 (2090s)) and base period (1976 to 2005)

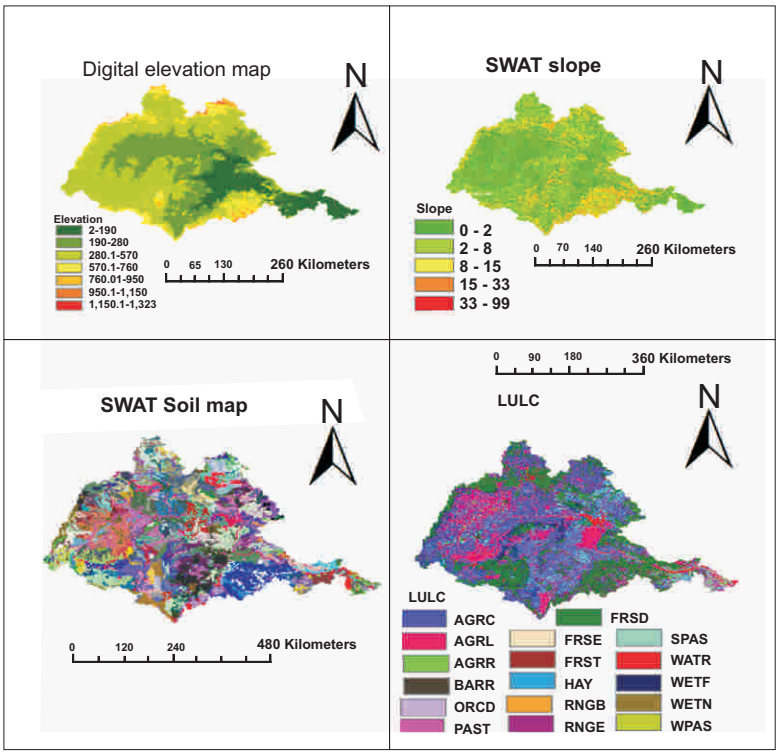


Fig. 10: Elevation, slope, Soil and Land Use Land Cover map of Mahanadi River basin

Projected climate model such as CNRM-CM5, GFDL_ESM2M, IPSL_CM5A-LR and MIROC with RCP2.6, RCP 4.5, RCP6.0 and RCP8.5 are downloaded from (https://esgfnode.llnl.gov) web portal. CMhyd is used to extract and bias-correct data obtained from global models. Distribution mapping is used bias correction of observed rainfall and temperature as well as GCM simulated data for base period (1976 to 2005) and future periods (2010-2039 (2030s), 2040-2069 (2060s) and 2070-2099 (2090s)).Below figure are shown comparison of stream flow for different future periods with different RCP sceneries. In GFDL_ESM2M model, simulated peak stream flow of RCP6.0 has been shifted to next month and increased as compared to base period in 2090s, Total simulated discharge of RCP4.5 in all future periods has been decreased as compared to base periods, besides other RCPs, discharge is increased. In IPSL_CM5A-LR model, simulated peak discharge as well as total discharge of all RCPs in future periods has been increased as compared to base periods. In MIROC model, simulated peak discharge of all RCPs excluding RCP2.6 in 2030s and 2060s has been increased and also increased total simulated streamflow as compared base period. In CNRM-CM5 model, simulated peak streamflow is appeared early as compared to base period.

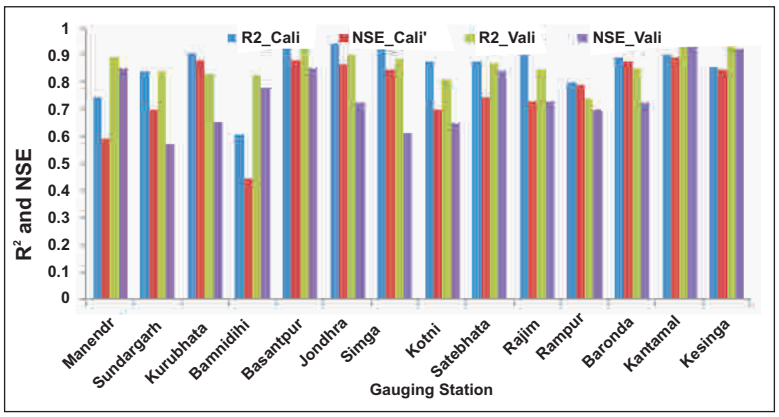
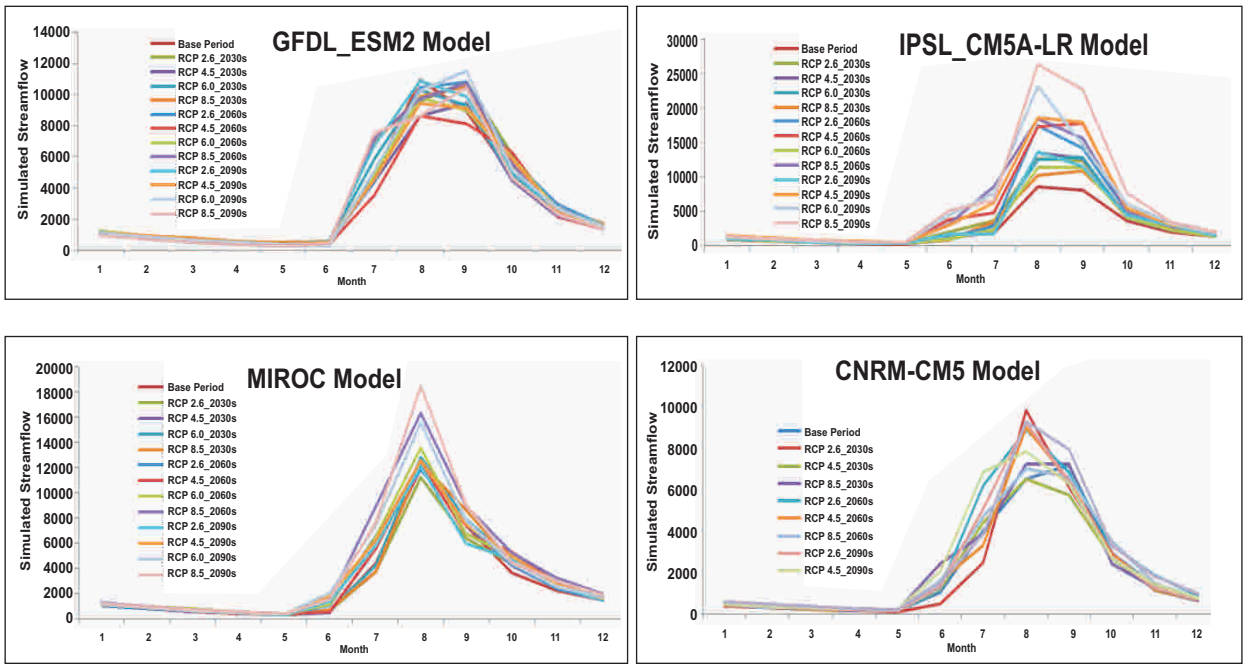


Fig. 11: Statistical indicator during calibration and validation of SWAT model on monthly stream flow in Mahanadi River basin



Crop Water Requirement for Mahanadi River basin using CROPWAT 8.0 model

The CROPWAT 8.0 model carries out calculations for reference evapotranspiration, crop water requirements and irrigation requirements in order to develop irrigation schedules under various management conditions. The Reference evapotranspiration was calculated in CROPWAT 8.0 Model which uses the FAO Penman-Monteith method and to calculate the effective rainfall USDA Soil Conservation Service method was used and after than calculation of crop evapotranspiration CROPWAT 8.0 model uses crop coefficient approach and Crop water requirements of different crops have been estimated by summing up the crop evapotranspiration in all growth stages

This study will help in the calculation of net irrigation water requirement and understanding the behaviour of weather parameter on reference evapo-transpiration. The results of this study may help in planning of efficient water management and ultimately in increasing the efficiency of available water which is presented in Table 4 and Fig 12.

Table 4 : Total Water Demand for Various Sectors

Total crop Water demand (BCM)	Water demand for Rice (BCM)	Livestock Water Demand (BCM)	Domestic Water demand (BCM)	Industrial water demand (BCM)
19.74	12.95	0.11	0.01	8.39

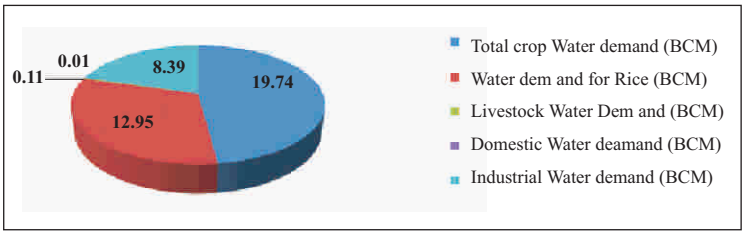


Fig 12 : Total Water Demand for Various Sectors

Development and validation of a spatially explicit simulation framework to quantify runoff-erosion-carbon flux at watershed scale (Deepak Singh, P. R. Ojaswi, A.C. Rathore, Trisha Roy**- DehraDun)**

The data on the interaction between runoff, soil erosion and carbon dynamics on watershed scale in different land-uses viz., S1 (Agricultural land), S2 (Pine tree), S3 (Citrus plant), S4 (Grassland), S5 (Agro-Forest terraced land), S6 (Araucaria tree) and S7 (Watershed outlet) were recorded. In 2018-19, the average yield of maize crop in agricultural field was observed 14.51 Q/ha, while 3.10 Q/ha was observed in terraced field (Fig.13). Organic carbon was monitored from different land use systems in the micro-watershed before Kharif crop (Fig.14). The highest organic carbon was observed in pine forest (0.92%) and lowest organic carbon was observed in grass land (0.42%).

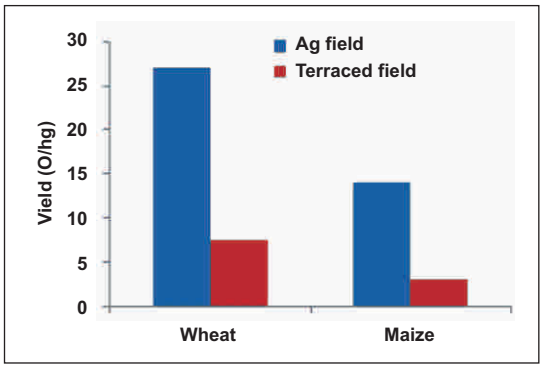


Fig. 13 : Yield of Wheat and Maize Crops

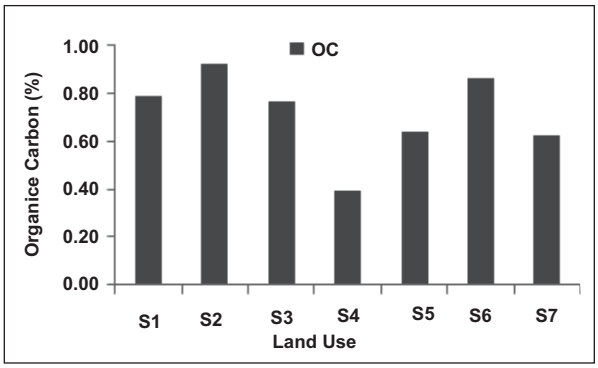


Fig. 14 : Organic Carbon in different land use system

Litterfall was monitored from five different tree species in the micro-watershed during 2018 (Fig. 15). In *Aurocaria*, litterfall was highest (27.85 q ha^{-1}) in May. In case of *Pinusroxburghii*, maximum litterfall of 15.52 q ha^{-1} was observed in April. In *Grewia optiva* litterfall showed maximum litterfall in November (6.49 q ha^{-1}). In Mango maximum litterfall was observed in March (7.85 q ha^{-1}). In citrus, maximum litterfall (4.98 q ha^{-1}) was recorded in January.

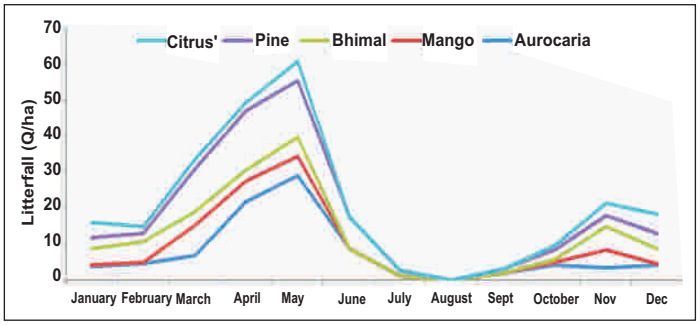


Fig. 15 : Litter fall for different tree species

The Water Erosion Prediction Project (WEPP) model was tested using data on runoff, soil water and sediment together with weather information collected from experimental plots. WEPP was first applied to simulate the surface runoff, soil water and erosion. Results indicated that WEPP could adequately simulate the relationship between runoff and soil loss for the model plot. Comparison between model predicted data and observed data indicates that WEPP tends to predict runoff as well as soil erosion with absolute error-3.34% and -4.12%, respectively (Table -5). The Average simulated runoff and soil erosion in micro-watershed was 249.58 mm and 4.42 t/ha, respectively.

Table 5 : Output of WEPP Model

Parameters	Observed Data	Simulated Data	Abs error (%)
Rainfall (mm)	1362.5	1362.5	
Runoff (mm)	258.22	249.58	-3.34
Soil erosion (t/ha)	4.61	4.42	-4.12

1.2: Soil Erosion Process Modelling and Climate Change Studies

National Mission on Sustaining Himalayan Ecosystem (NMSHE) - Task Force on Himalayan Agriculture for Lower and Middle Himalayan region

Dehra Dun (N.K.Sharma, P.R. Ojasvi, A.K. Tiwari, P. Dogra, C. Singh,, D.R.Sena, S.S.Shrimali, B.Bihari, M.Murugandam, R.Kaushal, L.Chand, U.K.Maurya, V.C.Pande (Vasad), A.C.Rathore, J.M.S.Tomar, R.J.Singh, Uday Mandal, A.K.Gupta, T.Roy, G. Kumar and M.Singh).

- Compilation of database content and its structuring for web pages has been carried out and is an ongoing process.
- Data being collected from all the institutes (Lead and Partners) to be used in flash player and photo gallery section of the portal.
- The Phosphorus, Potassium, total N content, oxidisable organic C and the total C stock (0-45 cm) and soil moisture content was measured in the different land use systems of targeted intervention site: Kotha-Tarli village.
- The soil samples of the demonstrated crop fields are being analysed for major and micronutrients.
- District wise climate change projection data (MarkSim) of rainfall, max temperature, minimum temperature and radiation has been compiled for IHR region.
- Climate suitability parameters for Litchi, Apple and Tomato have been compiled, to be used in Eco-crop model.
- IMD grid weather data of different districts of Uttarakhand has been analysed.
- Extreme temperature events of Uttarakhand have been quantified and change in number of extreme events has been mapped on monthly scale for summer season.
- Climate change projection data of all districts of IHR, for RCP 8.5, year 2050, RCP 4.5, year 2030 has been compiled.
- A new empirical auto regressive relationship was developed to predict the water temperature from air temperature on a daily basis which accurately works based on a unique coefficient that innately differentiate between running and stagnant water condition in a storage structure.
- The ecological niche modelling completed for 39 Maize varieties to find their cardinal weather variables of suitability and abundance based on enveloping the appropriate bioclimatic variables.
- The rate of change (trend) in rainfall (mm/year) for Uttarakhand state from 1960-2015 was analysed for months of July, August and September.
- Baseline information on existing policies and programmes pertaining to water conservation / management relevant for climate change adaptation in agriculture in Uttarakhand, Jammu and Kashmir and Himachal Pradesh are being collected from secondary sources (websites, published documents).
- Some potential adaptation indicators to measure action taken for adaptation have been identified from secondary sources.

- Interventions for climate change adaptation from district contingency plans are being identified for Uttarakhand State.
- Treatments of moisture conservation and nutrient management on Horticultural plantation (apple, pomegranate and peach planted during 2017-2018) at Kotha-Tarli.
- On-farm seed distribution programme along with soil and water conservation activities were carried out in Kotha-Tarli village of block Kalsi of DehraDun district. This programme included introduction of wheat varieties viz. HDCSW 18 & HD 3117 especially developed for conservation agriculture practices + crop-residue mulching for moisture conservation ange scenarios in mid-Himalayan region.
- A farmer's meet was organized at Jur Kafun, Almora on May 04, 2018 by ICAR-IISWC, DehraDun.
- NMSHE team of ICAR-IISWC, DehraDun participated in plantation drive under Mission Rispana to Rishiparna on May 19, 2018 at Karwana Village of Rajpur Block, Dehradun.
- NMSHE team (3 participants) of ICAR-IISWC, DehraDun participated in one day workshop on "Application of Satellite Altimetry for Inland Waterbodies" organized by Indian Institute of Remote Sensing, DehraDun on May 30, 2018.
- Frequent meetings were organized from time to time at ICAR-Indian Institute of Soil & Water Conservation (IISWC), DehraDun, Uttarakhand to review the progress and discuss the future plans under National Mission on Sustaining Himalayan Ecosystems (NMSHE), Task Force (TF)-6 of Lower and Middle Himalayan Agriculture.
- An awareness program "Swachh Bharat Pakhwara" was organized on 20th September, 2018 in Samalta village, DehraDun, Uttarakhand by ICAR-IISWC, DehraDun by Project Team under National Mission for Sustaining the Himalayan Ecosystem (NMSHE- TF 6).
- A workshop on "Water Census & Hot spot analysis in selected villages in Upper Ganga Plain organised by NIH, Roorkee (Uttarakhand) for NMSHE TF-2 Project" in association with NMSHE TF-6 (Agriculture) on 30-11-2018 at ICAR- IISWC, DehraDun.
- Training on "Soil and Water conservation under climate change scenario" organized during 16-18th Oct, 2018. Course content of the training included Effect of climate change on agronomical aspects, engineering measures for soil & water conservation, importance of millets under rainfed conditions, natural resource conservation through agroforestry, soil fertility & its management. It also includes field visits to the research farm Selakui, and KVK, Dhakrani. Twenty Five farmers participated.
- Scientists-Farmer's Meeting at Satyon Jar village, block Jaunpur District Tehri-Garhwal was organized for Himalayansustainable agriculture on 27 February, 2019.

On-farm seed distribution programme & soil and water conservation activities

A Workshop by NIH, Roorkee (Uttarakhand) NMSHE TF-2 with IISWC Dehradun

Chandigarh (P. Panwar, V.K. Bhatt, S.L. Arya, Sharmistha Pal, Ram Prasad, and Pawan Sharma)

Meteorological data on five parameters *viz.* temperature, rainfall, humidity, wind speed and direction and Barometric pressure have been collected through Automatic Weather Station installed at project site in Kumhali District Shimla, Himachal Pradesh.Water discharge of two natural springs at Kumhali is being monitored after every 15 days interval. The discharge ranged from 5 liters/minute in first fortnight of April to 48 liters/minute in the month of October, 2018.Variability and trend analysis of temperature and precipitation data was done for two stations viz. Shimla and Dharmshala of HP. Annual variability for minimum and

maximum temperature at Shimla were 9.86% and 6.55%, respectively and the corresponding values at Dharamshala were 9.68% and4.08%. Annual rainfall variability at Shimla (17.1%) is 4 percent lower than Dharmshala (21.2%). Results from trend analysis using Sen's estimator and Mann Kendall's Z statistics for Shimla and Dharmshala are shown in Fig. 16 and 17, respectively. A study was conducted in five micro plots of 20 sq m each to observe runoff and soil loss in village Kumhali of district Shimla. All plots are located at an average slope of about 70%. Landuse of these plots is grassland. These micro-plots are equipped with Ramser's samplers for recording runoff and soil loss. There were total 12 runoff causing storms (from June to Sept.2018) varying from 10 to 87 mm. Total runoff causing rainfall was 547 mm. Highest rainfall of 87 mm occurred on 23.09.2018. Runoff analysis indicated mean runoff 45.9% for the season and mean soil loss was found 2.41 t ha^{-1}.

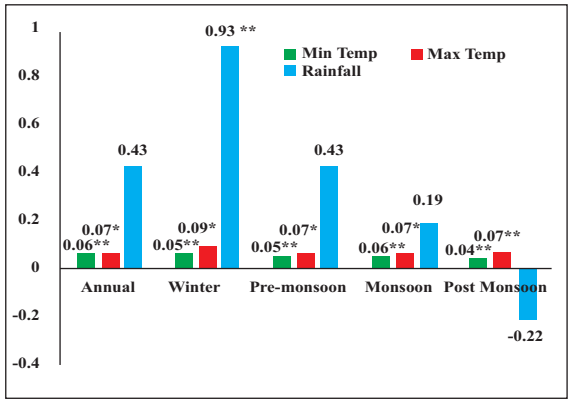


Fig. 16 : Seasonal and annual Sen's estimator of Slope for weather parameters of Shimla

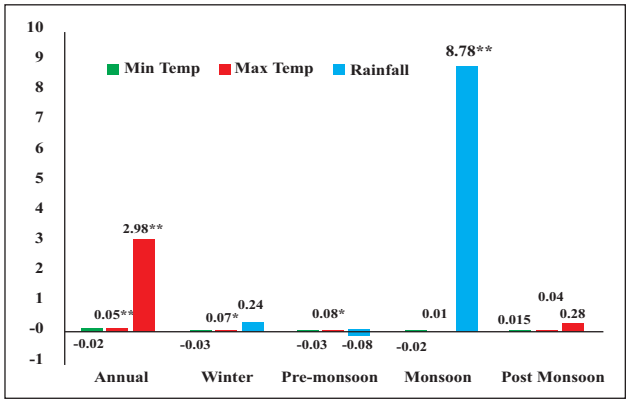


Fig. 17: Seasonal and annual Sen's estimator of Slope for weather parameters of Dharmshala

Study of atmospheric and soil carbon dioxide fluxes in temperate mountainous ecosystem of Western Ghats with reference to climate change impact assessment. (P. Raja, K. Rajan, K. Kannan and O.P.S. Khola-Udhagamandalam)

During the period under report various carbon fractions *viz.,* very labile, labile, less labile and recalcitrant were estimated at every 15 cms interval up to 60 cms from different land uses viz. Tea plantation, agricultural land, Eucalyptus forest, *Shola* forest, Pine forest, Pure Acacia, Eucalyptus plus Acacia and Grassland. Very labile fraction of carbon is found maximum (14.6%) in pine forest followed by grass land (13.3%) and *Shola* forest (12.6%). It is found lowest in agricultural land (4.2%), Fig.18. Labile fraction of carbon is found maximum in pure acacia (9.3%), followed by eucalyptus forest (6.5%), Fig.19. High availability of very labile and labile fractions of carbon in forest soils is attributed to high microbial and root activity and higher amount of humus accumulation and the lower amount in agricultural land attributed to tillage activities and crop rotations. This is again supported by the fact that dehydrogenase activity is found maximum (201.2ppm) in pine forest followed by *Shola* forest (183.8ppm) whereas agricultural land uses and tea plantation has 37.4 and 21.5ppm (Fig.20) respectively. Carbon dioxide emission was found maximum in *Shola* forest (527.5 mg CO_2/50g of soil) followed by

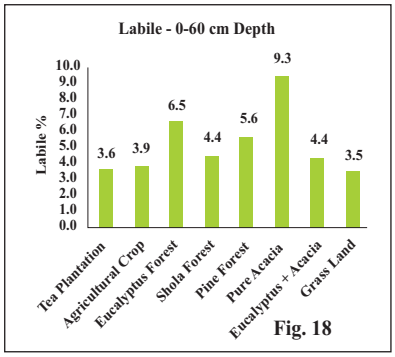


Fig. 18

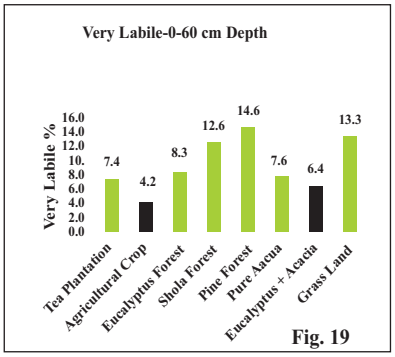


Fig. 19

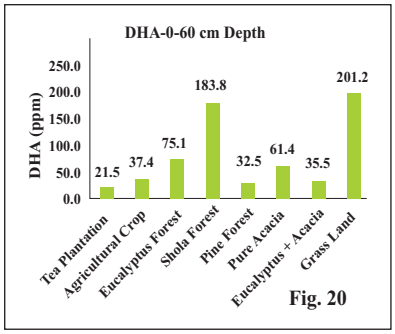


Fig. 20

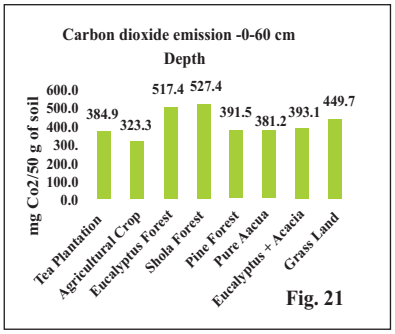


Fig. 21

Eucalyptus forest (517.4) and grassland (449.7) Fig.21. To measure the CO_2 exchange between various land use systems and atmosphere eddy covariance system was installed at our research farm, Udhagamandalam recently (Plate1). Nitrogen is found enormously high in *Shola* forest soils (478.3kg/ha) due to continuous accumulation of leaf litters. Nitrogen are sufficiently available (>240 kg/ha) in all the land uses. Phosphorous is found enormously high (120.7kg/ha) in agricultural soils, possibly because continuous accumulation of remnant P fertilizer in insoluble form under acidic conditions. Phosphorous are sufficiently available (>11 kg/ha) in all the land uses except in *Shola* forest (7.2kg/ha) and pure acacia (7.6 kg/ha). Potassium is found enormously high in agricultural soils (387.6 kg/ha), possibly because continuous accumulation of remnant K fertilizer in insoluble form under acidic conditions. Potassium are sufficiently available (>110 kg/ha) in all the land uses except in eucalyptus + acacia (77.8kg/ha) pure acacia (99.6 kg/ha) and Grass land (74.2 kg/ha). Soil moisture was found to increase with increasing depth, but becomes more or less similar in surface and subsurface layers in the middle of August because of continuous rainfall. Soil moisture was found to increase with increasing depth, but becomes more or less similar in surface and subsurface layers in the middle of August because of continuous rainfall (Fig. 22).

Plate 1 Eddy Covariance

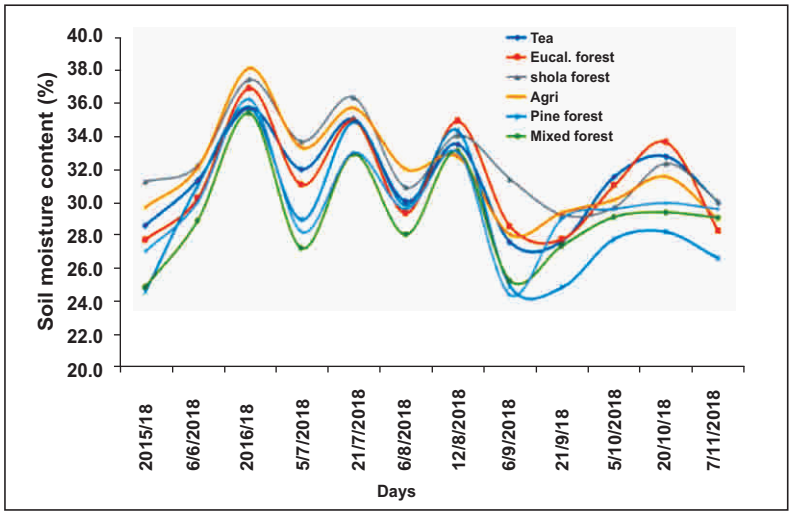


Fig. 22 Soil moisture dynamics

1.3: Soil Carbon Dynamics and Erosion Productivity Studies

Erosion-productivity relationships for evaluating vulnerability and resiliency of soils under different agro-climatic regions of India

Agra (S.K. Dubey, K.K. Sharma and R.K. Dubey)

This modified treatments of improved and farmers practices were imposed in this study in 2016-17 on standard runoff plots (22 x 1.83 m) of 0.5,1.0,2.0 and 3.0 per cent slopes at Research Center, Agra, as a part of core project originally started in 2008. The study aimed to develop the erosion productivity relationship and to quantify the impact of erosion on productivity of pearl millet crop. Total rainfall during crop period during 2018-19 was 660.7 mm in 32 events while runoff causing events that were 10 with 474.1mm which constituted 71.8% of total rainfall during the crop period. Data (Table 7) show that the runoff and soil loss increased with increase in slope which corresponded to 147.6 mm and 1143.9 kg ha^{-1} at 0.5% slope as against the respective values of 196.0 mm and 3406.6 kg ha^{-1} at 3% slope over and above both the practices (improved and farmers) tested in the study. The improved practice (recommended dose of fertilizers

A view of pearl millet crop at different slopes in 2018-19

or RDF) registered considerably lower runoff (139.2 mm) and soil loss (1912.3 kg ha^{-1}) than the farmer's practice/no fertilizer (runoff: 181.3 mm and soil loss: 2571.8 kg ha^{-1}) over and above the various slopes tested in the study. The improved practice registered lower runoff and soil loss over the farmer's practice at all the slopes. The improved practice recorded a minimum runoff of 138.1mm and soil loss of 895.6 kg ha^{-1} at 0.5% slope and a maximum runoff of 185.3 mm and soil loss of 3066.3 kg ha^{-1} at 3% slope. In case of farmers practice the runoff and soil loss was 157.1 mm and 1392.2 kg ha^{-1} at 0.5 % slope and 206.6 mm and 3746.8 kg ha^{-1} at 3% slope. This can be ascribed to higher growth of both roots and shoots under improved practice which in term provided higher ground cover/soil binding.The grain and stover yield of pearl millet (Table 6) showed that improved practice registered higher grain yield (3702.8 kg ha^{-1} at 0.5% slope and 1560.2 kg ha^{-1} at 3% slope) than the farmer's practice (1983 kg ha^{-1} at 0.5% slope and 1433.2 kg ha^{-1} at 3% slope). The stover yield also recorded a trend similar to the grain yield (7092.33 kg ha^{-1} at 0.5% slope and 2774.94 kg ha^{-1} at 3% slope under improved practice as against 3613.69 kg ha^{-1} at 0.5% slope and 2530.53 kg ha^{-1} at 3% slope in farmer's practice). The pearl millet productivity at different segments of runoff plot showed that improved practice registered higher values than the farmer's practice at upper, mid and lower segments over and above the various slopes used to evaluate different practices (543.33, 703.68, 906.26 kg grain ha^{-1} and 3767.51, 4842.83 and 6321.25 kg stover ha^{-1} under improved practice as against 4001.6, 468.31, 498.29 kg grain ha^{-1} and 2752.7, 3156.89 and 3367.67 kg stover ha^{-1} under the farmer's practice at upper, mid and lower segment, respectively). Data show that the productivity of both grain and stover of pearl millet was in order bottoms>mid>upper segment of runoff plots i.e. 906.26, 703.68 and 543.33 kg grain ha^{-1} and 6321.25, 4842.83 and 3767.51 kg stover ha^{-1} under improved practice as against 498.29, 468.31 and 401.60 kg grain ha^{-1} and 3367.67, 3156.89 and 2752.70 kg stover ha^{-1} under farmer's practice at bottom, mid and lower segments of runoff plots, respectively. Data conclude that the improved practice enhanced the peal millet productivity by producing 261.03 kg more grain ha^{-1} and 1979.7 kg higher stover ha^{-1} over the farmer's practice.

Table 6 : Grain and stover yield (kg ha^{-1}) of pearl millet at different slopes and segments of runoff plots during 2018-19.

Slope grade/ Plot portion	Grain yield		Stover yield	
	Farmer's practice	Improved practice	Farmer's practice	Improved practice
0.5% slope				
Upper	586.2	986.8	2904.46	5468.96
Mid	684.8	1320	3871.33	7590.68
Lower	712	1396	4092.46	8270.68
Total	**1983**	**3702.8**	**3613.69**	**7092.33**
1.0% slope				
Upper	632	814.2	3105.80	3942.07
Mid	676.7	1046	3385.53	5189.88
Lower	677.2	1782	3646.59	8151.60
Total	**1985.9**	**3642.2**	**3370.86**	**5761.18**
2.0% slope				
Upper	575.1	461.2	2562.40	2978.69
Mid	624.2	841	2834.07	3793.98
Lower	676.7	1248	3115.08	6015.04
Total	**1876**	**2550.2**	**2830.09**	**4262.57**
3.0% slope				
Upper	343.2	628.3	2438.15	2680.31
Mid	505.7	536.6	2536.62	2796.78
Lower	585	395.3	2616.82	2847.71
Total	**1433.2**	**1560.2**	**2530.53**	**2774.94**
Pearl millet productivity at different segments of runoff plot over and above various slopes				
Upper	401.60	543.33	2752.70	3767.51
Mid	468.31	703.68	3156.89	4842.83
Lower	498.29	906.26	3367.67	6321.25
Total	**1368.20**	**2153.27**	**9277.33**	**14931.59**
Pearl millet productivity under different practices over and above various slopes and segment of runoff plot				
	Grain	**Stover**	-	-
Farmer's practice	454.93	2976.65	-	-
Improved practice	715.96	4956.41	-	-

Table 7 : Soil loss (kg ha^{-1}) and runoff (mm and per cent) in pearl millet crop at different slopes during 2018-19.

Land slope (%)	Practice	Soil loss	Runoff (mm)	Runoff (%)
0.5	Improved practice	895.6	138.1	20.9
	Farmer's practice	1392.2	157.1	23.8
1.0	Improved practice	1584.3	158.0	23.9
	Farmer's practice	2093.1	171.3	25.9
2.0	Improved practice	2103.0	174.4	26.4
	Farmer's practice	3055.2	190.3	28.8
3.0	Improved practice	3066.3	185.3	28.0
	Farmer's practice	3746.8	206.6	31.3
Average of different land slopes				
0.5		1143.9	147.6	22.3
1.0		1838.7	164.7	24.9
2.0		2579.1	182.4	27.6
3.0		3406.6	196.0	29.7
Average of different practices				
Improved practice		1912.3	139.2	21.1
Farmer's practices		2571.8	181.3	27.4

Ballary (H. Biswas and S. L. Patil)

A field study was conducted on twelve standard runoff plots. The major crops i.e. sorghum (var. M35-1) and chickpea (var. A1) were cultivated with application of recommended rate of fertilizer (RRF) with farmyard manure and without fertilizer application in 0.5%, 1.0% and 2.0% slopes runoff plots. Chickpea was cultivated with application of 10 kg N and 25 kg P_2O_5 along with application of 2.0 t FYM ha^{-1} and sorghum was cultivated with application of 30 kg N and 30 kg P_2O_5 along with 5.0 t FYM ha^{-1}. Sorghum and chickpea were sown on 20th October, 2018 after receipt of sufficient conducive rainfall. During 2018, a total of 190 mm runoff-producing rainfall (out of the total annual rainfall of 306.9 mm) was received in eight storms. The runoff varied from 95 to 111 mm and soil loss, from 1.66 to 3.93 t ha^{-1}.

Chandigarh (Sharmistha Pal and V.K.Bhatt)

The aim of core project was to quantify impact of erosion on productivity of soils. Eight runoff plots of standard size (22.13 m x 1.83m) were constructed in 2010 with four slopes of 0.5, 1.0, 2.0 and 4.0 % slopes in duplicate. In first set of four slopes, maize crop was sown without any fertilizer addition. In second set, crop was grown with improved package of practices. Maize was sown on contour across slope and with fertilizer doses of 100:40:20:: N: P_2O_5: K_2O. Maize was sown during *kharif* followed by mustard during *rabi* under rainfed condition. Ramser's samplers were installed in each plot to monitor runoff and soil losses and determine clay and organic carbon in the sediments. During *kharif* (2018-19) season, runoff samples from all the events were collected and combined treatment wise and sediment was separated by decanting of clear water and drying it open. Soil loss showed variation from 1.2 to 5.10 t ha^{-1} having minimum value at 0.5 per cent and maximum with 4.0 per cent slope. The organic carbon content in the sediment ranged between 1.25 and 2.80 per cent. Clay content sediment was 17.2 to 20.5 percent. Maize (*kharif* 2018-19) grain yield ranged from 19.00 to 23.00 q ha^{-1}, under different treatments. Improved management practice of contour sowing with recommended doses of fertilizers caused increase in grain yield.

Datia (Dev Narayan and S.P. Tiwari)

The project was initiated in 2010-11 for quantifying the impact of erosion on crop productivity, and soil (particularly clay) and nutrient (particularly organic matter) losses on red soils of Bundelkhand region with four runoff plots (each measuring 20 m x 10 m) having 0.50, 1.50, 2.50 and 3.50 % slopes. The sorghum was grown using standard package of practices and recommended doses of fertilizers viz., N P K @ 80:60:40 kg ha^{-1}, respectively. In 2015, another set of four runoff plots at same slopes were constructed and sorghum was

taken on these plots without fertilizer. During the year 2018, sorghum was sown on July 12 and harvested on October 24, 2018. The rainfall received during crop period was 826.6 mm, of which 667.5 mm with 18 runoff-producing storms occurred during the cropping period. The data recorded suggested that erosion losses increased with increasing slope gradient. Plot having 0.5% slope produced minimum runoff (24.0 %), soil loss (1.22 t ha^{-1}), loss of organic carbon (3.8 kg ha^{-1}) and clay content (114.7 kg ha^{-1}) under fertilized plots. However, maximum losses in term of runoff, soil loss, organic carbon and clay were of the tune of 41.2%, 4.33 t ha^{-1}, 15.6 kg ha^{-1} and 441.6 kg ha^{-1} respectively on the plot having 3.5% slope under without fertilizer (Table 8 & 9). Grain yield of sorghum followed trend contrarily to runoff, soil, and organic carbon and clay content losses. Sorghum grain yield recorded higher (5.50 q ha^{-1}) at lower (0.50 %) slope than yield (3.80 q ha^{-1}) from plot having higher (3.50 %) slope under fertilized plots (Table 10). The magnitude of yield under unfertilized plots was lower than that of fertilized plots but recorded the similar trend as that of fertilized plots concerning to slope.

Table 8 : Runoff as influenced by different treatments

Slope (%)	Runoff							
	(mm)				(As % of rainfall)			
	2018		Mean		2018		Mean	
	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer
0.50	161	176	68.0	81.5	24.0	26.2	16.9	21.3
1.50	194	205	85.3	98.5	28.9	30.5	21.7	26.5
2.50	217	235	101	119	32.3	35.1	27.0	33.0
3.50	249	277	121	141	37.1	41.2	32.9	39.8

Table 9 : Soil loss and organic carbon as influenced by different treatments

Slope (%)	Soil loss (t ha^{-1})				Organic carbon (kg ha^{-1})			
	2018		Mean		2018		Mean	
	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer
0.50	1.22	1.61	0.59	0.82	3.80	4.80	1.90	2.40
1.50	1.97	2.40	0.94	1.27	6.50	7.70	3.10	4.00
2.50	2.57	3.17	1.24	1.82	9.00	11.1	4.30	6.20
3.50	3.56	4.33	1.87	2.60	12.5	15.6	6.50	9.40

Table 10 : Clay loss and grain yield of sorghum as influenced by different treatments

Slope (%)	Clay content (kg ha^{-1})				Grain yield (q ha^{-1})			
	2018		Mean		2018		Mean	
	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer
0.50	115	146	58.4	78.9	5.50	4.10	8.00	5.60
1.50	193	235	96.8	128	4.60	3.50	6.80	4.30
2.50	260	323	130	187	4.20	3.20	5.40	3.50
3.50	366	442	198	271	3.80	2.80	4.30	2.70

Koraput (P.P. Adhikary and M. Madhu)

To develop relationships between crop yield and soil erosion in Eastern Ghats High Land (EGHL) region of India, the experiment has been carried out at the research farm of ICAR-IISWC, Research Center, Sunabeda, Koraput, Odisha. The test crops are the two prominent crops grown extensively in the region *viz.* finger millet (*Eleusine coracana* L.) and upland paddy (*Oryza sativa* L.). The finger millet variety considered for the study was 'Bhairabi' and the upland paddy variety was 'Khandagiri'.Finger millet and upland paddy was cultivated under 4 slopes (2, 4, 8 and 10%) with 2 crop nutrient managements (0 and 100 % NPK). Therefore, the treatment combinations were: 4 slopes (2, 4, 8 and 10%) X 2 crop nutrient managements (0 and 100 % NPK) X 2 crops (Finger millet and Upland paddy) = 16. Runoff, soil loss, profile soil moisture and crop yield data were taken from each treatment. The design of the experiment was randomized block design (RBD). With an increase in slope from 2 to 10 %, there was an increase in the runoff for both finger millet and upland paddy for both the amendment conditions with few internal exceptions (Table 11). The similar trend was observed for soil loss also. Lowest runoff (10.2 %) and soil loss (9.57 t ha^{-1}) was observed for finger

millet crop grown at 2 % slope under recommended dose of fertilizer. Upland paddy crop which was grown in 10 % slope without fertilizer treatment showed highest runoff (31.4 %) and soil loss (25.51 t ha^{-1}).

Table 11: Runoff and soil loss under finger millet and upland paddy cultivation on different slopes

Slope (%)	Fertilizer management	Runoff (%)		Soil loss (t ha^{-1})	
		Finger millet	Upland paddy	Finger millet	Upland paddy
2	100 NPK	10.2	11.2	9.57	9.87
	0 NPK	11.4	11.8	12.85	9.85
4	100 NPK	17.8	16.9	14.56	14.85
	0 NPK	21.4	17.5	17.85	14.54
8	100 NPK	24.3	25.5	18.11	17.54
	0 NPK	26.3	27.7	20.29	18.84
10	100 NPK	29.1	30.1	24.57	25.65
	0 NPK	31.6	31.4	24.55	25.51

The runoff and subsequent soil loss were more on upland paddy crop than finger millet crop and the use of fertilizer reduced runoff and subsequent soil loss over unfertilized plots for both the crops and all the slope conditions.

The distribution of soil moisture in the soil profile of finger millet and paddy field was analyzed. During sowing of the seeds, the surface (0-15 cm) soil moisture content varied between 22.4 and 24.7 %. During harvest of the crops, the surface soil moisture varied between 16.2 and 17.7 %. With the increase of soil depth the soil moisture content also increases and up to 60 cm depth, there was an accumulation of moisture and below that the moisture content decreases. The shift of profile soil moisture curve to the lower side for the paddy crop during the crop growth period (Fig.23) indicated that paddy removed more soil moisture for its growth and development. Hence, paddy needs more water than finger millet.

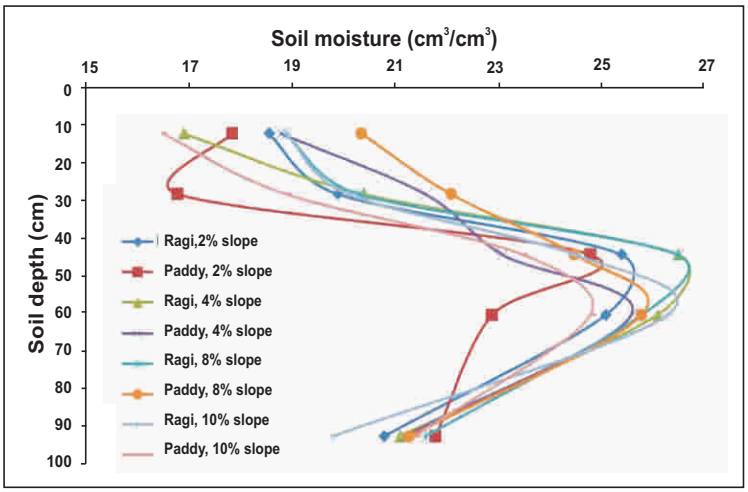


Fig. 23: Profile soil moisture distribution pattern during initial and harvesting stage of ragi and upland paddy crops

Soil moisture content under different slopes of finger millet and upland paddy crops is presented in Fig. 24. Soil moisture content is relatively better at subsoil (15-30 cm) on all the slopes compared to the surface soil (0-15 cm) and this difference is highly prominent at higher slopes. With the increase of field slope from 2 to 10%, surface and sub-surface soil moisture content decreased by 1.6-6.5% and 2.9-4.7%, respectively. Availability of moisture at 15-30 cm soil layer is higher than 0-15 cm soil layer. Finger millet conserves more water than upland paddy within 60 cm soil profile. Surface drying is more pronounced in upland paddy crop.

Highest yield of finger millet (1365 kg ha^{-1}) and upland paddy (1195 kg ha^{-1}) was observed under 2 % slope with 100 % NPK. Lowest yield of finger millet (795 kg ha^{-1}) and upland paddy (798 kg ha^{-1}) was observed under 10 % slope grown with 0 % NPK (Fig. 25). With the increase of field slope from 2 to 10%, finger millet and paddy yield has been decreased by 10.92-13.87 % and 2.78-6.56 %, respectively. In finger millet plots, the grain yield decreased by 33.5 % in the unfertilized plots in comparison to the fertilized plots. The same for upland paddy crops was only 29.4 %. Under both fertilized and unfertilized plots finger millet yield was always more than paddy yield. This was an indicator of high adaptive capacity of finger millet to the degraded condition.

Rain water use efficiency (RWUE) of finger millet and upland paddy crops grown under four different slopes was calculated and presented in Fig. 26. In fertilized plots, Rain Water Use Efficiency of finger millet and upland paddy varied between 2.01-2.74 and 0.68-1.41 kg/ha-mm, respectively. In the unfertilized plots, the RWUE of finger millet and upland paddy varied between 1.54-1.91 and 0.48-1.12 kg/ha-mm, respectively. RWUE of both the crops decreases with increase in slope. Fertilizer application has a positive impact on RWUE. In both fertilized and unfertilized plots, finger millet showed higher RWUE than paddy.

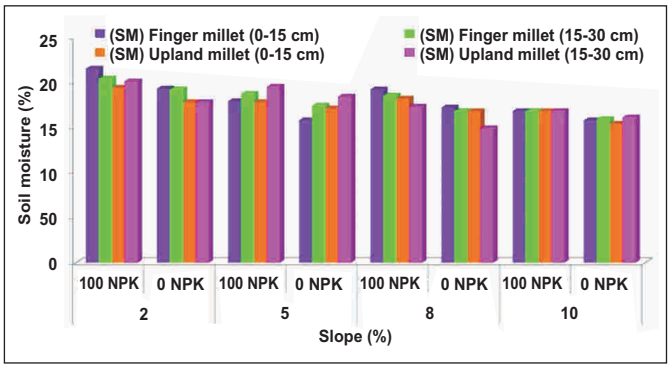


Fig. 24 : Soil moisture distribution pattern in the surface (0-15 cm) and sub-surface (15-30 cm) soils of finger millet and upland paddy crops.

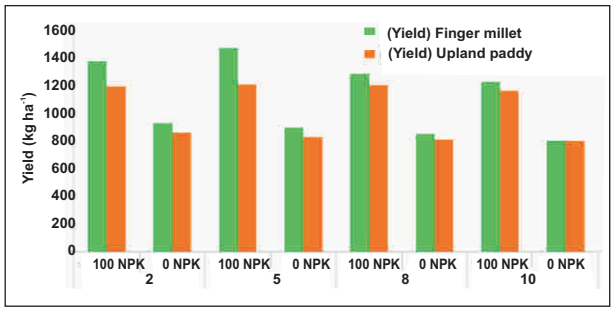


Fig. 25 : Grain Yield under finger millet and upland paddy crops grown on different slopes under different nutrient managements

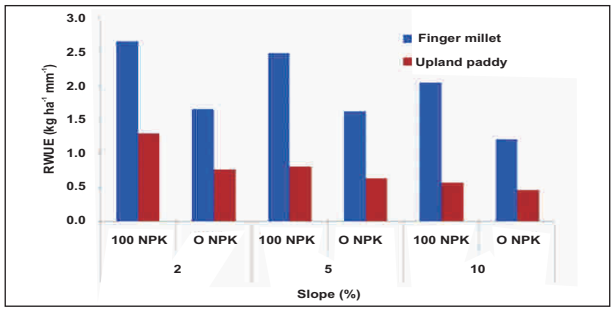


Fig. 26 : Rain water use efficiency of finger millet and paddy grown under various slopes

Kota (R.K. Singh, Kuldeep Kumar and B.L. Mina)

For developing erosion-productivity relationships for medium-deep black soils of South-eastern Rajasthan erosion status and crop productivity levels are being monitored on 12 standard size runoff plots having 0.5, 1.0, 2.0, and 4.0% slopes. These plots were cultivated for rainfed soybean with 0, 100% and 150% recommended doses of fertilizers. During Monsoon 2018 the Kota region received total 798 mm *rainfall which is slightly higher* than the mean rainfall of this region. The 4 per cent land slope recorded highest percent of runoff and soil loss. The mean effect of land slope on soil loss varied from 744 kg/ha in 0.5 % slope to 1825 kg/ha on the highest land slope of 4%. The fertility effect also had positive influence on reduction of soil erosion parameters like runoff and soil loss. Land slope has near about linear relationship with soil loss and the mean effect of land slope had positive influence on yield upto 2% slope

Udhagamandalam (K. Kannan, P. Raja and V.Selvi)

A field experiment was conducted under rainfed condition to assess the impact of erosion on crop productivity for principal crops (potato-cabbage) in the Nilgiris. Runoff plots (18 m length and 2.5 m width) have been constructed at the Research Farm with six different slopes (5, 9, 14, 20, 24 and 28 %) in order to induce different levels of erosion in the study. Three levels of fertilizer application (No fertilizer (NF), 50 and 100 % of the recommended dose of fertilizers) have been followed in each slope category. Recommended dose of nutrients is 120:240:120 kg NPK/ha and 135:135:135 kg NPK/ha respectively for potato and cabbage crop. Data on plant growth, crop yield, and soil moisture and runoff and soil loss have been recorded from each plot.Runoff and soil loss gauging devices have been installed in all three plots of each slope category and monitoring of these parameters carried out. Data recorded on runoff and soil loss is presented in Table 12. It can be observed from this table that there was a clear cut trend for runoff and soil loss with both parameters increasing with increase in slope. Runoff varied from 119mm (8.6 % of rainfall) in 5 per cent slope to 168.1 mm 12.1% of rainfall) in 28 per cent slope, while soil loss varied from 4.9 t/ha under 5 per cent slope to 25.1 t/ha under 28 per cent slope categories (Table 12). The highest average soil loss across slope (12.6 t ha^{-1}) was

observed under no fertilizer treatment. The highest loss of clay (9.4 t ha^{-1}) and organic carbon (185 kg/ha) was recorded under 28% slope (Table 13). Among the fertilizer level, the highest loss of clay (4.1 t ha^{-1}) and organic carbon (99.1 kg/ha) was observed under no fertilizer treatment. The highest potato yield (17 t ha^{-1}) was recorded under 9% slope and the lowest potato yield (11.9 t/ha) was recorded under 28% slope (Table 14). The highest potato yield (19.8t ha^{-1}) was recorded under 100 % RDF.

Table 12 : Runoff and soil loss under different slope and fertilizer levels

Attributes	Runoff (mm)				Runoff %				Soil loss (t ha^{-1})			
Slope (%) / Ferti. rate	No fertilizer	50% RDF	100% RDF	Mean	No fertilizer	50% RDF	100% RDF	Mean	No fertilizer	50% RDF	100% RDF	Mean
5	119.2	103.2	96.1	106.2	8.6	7.4	6.9	7.6	4.9	2.3	4.4	3.9
9	153.1	117.5	113.9	128.2	11.0	8.4	8.2	9.2	5.6	6.5	4.2	5.4
14	135	130.5	129.5	131.7	9.7	9.4	9.3	9.5	14.1	9.7	12.9	12.2
20	136.5	128.2	120.9	128.5	9.8	9.2	8.7	9.2	12.8	11.1	12.8	12.2
24	143.7	148.5	128.5	140.2	10.3	10.7	9.2	10.1	13.0	14.5	10.1	12.5
28	168.1	127.1	126.9	140.7	12.1	9.1	9.1	10.1	25.1	18.0	16.5	19.8
Mean	142.6	125.8	119.3		10.2	9.0	8.6		12.6	10.4	10.1	

Table 13 : Clay and organic carbon loss under different slope and fertilizer levels

Attributes	Clay loss (t ha^{-1})				Organic carbon loss (kg/ha)			
Slope (%)/ Ferti. rate	No fertilizer	50% RDF	100% RDF	Mean	No fertilizer	50% RDF	100% RDF	Mean
5	0.9	0.4	0.7	0.7	18.9	11.8	15.9	15.5
9	1.6	1.7	1.4	1.6	42.8	39.7	38.9	40.4
14	3.3	3.4	2.6	3.1	68.4	82.9	62.4	71.2
20	5.1	4.2	4.0	4.4	136.5	104.3	85.2	108.6
24	4.3	4.9	4.9	4.7	143.7	110.2	135.2	129.7
28	9.4	6.8	4.8	7.0	185.0	138.3	94.5	139.3
Mean	4.1	3.6	3.1		99.2	81.2	72.0	

Table 14 : Potato yield (t/ha) under different slopes and fertilizer levels

Slope (%)	No fertilizer	50% RDF	100% RDF	Mean
5	11.20	18.60	18.99	16.26
9	11.50	19.76	20.22	17.16
14	10.80	18.60	20.20	16.53
20	9.60	16.15	19.73	15.16
24	9.00	13.93	20.75	14.56
28	6.05	10.22	19.10	11.79
Mean	9.69	16.21	19.83	

Soil moisture was monitored at three soil depths (0-15 cm, 15-30 cm and 30-45 cm) on fortnightly basis in eighteen experimental plots. Soil moisture was found to be highest in the plots pertaining to 5% & 9% in all three soil depths closely followed by the moisture in the plots of 24% and 14% slopes.

Assessment of soil organic carbon in transit under erosion processes: A source or sink for Atmospheric CO_2 (M.Sankar, Lekh Chand and D.R.Sena-Dehra Dun)

During the period of 2018-19 all the treatments were adopted in our experiment. Runoff and Sediment sample collected during the Kharif and Rabi season and estimated for soil loss. Highest Soil loss and runoff

estimated in CT field. This time CO_2 release measured from soil with high frequency (every week) during entire crop period and shows highest CO2 release from CT and MT (Fig.27). Also the measurement of soil CO_2 release conducted before tillage and after tillage in all slope position during the *Kharif* (Fig.28a,28b) and *Rabi* (Fig.29a,29b) season continuously up to the CO_2 release get stabilised. Similarly this measurement also conducted before and after sowing and fertilizer application in wheat crop. The CO_2 release accelerated after tillage in all slope position and particularly bottom slope of the field release more. Vertical distribution of SOC at different tillage is presented in Fig. 30. Further soil samples were collected for this scheduled period from all treatments and some soil samples were processed and submitted for SOC and TN analysis at IIRS, DehraDun and remaining soil samples under process. We have measured Maize yield parameters in all the treatments. When compare to all field, this time no till observed lowest yield than others and particularly this year maize yield shows lower than previous year. Conventional and Minimum tilled fields almost similar yield level obtained. From this project we have completed the process to sign the MoU for exchange of Research and Education between ICAR-IISWC and ISRO-IIRS, DehraDun.

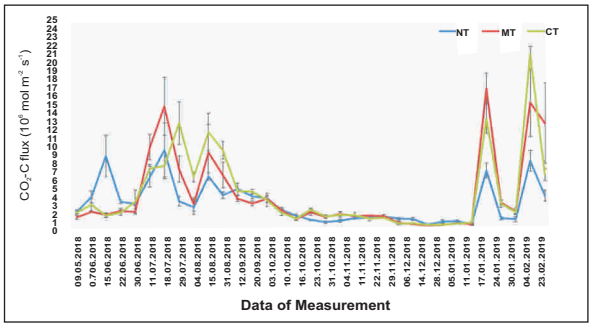


Fig.27. : CO_2 flux under different tillage field (Data average value of all slope positions in each tillage)

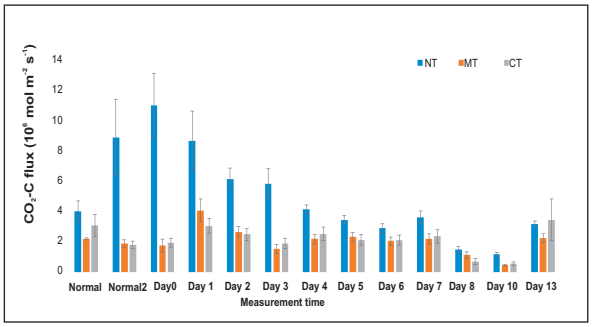


Fig.28 a : Before (Day 0) and after tillage (from Day 1) CO_2-flux -Sowing time (Kharif-2018)

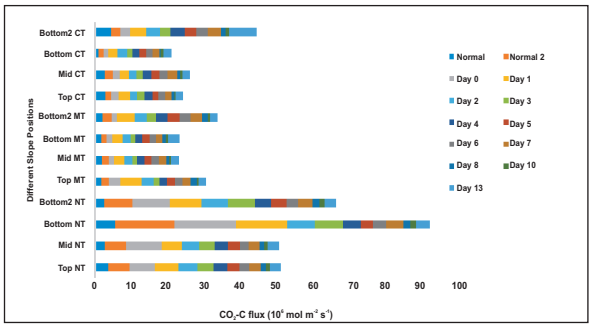


Fig.28b : Before (Day 0) and after tillage (from Day 1) CO_2-flux at different slope positions-Kharif 2018

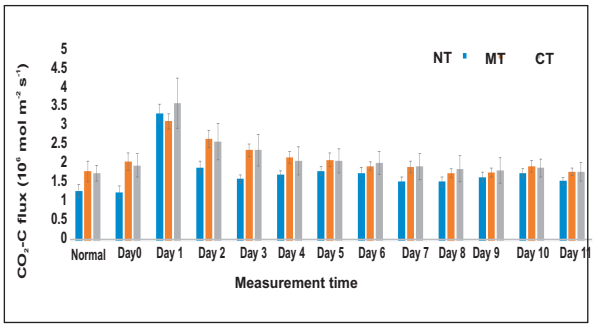


Fig. 29a : Before (Day 0) and after tillage (from Day1) CO_2-flux -Rabi 2018

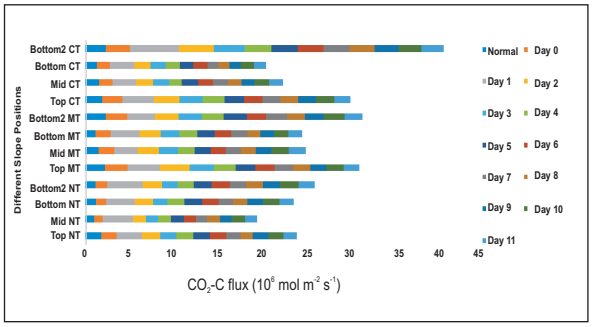


Fig. 29b : Before (Day 0) and after tillage (from Day 1) CO2-flux at different slope positions-Rabi-2018

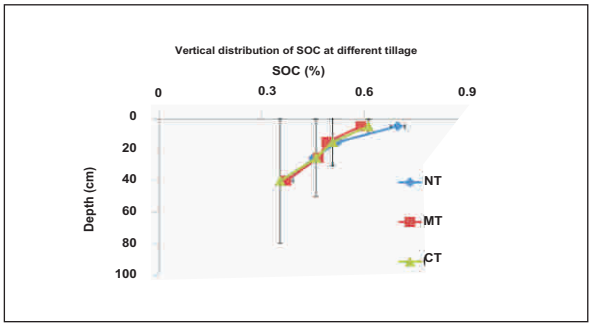


Fig. 30 : Vertical distribution of SOC at different tillage

Assessing the vegetation and SOC recovery potentials of abandoned/fallowed shifting cultivated sites in Central Eastern Ghats (H. Gowda, P. Jakhar and Karma Beer-Koraput)

Shifting cultivation (SC) is considered as the most ancient practice of tribal agriculture practiced for their livelihood. The major problems of shifting cultivation are loss of forest cover and biodiversity, soil

erosion and land degradation, decreased soil depth, drying up of springs, heavy floods, silting of the tanks, fields and damage to crops. Apart from the loss of forest cover this ancient practice also results in land degradation since the lands undergoes high degree of soil erosion due to the lack of protection. Even though shifting cultivation causes deforestation and soil degradation, the fallow period offers the opportunity for their recovery. Fallow duration in the SC cycle has a found influence on recovery rate of vegetation and soil, hence have a direct relationship between them. To develop relationships between fallow duration and recovery / build up rate of vegetation and soil organic carbon (SOC) in shifting cultivated areas in India, the study has been initiated in the Eastern Ghats region of Odisha. The study was aiming to address the recovery potential of different fallow period on vegetation and soil recovery and to develop relationship between the fallow duration and soil recovery. The present study is proposed at 5 locations in Eastern Ghats and two locations in North Eastern States. Eachlocation/ cluster consists of 11 treatments *viz.*Current shifting cultivated site, 5 year, 10 year , 20 year, 30 year, 40 year, 50 year, above 50 year fallow period sites. These sites are compared with three reference land use such as settled agriculture, Natural forest and the existing plantations in each cluster. From the each study sites, vegetation and soil samples are collected and are compared each other.

After deforestation, crop cultivation resulted in the sharp decline of SOC stocks across all the five locations, creating a loss of 57 to 70 % of the original SOC stock. During SC cycle, cultivation for a period of 3-6 years caused a strong decrease in the original SOC stocks. In Lilliguma cluster 6.4 to 14.1 and 3.0 to 6.5 Mg *C* ha^{-1} stock was lost during the first and second year cultivation respectively (Fig.31). Among the different land-use types investigated, SOC stocks were highest in natural forest, lowest in agriculture and intermediate for different fallow periods of shifting cultivated lands (Fig.32). Among the SOC stock of current SC sites, the lowest and highest level of SOC stock is reached at Balliguda (26.42%) and Lilliguma (43.6%) clusters in reference to forest respectively. Whereas the current SC sites in Sunkighat, Jeypore Ghat and Bonda hills cluster, the SOC stocks are 34.4, 28.8 and 33.6 % to the forest reference respectively (Fig.33).The build-up of SOC stocks during fallow period however dependent on the duration of fallow and vegetation recovery. In all the clusters, soil organic carbon (SOC) showed a positive relationship with the fallow duration but the rate of recovery is varied. After the fallow period, the gains in SOC stocks are slow in the initial years. The vegetation establishment on shifting cultivated lands in all five locations caused SOC stock build-up significantly. In the beginning years (up to 40 years) the build-up rate of SOC stock is at marginal level. In all five clusters, the highest SOC stock gain was recorded between 40 to 50 years of fallow duration. The total SOC stock gains over current shifting cultivation under different clusters were different. During 50 year fallow period, SOC stock reaches 79%, 86%, 70% , 72% and 60% of the forest value in Lilliguma, Sunki, Jeypore, Bonda hills and Balliguda respectively .Among all clusters, the highest gain of 26 Mg *C* ha^{-1} was achieved in Jeypore Ghats during the 40-50 year duration. Of the different years fallow period, SOC stocks in the top half meter of soil were highest in over 50 years in Jeypore Ghats (110.4 Mg *C* ha^{-1}) fallowed by 50 years plot (100.2 Mg *C* ha^{-1}).

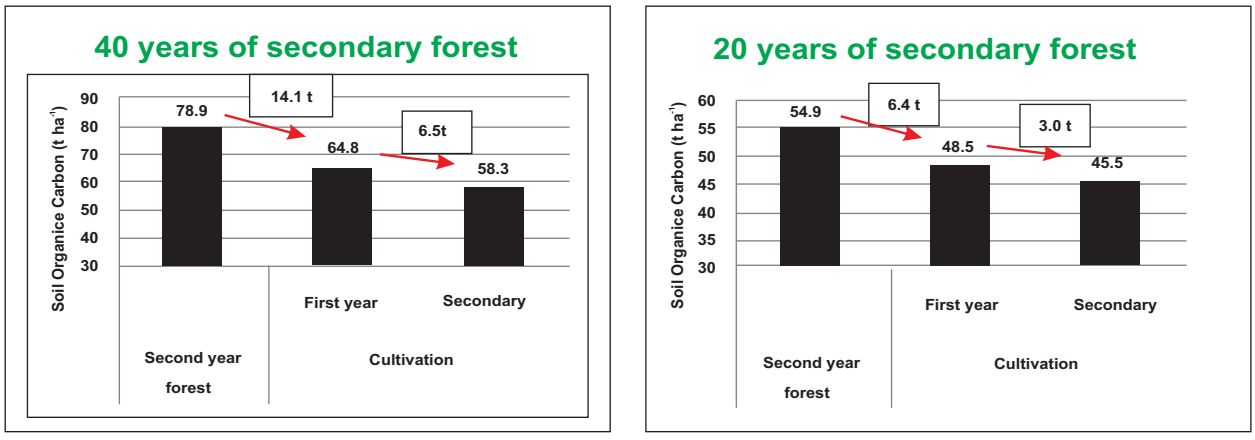


Fig. 31 : SOC Stock change during the first year and second year of shifting cultivation in Lilliguma

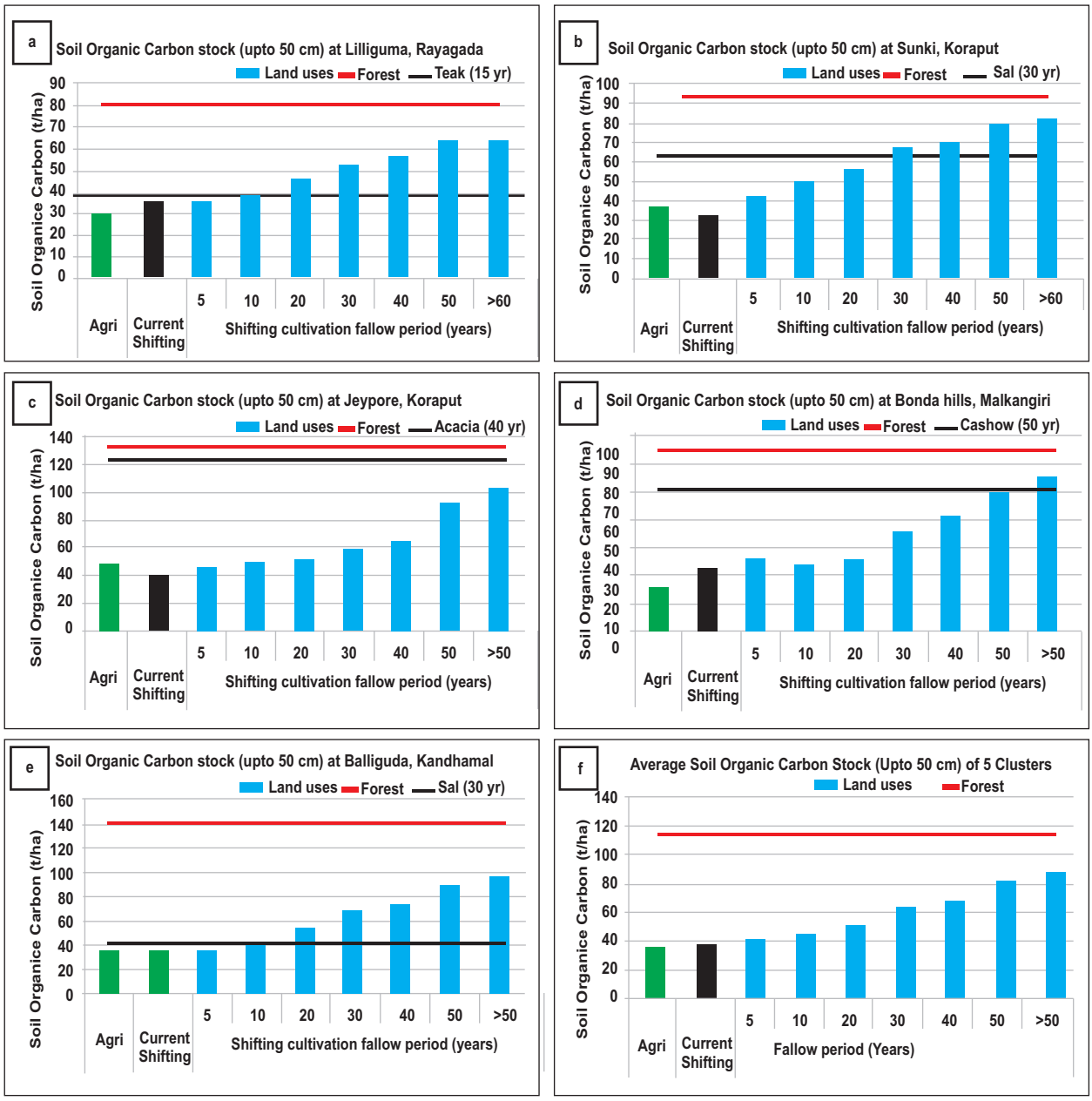
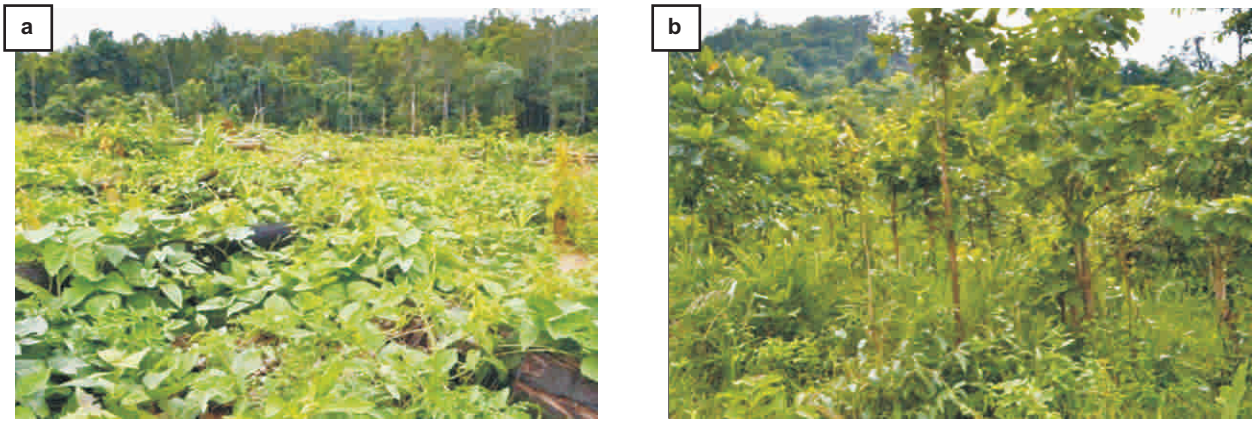


Fig. 32 : Soil Organic Carbon stock (SOC) recovery trend during different fallow periods at a) Lilliguma clusterand b) Sunki ghat, c) Jeypore Ghat, d) Bonda hills, e) Balliguda and f) avg. of all five clusters



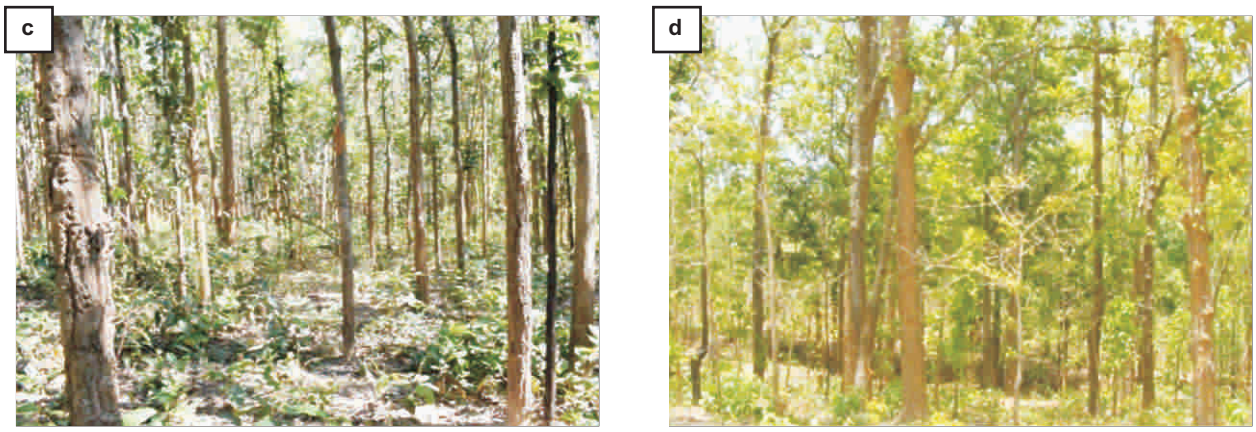


Fig. 33 : a) Current shifting cultivation site, b) vegetation recovery in 3 year old fallowed site, c) sapling growth in 10 year old fallowed site and d) vegetation recovery in 25 year old fallowed site in Lilliguma cluster.

Land use effect on soil carbon stock and soil quality in Mahi ravine ecosystem of Semi-arid tropics (D. Dinesh, Gaurav Singh, Vijaysinha Kakade, R S. Singh, Pravash C. Moharana, B.I. Tailor-Vasad**)**

To prepare the thematic map we have adopted the following flow chart showing LULC mapping model using remote sensing and GIS techniques. Generation of soil and Thematic maps

Preparation of Base map: Mahi ravine shape file from RC, Vasad

↓

IRS-P6 (LISS-4) 2015-16 satellite data 5.8m resolution

↓

LULC mapping done by image classification techniques used as per BISAG, Gandhinagar

↓

Creation of different ravine buffer zone layer (50-500 m) using Arc GIS 10.2

↓

Preparation of Mahi ravine LULC buffer zone

For preparing the thematic maps various land use and land cover characteristics arranged in attribute database are linked to the master ravine land affected layers and reclassified to produce different thematic maps. Thematic mapping is operationalised based on logical evaluation of attributes. The various thematic maps generated during the study include land use/land cover, slope, and landform, soil, contour and drainage network using satellite data and SOI topo sheet as primary layers. The derived data by linking landform map with corresponding attribute data. Similarly, the 50m and 100 buffer zone layer of land use and land cover for Mahi ravine has been prepared using primary layers like physiography, soil and land use/land cover. All the ravine buffer zone layer maps and its attributes data given blow Table 15 through 17 and Fig. 34 through 36.

Table 15 : Mahi Ravine Area extent with different width of buffer zone

Buffer Zone Area	Area (ha)	Area increase (ha)
50 m	28567	-
100 m	34340	5773
200 m	43322	8982
300 m	50656	7334
400 m	56954	6298
500 m	63042	6088

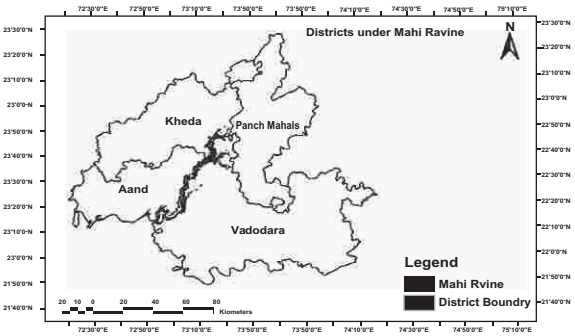


Fig. 34: Districts under Mahi Ravine Area

Table 16 : Land use under 50 m buffer zone layer

Landuse under (50 m buffer)	Area (ha)	Area(%)
Agriculture	14473	50.7
Fallow land	90	0.3
Plantations	8	0.0
Built -up	270	0.9
Forest	141	0.5
Others	6818	23.9
Wastelands	5946	20.8
Water bodies	919	3.2
Wetlands	1	0.0
Grand Total	28567	100.0

Table 17 : Landuse under 100 m buffer zone layer

Landuse under (100 m buffer)	Area (ha)	Area (%)
Agriculture	19067	55.5
Fallow land	98	0.3
Plantations	20	0.1
Built-up	392	1.1
Forest	141	0.4
Others	6941	20.2
Wastelands	6156	17.9
Land with Scrub	2616	7.6
Land without Scrub	156	0.5
Salt-affected Land	36	0.1
Water bodies	1640	4.8
Wetlands	3	0.0
Grand Total	**34340**	**100.0**

In the continuation of NBSSLUP Udaipur centre technical discussion, the ground truth verification (Lat. Log.) points were selected in different land use system in the different Mean Sea Level (MSL) (m). The mean average MSL of the Mahi ravine were 2- 92 m. ALOS PALSAR DEM (Resolution: 12.5 m) for categories the different MSL groups. In the each groups, five GCP were selected randomly with different land uses system wherein, acceptability of GCP also taken care before finalizing points to study. The selected GCP points here marked in Google earth pro. The project team surveyed physically verified the respective GCP (Lat&Log.) with Garmin Montana 680 Touchscreen Mapping Handheld GPS device. During survey work we collected secondary information related to the land use system from local farmer groups as per standard questioner. During week long survey there are 30 GCP points were surveyed and checked the present conditions. The survey results observed that the among the GCP points 24 points were correctly matching with our land use and land cover (LULC) classification map used for project purpose. In the LULC classifications map is concern if the mapping accuracy is >75 percent. Then we can adopt the map for study purpose from our survey it's found that is 83.33 percent area was as per LULC classification map. As per project target, the transect survey was carried out along with NBSSLUP survey team to locate suitable site for soil profile sampling. There were 12 pedon was open at different land use system and 80 surface samples were collected and analysis are under progress.

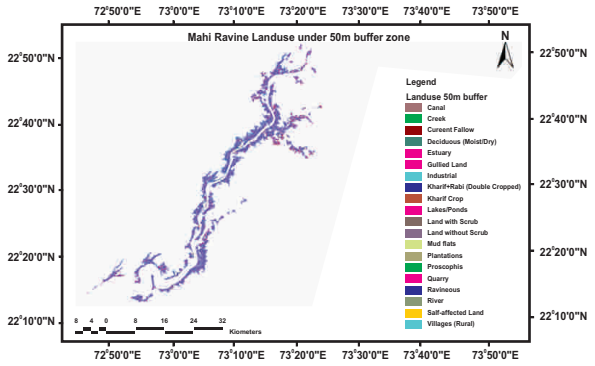


Fig. 35 : Landuse under 50m buffer zone layer

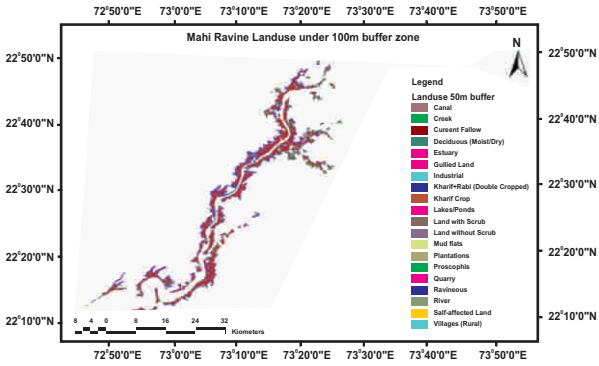


Fig. 36 : Landuse under 100m buffer zone layer

P.2 : CONSERVATION MEASURES FOR SUSTAINABLE PRODUCTION SYSTEM

P-2.1: Resource Conservation Measures for Arable Lands

Development of conservation agriculture practices for rain fed production systems in North-Western Himalayan region (N.K. Sharma, Raman Jeet Singh, Uday Mandal, Trisha Roy and A.K. Gupta-Dehra Dun)

To understand the interaction effects of different tillage practices in main plots (Conventional tillage, reduced tillage and zero tillage) and cropping sequences with crop residue management practices in sub-plots (maize-wheat with crop cutting at 5 cm height; maize+ *in-situ* green manuring of sunnhemp- wheat+ mustard with crop cutting at 15 cm height; and maize +cowpea-pea-wheat with crop cutting at 15 cm height), an experiment was started in June, 2017 on 2% land slope in split plot design (Fig. 1 through 4). Among all the treatments, the lowest runoff and soil loss was recorded in zero tillage maize with *in-situ* green manuring of sunnhemp with 15 cm tall crop residues. The highest maize grain yield was recorded in conventional tilled pure maize and pure wheat crops with 5 cm tall crop residues, while the highest system productivity was recorded in conventional tilled maize +cowpea-pea-wheat with crop cutting at 15 cm height (Table 1).

Table 1 : Runoff, soil loss, and productivity of different crops recorded under different treatments.

Treatments	Runoff (%)	Soil loss (t ha^{-1})	Maize grain yield (kg ha^{-1})	Pea pod yield (kg ha^{-1})	Wheat grain yield (kg ha^{-1})	Wheat Equivalent Yield (kg ha^{-1})
Main plots						
Conv. Till	43.1	20.95	3493 (316)	2362	2136 (40)	6488
Reduce Till	39.7	16.18	3353 (396)	2092	2146 (42)	6245
Zero Till	28.1	9.91	2284 (385)	1350	1135 (34)	3937
Sub-plots						
M-W (5 cm)	47.6	19.75	3530	-	2224	5124
M+ S-W+M (15 cm)	28	8.21	2788	-	2109 {39}	4399
M+ C- P-W (15 cm)	39.6	19.08	2811 (366)	1935	1071	7147

() cowpea pod yield; {} Mustard yield

Fig. 1,2,3,4 : Treatments execution in the experiment

Evaluation of conservation tillage based *Arundo donax* mats for resource conservation and Enhancing cropping intensity on sloping crop lands (Raman Jeet Singh, N.K. Sharma and Gopal Kumar- Dehra Dun)

From 2017-18, an experimental trial being conducted at research farm, selaqui on 4% slope to evaluate the effect of different configurations of *Arundo donax* mats (5 and 10 cm heights and 1.0 and 0.5 m VI) and comparisons were made with bench terraces for runoff and soil loss reduction in maize crop and their moisture conservation effects on post monsoon vegetable pea and wheat crops (Photo 1). Results revealed that by placing 0.5 meter wide and 10 cm tall *Arundo donax* mats in zero-tilled maize crop at 0.5 meter vertical interval; runoff amount was reduced to 10-13% and soil loss was negligible (1.14-1.31 t/ha), compared to

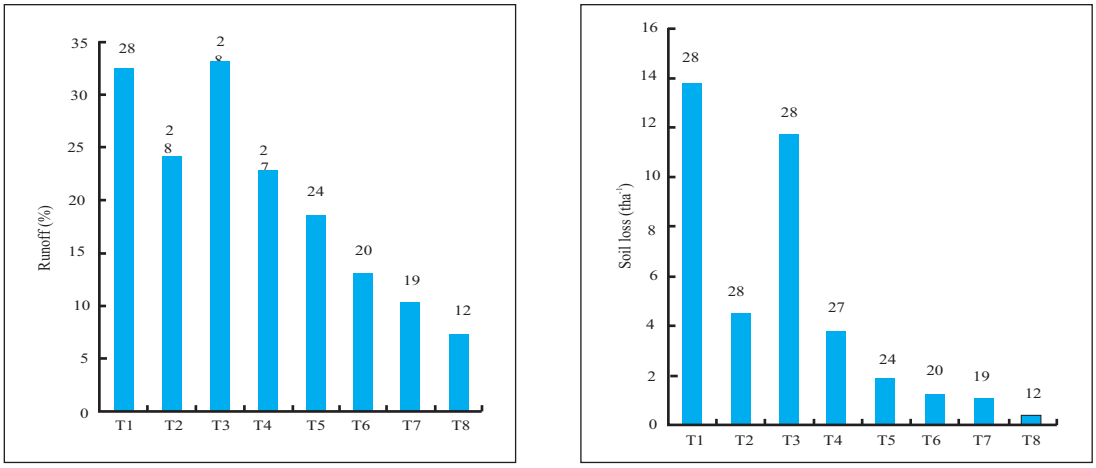


Fig. 5 : Runoff and soil loss recorded in different treatments

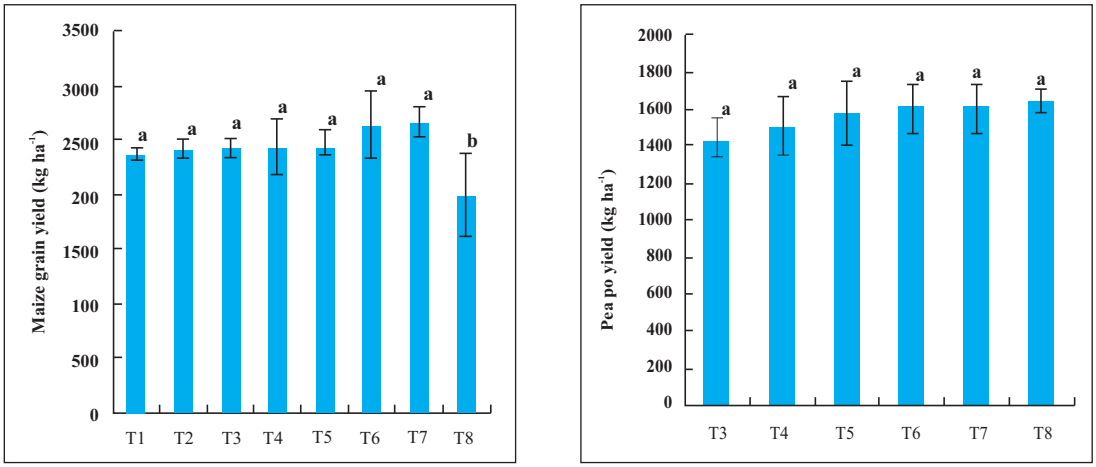


Fig.6 : Maize grain yield and pea pod yield recorded in different treatments

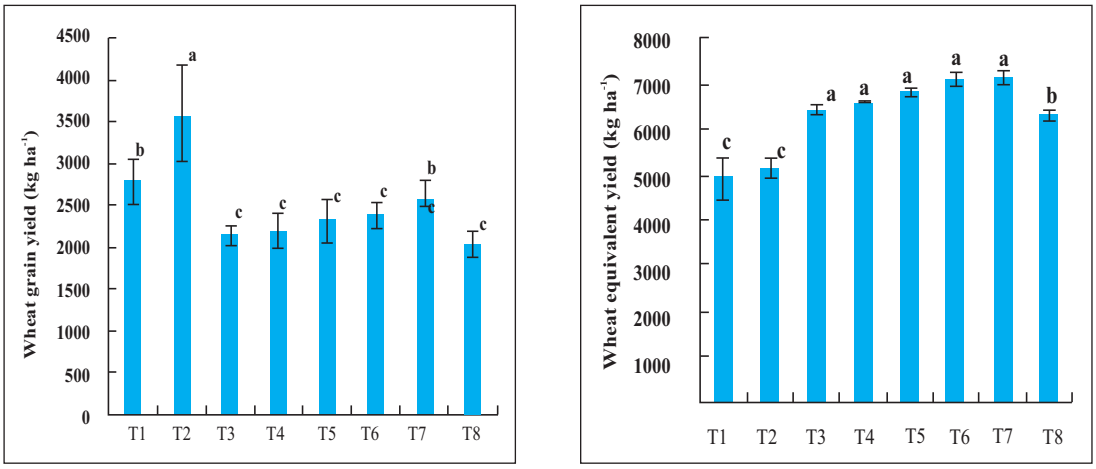


Fig.7 : Wheat grain yield and wheat equivalent yield recorded in different treatments

zero tilled maize crop grown without placing erosion controlling mat (32-33% runoff and 11.6-13.8 t/ha soil loss) (Fig.5). By this conservation technique, most of the rain water was stored into soil profile which was used to raise catch crop of vegetable pea in between rainfed maize-wheat crops without significantly affecting wheat crop yield. Similar maize grain yields and pea pod yields were recorded in all the treatments except maize grain yield in bench terraces (Fig.6). The highest wheat grain yield was recorded in maize (*Arundo donax* mats at 1.0 m VI)- wheat treatment (Fig.7) but the highest wheat equivalent yield was recorded in maize (*Arundo donax* mats at 1.0 or 0.5 m VI)- pea-wheat treatment (Fig.7) which also fetched the highest net return (Table 2).

Table 2 : Economic evaluation of different treatment

Treatment	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
T_1	62,290	1,01,335	39,045	1.63
T_2	68,290	1,18,323	50,033	1.73
T_3	78,290	1,30,775	52,485	1.67
T_4	84,290	1,35,083	50,793	1.60
T_5	86,290	1,40,779	54,489	1.63
T_6	90,290	1,45,242	54,952	1.61
T_7	91,840	1,49,473	57,633	1.63
T_8	81,290	1,29,343	48,053	1.59

Photo 1 : Effectiveness of erosion controlling mats on 4% land slope

Determining resource conservation potential of biodegradable wastes and their on farm utilization to increase crop productivity and profitability (Lekh Chand, N.K.Sharma and U.K. Maurya –Dehra Dun)

Among the 7 treatments under study, the highest yield of wheat (t ha^{-1}) was recorded under the treatment recommended fertilizer dose followed by vermicompost (cowdung) whereas, in maize crop, the highest grain yield was recorded under vermicompost (cowdung) closely followed by the treatment recommended fertilizer dose (Table3).

Treatments recorded noticeable variations in the soil moisture content(%) of the field (Fig.8). The highest moisture content was observed under vermicompost (cowdung) treatment at a depth of 15-30 cm on both times i.e. after harvesting of maize crop and before sowing of wheat.

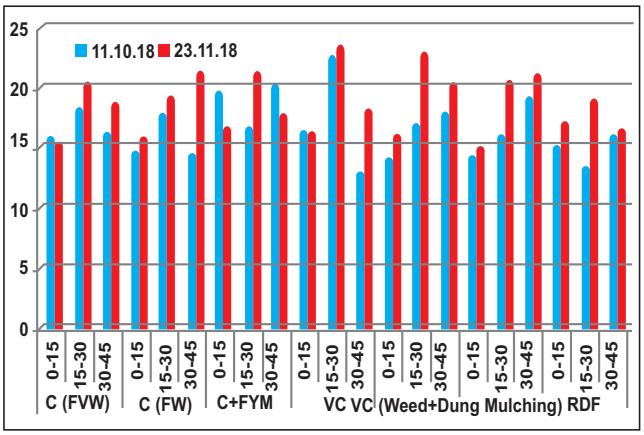


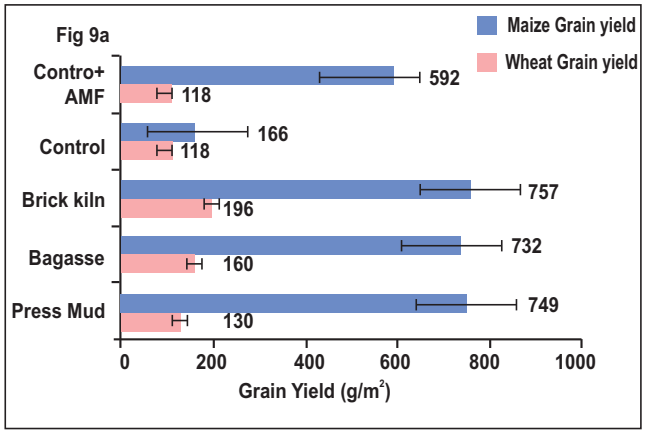
Fig. 8 : Soil moisture content(%) after harvesting of maize crop and before sowing of wheat

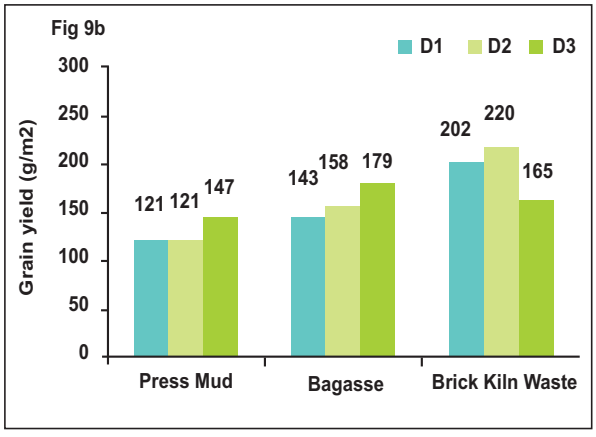
Table 3 : Grain yield (t ha^{-1}) of maize and wheat, as affected by different biodegradable wastes

Treatments	Wheat Grain yield (t ha^{-1})	Maize Gain yield (tha^{-1})
Compost (Fruit & Veg Wastes)	3.254	3.825
Compost (Farm Wastes)	2.933	3.744
Farm waste Compost +FYM	2.985	3.906
Vermicompost (cowdung)	3.392	4.270
Vermicompost (Weed+Dung)	3.262	3.850
Mulching+RFD	3.308	4.020
RFD	3.450	4.210

Utilization of different industrially derived waste along with Arbuscular Mycorrhizal Fungi (AMF) for sustainable soil management (Trisha Roy and Uday Mandal -Dehra Dun)

The project was initiated to study the impact of industrially derived waste and AMF in Wheat-Maize cropping system. The grain yield data for wheat and maize is presented in Fig. 9a. A total of 20 treatments have been laid out in completely randomized design and three amendments *i.e.* press mud, bagasse and brick kiln waste was added @ 5 t ha^{-1} (D1), 10 t ha^{-1} (D2) and 20 t ha^{-1} (D3). For each dose of inoculum two treatments were maintained one with Arbuscular mycorrhizal fungi (AMF) added @ 5 g per plot and the other without inoculum. Plot size is maintained at 1 m x 1 m. For both wheat and maize, soil amendment with brick kiln dust recorded the highest grain yield compared to press mud and bagasse. The initial surface soil reaction was moderately acidic (pH 5.37) and the amendments were chosen with the hypothesis that the Ca and Mg content





would act as a liming material and help in improving soil pH. The Ca and Mg content in the press mud was highest (0.62 % and 0.43 % respectively) followed by brick kiln waste (0.47 % and 0.29 %) and bagasse (0.34 and 0.024 %). Yield increase in wheat was observed with increased dose of bagasse and press mud while there was a decline in yield with increased dose of brick kiln (Fig 9 b). The control plot showed the lowest yield followed by control + AMF in both wheat and maize indicating a positive impact of the amendments on crops.

Effect of varying water regimes on Zn and N dynamics and rice productivity in saline Vertisols. (M. Prabhavathi and H. Biswas-Ballary)

A field experiment was conducted at Research farm of ICAR-IISWC, RC, Ballari to study the effect of water regimes and nutrient combinations (Zn & N) on rice (*var*-TRY 3) productivity in saline Vertisols in the year 2018. The soil of study location was clayey with pH 8.52, EC 5.1 dS m^{-1}, OC 0.42%, available N 562 kg ha^{-1}, available P 61.8 kg ha^{-1}, available K 449 kg ha^{-1} and available Zn 0.77 mg kg^{-1}. Fertilizer treatments consisted of Zn and N each at 3 levels were applied in the form of $ZnSO_4$ and Urea. Three irrigation regimes *viz.,* continuous flooding (M_1- CF), safe Alternate wetting and drying (M_2- AWD) and saturated soil culture (M_3- SSC) were treatments that were imposed from 10 days after transplanting to maturity. The experimental design was a split plot with three replications. Number of tillers and panicles were significantly varied with application of Zn and N, while water management practices did not produce significant differences (Table 4 and Fig. 10). Combined application of Zn and N improved number of tillers (28-56%) and panicles (17-60%) compared to sole application of Zn or N and in control. Grain yield was higher in M_2 (3.10 t ha^{-1}) and straw yield in M_1 (3.36 t ha^{-1}), respectively across moisture regimes. The study led us to conclude that water saving practices can maintain yield as equivalent to traditional practices apart from saving water under water scarce situations prevails in Tungabhadra command area.

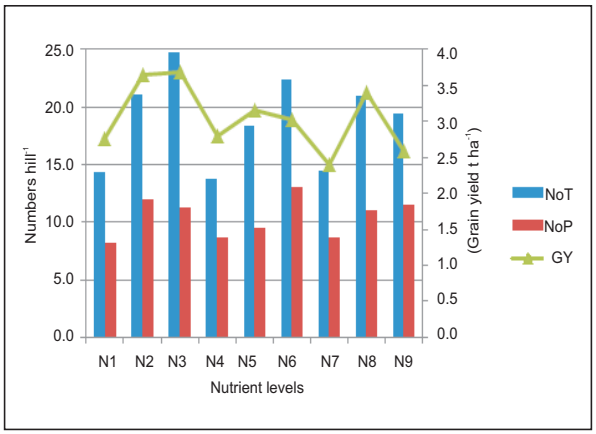


Fig. 10 : Influence of nutrient management on number of tillers and panicles $hill^{-1}$ and grain yield tha^{-1}

Table 4 : Effect of water management practices on yield and components of paddy

Water management practices	Number of panicles $hill^{-1}$	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
M_1	11.0	3.02	3.36
M_2	9.3	3.10	2.85
M_3	11.0	3.04	2.77
SEd	0.75	0.23	0.12
CD (p=0.05)	ns	ns	0.35

Efficient utilization of fruit/vegetable waste for improving soil health and productivity of organic agri-oleri system (Sathiya.K, Ram Prasad, V.K.Bhatt, S.L.Arya and Pawan Sharma-Chandigarh)

The study was initiated in Kharif 2018 to evaluate the efficient utilization of fruit/vegetable waste for improving soil health and productivity of organic agri-oleri system and to study the effect of compost from fruit/vegetable wastes. An experimental trail was taken in Randomized Block Design with four replications. The treatment comprised of

T_1 = Absolute control
T_2 = Recommended NPK
T_3 = Fruit/Vegetable Waste + Fresh soil (5:1)
T_4 = Fruit/Vegetable Waste + Fresh soil (3:1)
T_5 = Fruit/Vegetable Waste + Cow dung (5:1)
T_6 = Fruit / Vegetable Waste+ Cow dung (3:1)

During Kharif 2018 the runoff and soil loss was measured for calibration purpose. In the Rabi 2018 the tomato crop var. Heem sona is planted in the field. The crop is at maturity stage. The fruit and vegetable waste was collected from the market and preparing the compost by using different ratios of fresh soil and cow dung.

Table 5 : Runoff (mm) from six micro plots without any treatment (control) during 2018

Month	Rainfall mm	T1	T2	T3	T4	T5	T6
June	28.6	10.1	12.8	13.4	10.9	12.3	8.5
July	319.8	86.8	77.5	75.5	57.1	79.8	86.4
August	294.8	72.9	67.9	59.5	45.5	67.9	62.0
September	107.6	43.5	39.4	39.8	29.0	36.3	27.7
Total	750.8	213.2	197.5	188.2	142.5	196.3	184.5
	%	28.43	26.34	25.09	19.00	26.18	24.61

Twenty four micro plots of 5.5X4.5 m were constructed at Research farm Mansa Devi in the month of May 2019. Out of 24 micro-plots, six were selected for measurement of runoff and soil loss. During *kharif* season of 2018-19 no crop was sown in these plots. Ramser's samplers were installed at the outlet of these 6 micro plots for monitoring runoff and soil loss (Fig. 11a). Six treatments were imposed in all the micro plots during *rabi* season in randomized way. Runoff was recorded during monsoon season from all the six micro plots. There were total 21 runoff causing storms (from June to Sept.2018) varying from 12.6 to 116.6 mm. Runoff varied from 19 to 28 % in all the control plots (Table 5). This variation may be due to variation in sub soil.The data on plant height, Stem girth and No.of.branches per plant of tomato at vegetative, flowering and maturity stages are given in the table.6, (Fig. 11b). The growth in terms of plant height at all the stages of development showed different ratios of compost. In vegetative stage T5 (FVW+ cow dung (5:1) ratio) resulted highest plant height (40.50 cm). In the flowering and maturity stages the T2 showed a highest plant height. Regarding composting treatments the fruit and vegetable waste + cowdung with different ratios shows better effect on plant growth. The tomato stem girth in the vegetative stage the T6 treatment resulted a highest stem girth and flowering and maturity stages the T2 showed a highest stem girth. Regarding the No.of.branches per plant the T2 treatment showed highest branches compared to the other treatments. The fruit and vegetable waste compost treatments shows a good results equivalent to the inorganic treatment.

Fig. 11 a : Installation of Ramser sampler to measure the runoff and soil loss

Fig. 11 b : Vegetative stage of tomato crop with staking

Table 6 : Effect of FVW compost treatments on growth parameters of tomato

Treatments	Plant height (cm)			Stem girth (cm)			No.of.branches per plant		
	Vegetative	Flowering	Maturity	Vegetative	Flowering	Maturity	Vegetative	Flowering	Maturity
T_1 = Absolute control	38.05	53.9	62.1	0.56	0.82	0.91	3.15	5.00	5.1
T_2 = Recommended NPK	40.10	56.2	67.4	0.57	0.93	0.97	4.00	6.05	5.0
T_3 = Fruit/Vegetable Waste + Fresh soil (5:1)	36.50	49.9	60.3	0.55	0.80	0.95	3.50	5.05	4.6
T_4 = Fruit/Vegetable Waste + Fresh soil (3:1)	40.15	53.6	62.8	0.52	088	0.92	3.40	5.75	4.9
T_5 = Fruit/Vegetable Waste + Cow dung (5:1)	40.50	53.3	62.4	0.63	0.87	0.83	3.50	5.40	4.8
T_6 = Fruit / Vegetable Waste+ Cow dung (3:1)	38.20	50.8	65.3	0.71	0.87	0.82	3.35	5.15	4.9

In-situ moisture conservation practices under aonla based agro-forestry system for sustainable production in red soils of Bundelkhand (Dev Narayan, RS Yadav-Datia)

The study was initiated in 2010 to evolve a suitable *in-situ* rain water harvesting practice for higher growth and yield of Aonla in agri-horti system in red soils of Bundelkhand. Four treatments *i.e.* i) farmer's practice of aonla planting with 0.027 m^3 pit, ii) Pit filled up to 0.75 m with 1 m^3 pit, iii) Crescent shape micro-catchment with 1 m^3 pit and iv) V- Shape micro-catchment with 1 m^3 pit at 2.00 % slope plots (14.0 m x 21.0 m) were laid in RBD with four replications. Six aonla plants (7.00 m x 7.00 m) in each plot were accommodated and black gram- Indian mustard cropping system was followed. The rainfall received during crop period 2018 was 847 mm, of which 688 mm with 19 runoff-producing storms occurred during the cropping period. The results of eight years indicated that the runoff, soil and nutrient losses reduced under different treatments over farmer's practice of aonla planting (Table 7 and 8). During 2018, runoff in terms of per cent of rainfall reduced by 25.0, 3.00 and 31.0 % under pit filled up to 0.75 m, crescent shaped and V-shaped micro-catchment respectively, over farmer's practice of aonla planting with corresponding reduction in soil loss by 22.0, 11.0 and 33.0 %. Further, organic carbon reduced by 32.0, 14.0 and 34.0 %, N reduced by 24.0, 10.0 and 27.0%, P reduced by 23.0, 3.00 and 31.0 % and K reduced by 25.0, 5.00 and 31.0% under pit filled up to 0.75 m, crescent shaped and V-shaped micro-catchment, respectively, over farmer's practice of

Amla based agro forestry system in red soils of Bundelkhand

aonla planting. The fruit yield of aonla and seed yield of inter crops increased under *in-situ* rain water harvesting practice (Table 9). The grain yield of black gram increased by 10.0, 6.00 and 26.0 % under pit filled up to 0.75 m, crescent shaped and V-shaped micro-catchment, respectively, over farmer's practice of aonla planting with corresponding increase in seed yield of Indian mustard by 12.0, 3.00 and 13.0 %. The fruit yield of aonla also increased by 31.0, 18.0 and 37.0 % under pit filled up to 0.75 m, crescent shaped and V-shaped micro-catchment, respectively, over farmer's practice of aonla planting.

Table 7 : Runoff and soil loss as influenced by different treatments during 2018 and mean of 8 years

Treatment	Runoff				Soil loss (t ha^{-1})	
	(mm)		(%)			
	2018	Mean of Eight years	2018	Mean of Eight years	2018	Mean of Eight years
Farmer's practice	246	137	36.6	27.9	6.70	3.16
Pit filled up to 0.75 m	183	114	27.3	23.2	5.23	2.39
Crescent shape	238	114	35.4	22.6	5.96	2.26
V shape	169	94.1	25.1	18.6	4.46	1.66

Table 8 : Nutrient loss as influenced by different treatments during 2018 and mean of 8 years

Treatment	Nutrient loss (kg ha^{-1})							
	Organic carbon		N		P		K	
	2018	Mean of Eight years	2018	Mean of Eight years	2018	Mean of Eight years	2018	Mean of Eight years
Farmer's practice	28.8	13.7	7.10	4.40	3.90	2.10	12.6	6.60
Pit filled up to 0.75 m	19.5	10.0	5.40	3.70	3.00	1.80	9.40	5.50
Crescent shape	24.9	9.70	6.40	3.40	3.80	1.80	12.0	5.30
V shape	19.1	7.20	5.20	3.10	207	1.40	8.30	4.30

Table 9 : Seed yield of inter crops and fruit yield of aonla as influenced by different treatments

Treatment	Yield of inter crops (kg ha^{-1})				Fruit yield of aonla (t ha^{-1})	
	Black gram		Indian mustard			
	2018	Mean of Eight years	2017-18	Mean of Eight years	2018	Mean of Eight years
Farmer's practice	395	281	323	862	9.82	5.23
Pit filled up to 0.75 m	434	331	361	1028	12.9	6.46
Crescent shape	418	356	332	992	11.6	5.93
V shape	497	406	366	1199	13.5	7.54

Restoration of shifting cultivated lands for resource conservation and sustainable production in Western Ghats (D.C. Sahoo, P.P.Adhikary, P.Jakhar and Karma Beer-Koraput)

The study on restoration of shifting cultivated land for resource conservation and sustainable production in Eastern *Ghats* was carried out at the research farm for two scenarios *viz*., currently under shifting cultivation and shifting cultivated area currently under fallow for restoration. Under shifting cultivation, four different treatment measures taken are Earthen bunding + boundary plantation of *Gliricidia sepium* (T_1), Earthen bunding with vegetative barrier of sambuta + boundary plantation of *Gliricidia sepium* (T_2), Earthen bunding + Pigeon pea + boundary plantation of *Gliricidia sepium* (T_3), and Earthen bunding + mango + boundary plantation of *Gliricidia sepium* (T_4). The shifting cultivated area currently kept under fallow for restoration are treated with all those measures other than T_3 and with a cover crop of *Mucuna bracteata*.

Better grain yield found among the treatments (12.83-15.22 q ha^{-1}) and significantly (CD (0.05) = 1.63) higher than control (8.3 q ha^{-1}) (Table 10). However, maximum grain yield is found in T_1 (Earthen bunding + BP of *Gliricidia sepium)* (15.22 q ha^{-1}) *followed by* T_2 (Earthen bunding with vegetative barrier of *sambuta* + BP of *Gliricidia sepium)* (14.09 q ha^{-1}) and T_3 (Earthen bunding + Pigeon pea + BP of *Gliricidia sepium)* (13.7 q ha^{-1}) and found statistically non-significant among these treatments. *The lowest yield among the treatments was found in* T_4 *(*Earthen bunding + Mango + BP of *Gliricidia sepium) (12.83* q ha^{-1}*) and significantly different*

from maximum yield in T_1 where as it is non-significant with other treatments. Similar trend also found in biomass yield with significantly (CD (0.05) = 4.5) higher yield in all treatments than control. Statistically non-significant with maximum biomass yield is found in T_1 (Earthen bunding + BP of *Gliricidia sepium)* (41.27 q ha^{-1}) *followed by* T_2 (Earthen bunding + Sambuta + BP of *Gliricidia sepium)* (38.10 q ha^{-1}). However, the yield from T_3 (Earthen bunding + Pigeon pea + BP of *Gliricidia sepium)* and T_4 (Earthen bunding + Mango + BP of *Gliricidia sepium*) were statistically different from the maximum yield in T_1 whereas the yield from T_2,T_3,T_4 are statistically non significant. No interpretation on the grain and biomass yield could be drawn about the trend, being the early stage of experiment.

Table 10 : Yield and bio-mass yield under different treatments

Treatments	**Grain Yield** (q ha^{-1})	**Biomass Yield** (q ha^{-1})
T1: Earthen bunding + *BP of *Gliricidia sepium.*	15.22	41.27
T2: Earthen bunding + Sambuta + BP of *Gliricidia sepium.*	14.09	38.10
T3:Earthen bunding + Pigeon pea + BP of *Gliricidia sepium*.	13.70	36.32
T4: Earthen bunding + Mango + BP of *Gliricidia sepium*.	12.83	36.04
Control	8.3	21.49
CD (5%)	1.63	4.5

*BP: Boundary plantation

A total amount of 1366.8mm runoff producing rainfall received from 29 events during the crop period causing soil erosion from the all the treatments. Minimum runoff of 12.6% was observed in Earthen bunding with vegetative barrier of sambuta + BP of *Gliricidia sepium* (T_2) followed by Earthen bunding with BP of *Gliricidia sepium* (T_1) (16.5 %) and highest runoff of 23.1 % from control plot (Fig.12) under the shifting cultivated plots. Other than T_2 (Earthen bunding with vegetative barrier of sambuta + BP of *Gliricidia sepium*), there is close value of runoff among the treatments (T_1,T_3,T_4) (16.5-17.5%) may be due to the direct effect of bunding than any combination of vegetative measures. The wider difference between control and treated plots shows the positive impact of conservation measures in reducing runoff. Soil loss follows similar trend to runoff with minimum (8.96 t ha^{-1}) from the plot under *ragi* with vegetative barrier of sambuta and *Gliricidia sepium* on earthen bund. However, the soil loss from all the treated plots is only in the range of 11.4-12.18 t ha^{-1}. Maximum soil loss of 18.35 t ha^{-1} obtained from control (Fig.13).

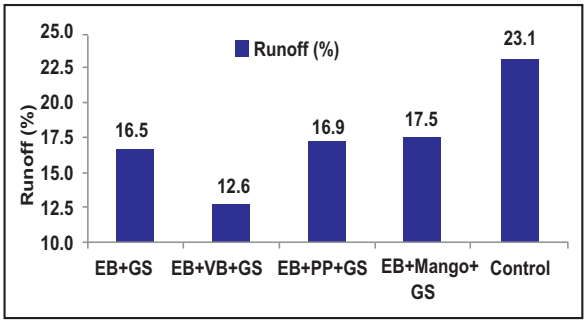


Fig. 12 : Runoff from different treatments

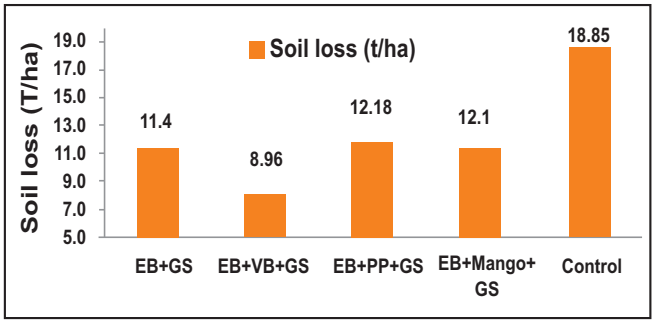


Fig. 13 : Soil loss from different treatments

In the shifting cultivated area currently kept under fallow for restoration, similar trend in runoff was observed as found in currently shifting cultivated plots may be due to the treatment effects and varies from minimum of 15.7% (T_2: Earthen bunding with vegetative barrier of sambuta + BP of *Gliricidia sepium)* to maximum of 24.9 % in control(Fig..14a). The runoff in all treatments were more than the respective treatments in previous year in both fallow as well as cultivated plots due to more no. of intense rainfall events and total runoff producing rainfall. The plots treated in combination of earthen bunding with *Gliricidia sepium and Gliricidia sepium* + mango produced intermediate runoff (18.3-20.3 %) between control and (T_2: Earthen bunding with vegetative barrier of *Sambuta* + BP of *Gliricidia sepium).* The variation in soil loss among treatments is also minimal (7.2-8.5 t ha^{-1}) and considerable less in comparison to the cultivated plots may due to the stable and compact surface covered with *Muccana Bracteta* over years resulting from no soil

disturbance. The soil loss followed a similar trend to runoff with minimum (7.2 t ha^{-1}) in vegetative barrier of sambuta and *Gliricidia sepium* on earthen bund and maximum from control (13.8 t ha^{-1}) (Fig. 14b).

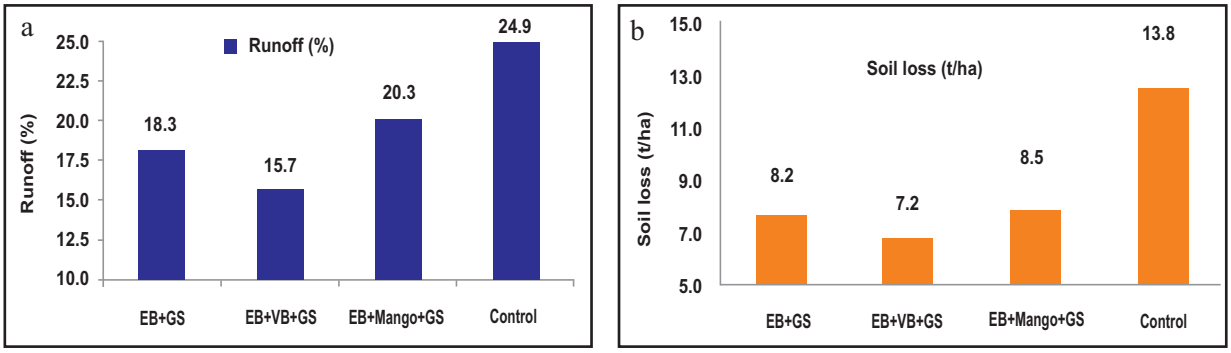


Fig. 14 a & b : Runoff and Soil loss from different treatments under fallow

Treatment measures under establishment

Jhola Kundi based vegetable farming with soil moisture conservation practices for increasing profitability of tribal farmers of Eastern Ghats High Land Region (Karma Beer, Ch. J.P. Dash and P. Jakhar-Koraput**)**

A study was initiated during 2017 with the objective of assessing the water availability in *Jhola* kundi during the post monsoon season for cultivation of vegetables with soil moisture conservation practices in tribal belt of Odisha. *Jhola* kundis at different location along the *Jhola* systems were selected and recuperation test of *Jhola* kundis have been conducted on monthly basis. From the recuperation study carried out in *Jhola* kundi with diameter of 4.5 m located at the research farm, it was observed that recuperation rate of research farm *Jhola kundi* was 1.2 m^3/day (Fig.15). The recuperation rate of another *Jhola* kundi which is present in the village Rajbidai having 2.1 m diameter and about 70 m away from *Jhola*, was observed to be 0.68 m^3/day. (Fig.16). In another recuperation test conducted at Sakiriput *Jhola* kundi having 5.0 diameter

and 5.0 m away from the *Jhola*, the recuperation rate was recorded as 1.31 m^3/day (Fig 17). Khillo *Jhola* kundi (diamerer 4.0 m, which is about 55 meter away from the *Jhola*) recuperation rate was found to be 0.93 m^3/day (Fig.18).

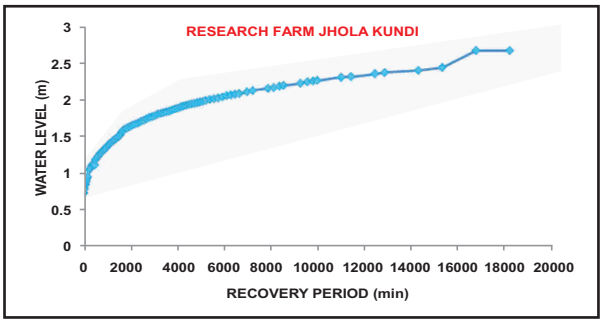


Fig. 15 : Recovery period of research farm *Jhola* kundi

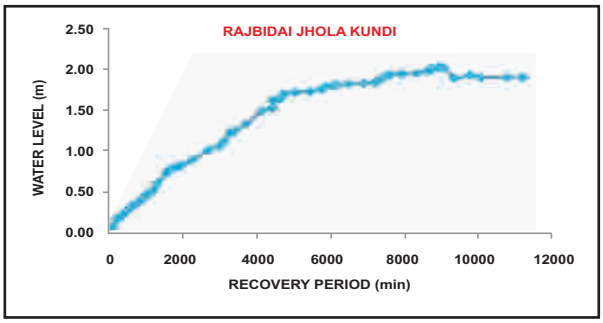


Fig. 16 : Recovery period of Rajbidai *Jhola* kundi

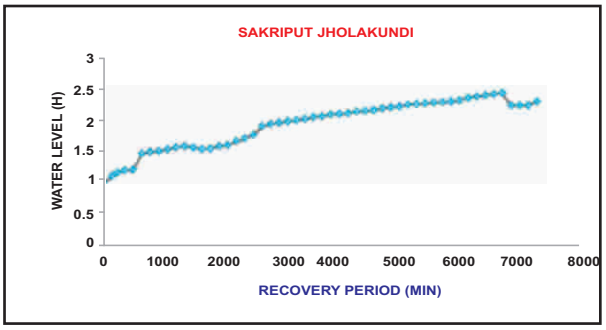


Fig. 17 : Recovery period of Sakriput *Jhola* kundi

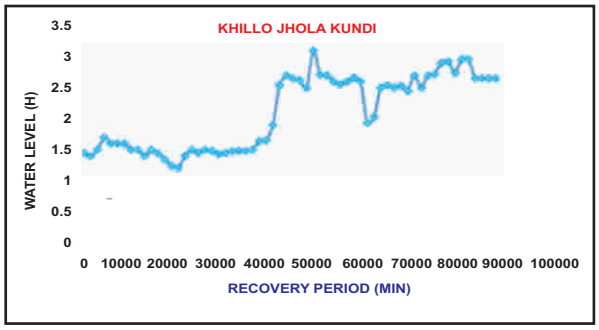


Fig. 18 : Recovery period of Khillo *Jhola* kundi

Evaluation of catchment-storage-command area relationship for improving rainwater productivity under integrated production systems ((P. Jakhar, D.C. Sahoo, P.P. Adhikary and Karma Beer -Koraput)

The present study was initiated this year to study the catchment command storage area relationship along with hydrological behaviour of an integrated production system. Treatment includes different production systems along the topo-sequence suiting the needs of the small farming community to minimize the risk and maximize rainwater utilization. The achievements of the project for first year (2018-19) includes formation of terraces and construction of dug out pond(20m X 15mX 2.5 m) for 1 ha catchment (Fig. 19, 20, 21). Using following background data(Table 11). Initiation of treatment execution on different terraces started with banana plantation. Evaluation of banana three different varieties indicates the maximum growth in terms of height, no. of leaves and leaf area for *Chakkerakeli* followed by *Plantain* (vegetable) variety. However tissue culture based *Grand nannie* was poor performer and recorded significant lower plant height as well as leaves (Table 12).

Table 11: Seasonal and annual variability of rainfall and rainy day at research centre

Parameter	Measure	Kharif	Rabi	Summer	Annual
Rainfall	Mean(mm)	1242.81	162.6	140.88	1540.12
	SD	277.16	127.43	81.38	323.11
	CV(%)	22.3	78.37	57.77	20.89
Rainy day	Mean(No)	59.04	8.92	9.38	77.33
	SD	9.13	4.81	3.87	11.36
	CV (%)	15.46	53.97	41.23	14.69

Probability Level (%)	Rainfall (mm)	Catchment (%)	Storage (%)	Command area (%)
80	1000	100	7.5	30.0
70	1135	100	8.5	35.0
60	1218	100	9.0	37.5
50	1267	100	9.5	40.0

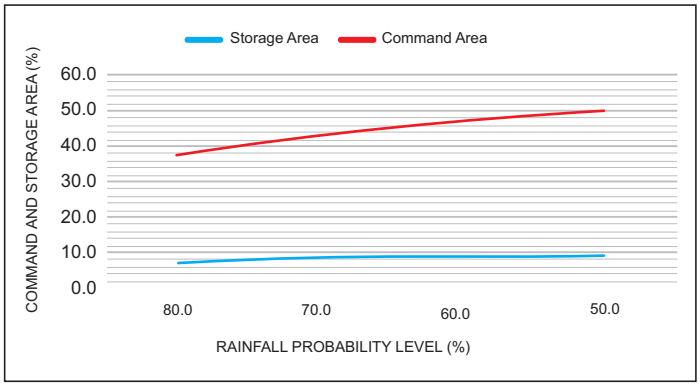


Fig. 19 : Relationship between Rainfall, storage and command area for unit catchment area

Table 12 : Growth parameters of different banana varieties

S. No	Varieties	Leaves (nos.)			Height (cm)			Leaf area (cm^2)		
		MAP-Months after planting								
		3	6	9	3	6	9	3	6	9
1.	Chakkerakeli (Fruit)	6.3	8.6	7.8	52.8	65.7	91.6	260	583	805
2.	Plantain (Vegetable)	4.6	5.2	4.5	25.2	48.6	69.1	210	486	644
3.	Grand Naine (Tissueculture)	3.7	4.8	5.3	12.3	16.8	19.3	86	210	204

Fig. 20 : View of various activities accomplished in the project and banana crop with mulch

Fig. 21 : Farm pond digging, rainwater harvesting and avoidance of evaporation losses using 25% shade net

Conservation tillage systems for enhancing productivity and resource-use efficiency in rainfed area of South-eastern Rajasthan(Kuldeep Kumar, B L Mina, Shakir Ali and Ashok Kumar-Kota)

A project has been initiated from 2015 at ICAR-IISWC, Research Centre, Kota to explore the feasibility of double cropping under rainfed ecosystem through resource-conserving practices. Soybean and mustard was grown as experimental crops during *Kharif* and *Rabi* season, respectively. The experiment was laid down in randomized block design with 10 treatments consisting of a combination of tillage, land configuration and

residue management of previous crop. Residue of previous crops i.e. residue of soybean @1.5 t/ha in mustard crop and residue of mustard @ 3.0 t/ha in soybean crop was retained**.** During monsoon 2018, Kota region received total 798 mm rainfall which is higher than average seasonal rainfall of this region. Permanent broad bed and furrow (BBF) with residue retention recorded minimum runoff and soil loss while maximum values of these parameters were recorded in reduced tillage without residue retention. Mean effect of residue retention was found to be beneficial in reduction of runoff and soil loss in the range of 10-15% as compared to no residue retention. During *Kharif* 2018, maximum soybean yield was recorded with broad bed and furrow with residue retention of previous crop while zero tillage with no residue retention recorded lowest soybean yield. Mustard crop also responded similarly to tillage and crop establishment treatments and residue retention *Rabi* season 2017-18. Effect of residue retention was more pronounced in Rabi season as compared to *Kharif.*

Resource conservation and productivity enhancement through organic and inorganic amendments in soybean-mustard cropping system (I.Rashmi, B.L.Mina, Kuldeep K, Shakir Ali, Ashok Kumar-Kota)

A field experiment was carried out in 2018-19 at research farm, Kota to study the effect of organic and inorganic amendments in soybean mustard cropping system on resource conservation and crop productivity in soybean mustard cropping system with eight treatments as follows T1: Control; T2: Recommended Dose of Fertilizer (RDF) (Soybean-Mustard); T3: RDF + Gypsum; T4: RDF + FYM (10t/ha); T5: RDF + Mulches (previous crop residues will be used as per requirement); T6: RDF+ Gypsum + Mulch; T7: RDF+ Gypsum + FYM; T8: RDF + Gypsum + Mulches + FYM. Among the different treatments soybean grain yield ranged from 698 to 1247.6 kg/ha and straw yield ranged from 950 to 2003 kg/ha. Maximum grain yield (kg/ha) was observed in T8 followed by T6, T7 and T4 treatment. Lowest grain yield was recorded in control plots without application of amendments and fertilizers. Rainfall received during crop period was 798 mm and produced 24 runoff storm events. Average runoff varied from 6.1 to 10.3% of rainfall and high soil loss was recorded in control plot (3.9t/ha) and lowest was recorded in T6 treatment (1.7t/ha). Low nutrient loss was observed in T6 and T8 treatments compared to control. Among the various treatments, T6 > T8 > T7 showed least runoff and soil loss. Application of gypsum, mulch in conjunction with FYM reduced runoff and soil loss in all the treatments and improved crop yield.

Cover crops and reduced tillage for enhancing productivity and soil health in rainfed farming system in the hilly area (K. Kannan, V. Kasthuri Thilagam, P. Raja and O.P.S. Khola-Udhagamandalm)

A study was initiated during 2014 with objective of assessing the productivity of potato – carrot cropping sequence and soil health under reduced tillage and cover crop system with respect to climate resilience farming. The treatments included: conventional (CT) and reduced tillage (RT) in main plot and winter cover crops: No cover crops, Oats, Lupin, Buck wheat and Mustard as sub plot. During 2018-19, potato in rainy season (March to July) and carrot in winter season August to November) was taken up with conventional and reduced tillage. Cover crops viz, fodder oats, lupin, buckwheat and mustard were sown in November after the harvest of carrot with conventional and reduced tillage treatments and residues were incorporated during flowering. Tillage effect was not significant for both potato and carrot. However, after fourth year of experimentation, yields of potato (17.6 t/ha^{-1}) and carrot (21.6 t/ha^{-1}) under reduced tillage were higher (Table 13). Yields of potato (19.2 t/ha^{-1}) and carrot (22.2 t/ha^{-1}) were higher under fodder oats and mustard cover crops.

Table 13: Potato and carrot yield under tillage and cover crop treatments

Treatments	Potato yield (tha^{-1})			Carrot yield (tha^{-1})		
	CT	RT	Mean	CT	RT	Mean
No cover crop	15.9	15.2	15.6	18.7	18.2	18.5
Fodder oats	17.6	19.2	18.4	21.3	23.0	22.2
Lupin	16.8	17.6	17.2	20.4	22.2	21.3
Buckwheat	16.8	18.0	17.4	21.5	22.0	21.8
Mustard	17.5	18.2	17.9	21.5	22.8	22.2
Main plot Mean	16.9	17.6		20.7	21.6	

Table 14: Yield and nutrient addition by cover crops

Cover crops	Yield (tha^{-1})		Nutrient addition (kg/ha)					
	CT	RT	CT			RT		
			N	P	K	N	P	K
Buck wheat	2.6	2.9	41.6	13.3	8.6	46.4	14.8	9.6
Lupin	1.9	1.8	31.2	10.3	12.2	29.5	9.7	11.5
Mustard	3.6	4.0	54.0	14.0	23.0	60.0	15.6	25.6
Oats	3.9	4.3	62.4	14.0	21.1	68.8	15.5	23.2

The days to 50% flowering of different cover crops were 50, 60, 70 and 100 days for buckwheat, mustard, fodder oats and lupin. At 50 % flowering, cover crops were cut to the ground level and kept as mulch. The highest biomass at (2.9 t ha^{-1}) quickest time (50 days) was achieved with buckwheat and the highest biomass at flowering was recorded in oats(4.3 t ha^{-1}), followed by mustard (4.0t ha^{-1}). The highest N (68.8 kg), P (15.5 kg) addition per hectare due to cover crops incorporation was observed in fodder oats & K (25.6 kg) in mustard under reduced tillage (Table 14). Higher soil moisture was observed under reduced tillage and cover crops compared to the conventional tillage and without cover crop. The highest cover crop residue cover at the time of planting potato were found in mustard followed by fodder oats.

P-2.2: Resource Conservation Measure for Non-Arable Lands

Improvisation of Soil Working Techniques for Enhancing Tree Establishment under Rainfed Conditions of North-Western Himalayas (D.V. Singh, J. Jayaprakash, D.M. Kadam and Vibha Singhal-Dehra Dun)

In India, large scale tree planting is taken up in different areas by various government departments and non-governmental organizations. But the survival rate of these tree saplings is very low due to the major problem of water scarcity during lean period. Therefore, the current study has been taken up to develop effective soil working technique which can counter water scarcity problem and enhance tree establishment under rainfed conditions of North-Western Himalayas. In Dhanpau-Lakhwar area, two field experiments on forestry had conducted, one each on southern and northern aspects. These sites were selected in consultation with Eco-Task Force and *Van Panchayat Samiti*. For forestry species, *Ritha* was planted on northern aspect with seven treatments while *Bahera* on southern aspect with eight treatments. During current year, experiment on agri-horticulture has been laid at Selakui Farm (Dhoolkot area) where mango has been planted with seven treatments. These field experiments have been laid in Randomized Block Design (R.B.D.) with three replications in forestry and four replications in horticultural experiment. Details of the treatments imposed under different field experiments are presented in Table 15.

Table 15. Details of the treatments imposed under different field experiments

Treatment	Treatment imposed in different field experiments		
	Ritha on Northern aspect in Lakhwar in 2016	*Bahera* planting on Southern aspect in Dhanpau in 2016	Mango planting on flat land in Dhoolkot, Selakui Farm in 2018
T1	Recommended practice		Recommended Practice
T2	Application of hydrogel in pit soil @ 5 g per plant		Application of hydrogel @20g/plant
T3	Modified Trenching (2.4x0.45x0.30 m) with planting in the centre of trench		Modified sub-surface planting through pipe /waste plastic bottles
T4	Modified sub-surface planting through PVC pipe		Plastic mulching in tree basin (Reflective 70 gsm / LDPE 100 miron)
T5	T4+T2		T3 + Plastic mulching in tree basin
T6	Sub-surface vertical barrier d/s in pit and plastic mulch in tree basin (LDPE 100 micron)		Application of enriched compost (VAM 2 kg, PSB 100 ml, Trichoderma 0.5 kg, SSP 15 kg and Urea 1.5 kg per 50 cft of FYM)
T7	T6+T4		T3 + T6
T8		Sub-surface planting through soil (30 cm below)	

During the period of report, data on plant growth parameters like survival, plant height and sprouting behaviour have been recorded for both forestry species and depicted in Fig.22 and 23. It is pertinent to note that both the forestry species (*Ritha* and *Bahera*) had 100 per cent survival rate under all treatments during current year as no water scarcity observed during the current year. It is also observed that application of hydrogel (T2) had shown negative effect on plant height in both *Ritha* and *Bahera*. Significantly higher values of plant height were observed in treatments where sub-surface planting through PVC pipe (T4, T5 and T7) was introduced. Similarly positive effect of modified trenches (T3) was also observed on plant height in both the forestry plantation.

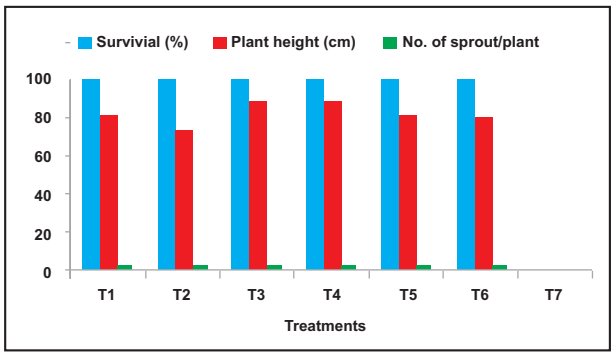


Fig. 22 : Plant growth of *Ritha* under different treatments

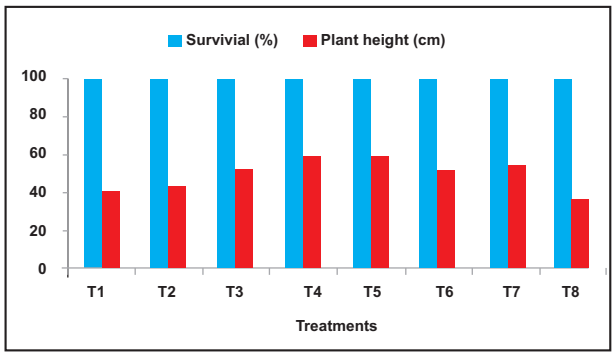


Fig. 23 : Plant growth of *Bahera* under different treatments

Data on different growth parameters like sprouting behaviour and survival rate was recorded for mango planted under agro-forestry system at Selakui Farm (Dhoolkot area) during the current period of report. It was observed that sprouting behavior of mango saplings recorded during autumn season was delayed under sub-surface planting (T3 and T5). However, it was normal when sub-surface planting was coupled with application of enriched compost (T7). During February 2019 severe die-back was observed in all the treatments due to prolonged low temperature and frost occurred in preceding winter. Under such stress, the higher survival rate (85.7 – 91.3 %) of mango saplings was recorded in all three treatments (T3, T5 and T7) where modified sub-surface planting was adopted. It is also observed that the lowest survival rate of mango saplings is observed under the treatment where hydrogel was applied (T2). Data on soil moisture recorded during dry spell (Jan 2019) under surface and sub-surface soil layer (Fig.24) shows that in sub-surface soil layer (30-45 cm), 78 % higher moisture was observed as compare to that was recorded in surface layer (0-15 cm). Therefore, modified sub-surface planting can provide proofing against stresses of moisture deficit in surface layer during dry spell and prolonged low temperature and frost prevalent during winter season in the study area.

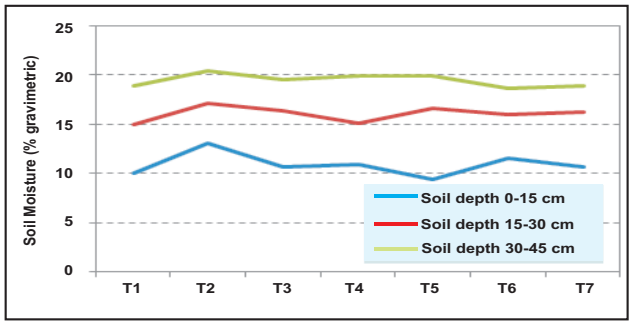


Fig. 24 : Soil moisture status under different soil layers during dry spell (Jan 2019)

Evaluation of traditional minor millet based agroforestry systems under recommended agri-silvicultural practices of North Western Himalayas (2008-2018) (Harsh Mehta, J.M.S Tomar and Trisha Roy-Dehra Dun **)**

The experiment was laid out in August 2009 by planting 324 saplings of improved provenances of *Grewia optiva (bhimal)* and *Morus alba* (mulberry). High yielding provenances of Bhimal viz. I.C. Bhaintan, I.C. Chamba and I.C. Malas were planted (54 each). Likewise 54 saplings of high yielding provenances of mulberry (S1, S146 and S1635) were planted in run off plots of 45x15 with uniform plant and row spacing of 5.0 x 4.25 m.

Initial recordings were taken for 324 bhimal and mulberry plants at the time of planting in respect of different growth parameters like plant height, collar diameter. Final recordings of plant height were 7.94 and

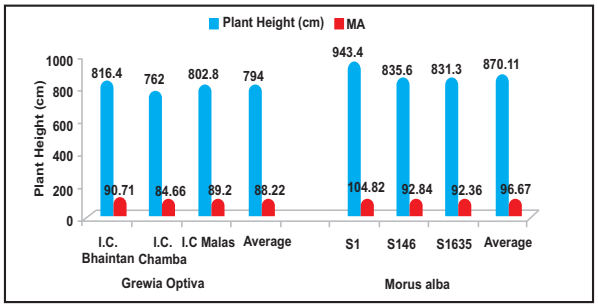


Fig. 25 : Plant height and Mean Annual Increment (cm) of *Grewia optiva* and *Morus alba* in 2018

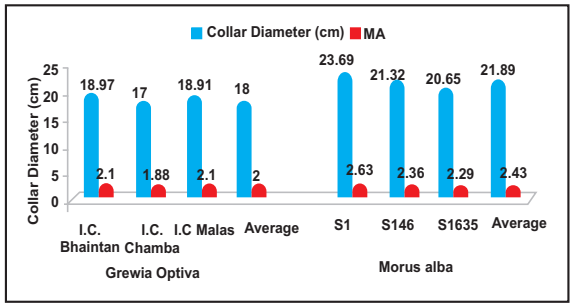


Fig. 26 : Collar diameter and Mean Annual Increment (cm) of *Grewia optiva* and *Morus alba* in 2018.

8.70m for *Gr. optiva* and *M. alba* respectively in Fig. 25. The mean annual increments in respect of plant height in Bhimal and mulberry were 88.2 and 96.7 cm respectively leading to very rapid growth of plants. Similarly the mean annual increments in respect of collar diameter in Bhimal and mulberry were 2.0 and 2.43 cm respectively. Final values of collar diameter were 18.0 and 21.9 cm for *Gr. optiva* and *M. alba* after 9 years of planting Fig . 26.

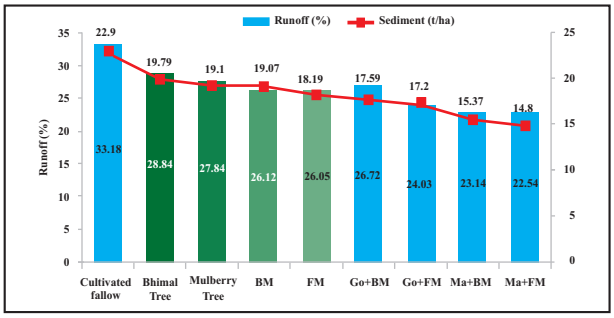


Fig. 27: Runoff and soil loss under different land uses in kharif 2018

The average productivity (Table 16) of improved varieties of finger millet and barnyard millet was 16.51 and 15.2 q ha^{-1} in comparison to 14.2 Q ha^{-1} and 13.4 Q ha^{-1} recorded in local varieties. The average productivity of finger millet and barnyard millet under *Gr. optiva* was 12.11 and 11.26 Q ha^{-1} while it was 11.28 and 9.97 Q ha^{-1} under M. *alba*, showing tree crop interactions. The per cent decline in yield of finger millet and barnyard millet was 21.3 and 21.1% under *Grewia optiva*, similarly the decline was 26.6 and 30.2% under *Morus alba* indicating strong tree crop interactions.

Table 16. Average productivity of finger millet and barnyard millet under different agroforestry trees in kharif 2018

Crops →	**FINGER MILLET**	**Yield (q ha^{-1})**	**BARNYARD MILLET**	**Yield (q ha^{-1})**
	Finger millet (PRM 1)	16.53 (13.9 %)	Barnyard millet (PRJ 1)	15.20 (12%)
	Finger millet(Local)	14.23	Barnyard millet (Local)	13.37
	Av. Finger millet productivity	15.38	Av. Barnyard millet productivity	14.28
↓ Trees *Grewia optiva*	Finger millet (VR708) under *Grewia optiva*	12.40	Barnyard millet (VL Madira 207) under *Grewia optiva*	11.83
	Finger millet(Local) under *Grewia optiva*	11.83	Barnyard millet (Local) under *Grewia optiva*	10.70
	Av. Finger millet productivity under *Grewia optiva*	12.11 (21.3 %)	Av. Barnyard millet productivity under *Grewia optiva*	11.26 (21.14%)
Morus alba	Finger millet (VR708) under *Morus alba*	11.93	Barnyard millet (VL Madira 207) under *Morus alba*	10.27
	Finger millet (Local) under *Morus alba*	10.63	Barnyard millet (Local) *Morus alba*	9.67
	Av. Finger millet productivity Under *Morus alba*	11.28 (26.6%)	Av. Barnyard millet productivity under *Morus alba*	9.97 (30.2%)

Conservation of natural resources under different land uses was evident in multi purpose trees (MPTs), native millet crops and tree crop combinations (Fig.27). The reduction of run off in *G optiva* and *M alaba* was 13.1 to16.1 with an average of 14.6 % while the reduction in run off due to sole finger millet and barnyard millet ranged from 21.3 -21.5%. The reductions in run off of tree crop combinations ranged from 19.5to 32.1% showing the effectiveness of tree crop combinations in reducing the run off. Likewise the reduction in soil loss ranged from 23.2 to 35.4 % in different tree crop combinations in comparison to MPTs 14.7 % and native millets crops 21.4% in comparison to control plot.

Development and characterization of quality planting material of MPT's for improving the productivity of degraded lands (Harsh Mehta, Rajesh Kaushal, Anand Gupta- Dehra Dun)

The study was initiated in the year 2012 with the aim of developing quality planting material of MPT's for improving the productivity of degraded lands. Screening provenances of *Celtis australis* and *Bauhinia variagata* under nursery and field conditions was initiated in 2013 and 2014. Planting materials of *Celtis australis*(*Khirak*) were collected from diverse locations of North-west Himalaya covering the states of Uttarakhand, Himachal Pradesh and Jammu and Kashmir, from 10 districts *viz*., Kathua, Chamba, Kangra, Kullu, Shimla, Solan, Sirmour, Dehradun, Tehri, Almora and Nainital. Similarly for *Bauhinia variegata* (*Kachnar)*, the planting materials were colleted from Uttarakhand and Himachal Pradesh with seven provenances viz., IC Ghatol, IC Sorus, IC Hamirpur, IC Bilaspur, IC Ranichauri and IC Dehradun. The healthy saplings of provenances were planted in the field conditions at the Selakui farm in randomized block design with three replications.

Maximum plant height of 7.06 m was recorded in I.C. Solan. It was followed by I.C. Almora (7.00 m) (Fig. 28). Maximum collar diameter of *C. australis* was recorded in I.C. Jammu (14.18 cm) followed by I.C. Tehri (18.08 cm). Maximum DBH of *C. australis* was recorded in I.C. Tehri (10.55 cm) followed by I.C. Jammu (10.26cm) (Fig. 29). Likewise material of *B. variegata* is being evaluated. Under field conditions I.C. - Ghatol recorded the maximum plant height of 5.81 m followed by I.C. Sorus (5.60). Maximum collar diameter of 12.14 cm was in I.C. Ghatol followed by I.C. Soras (11.02) (Fig. 30 and 31). The maximum DBH of *Bauhinia variegata* was recorded in I.C. Ghatol (9.90 cm) followed by I.C. Soras (8.44 cm) .

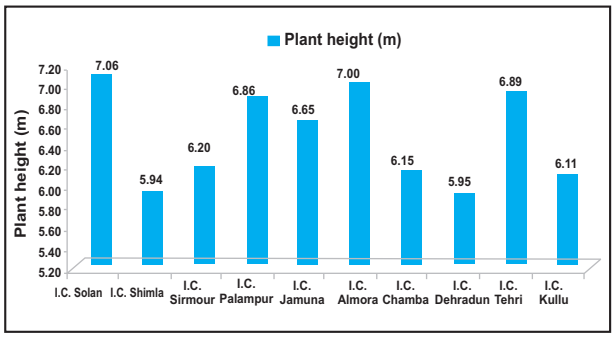


Fig. 28.: Plant height (m) of different provenances of *Celtis australis* after four years of planting

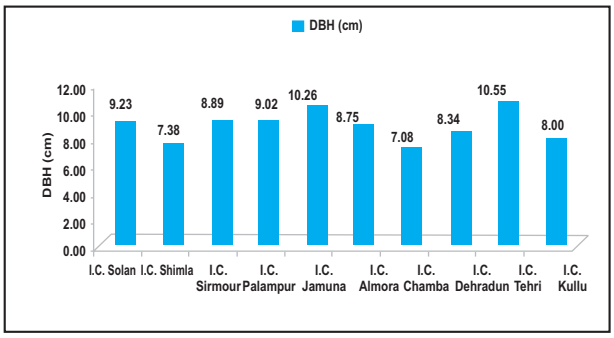


Fig.29 : DBH (cm) of different provenances of *Celtis australis* after three years of planting.

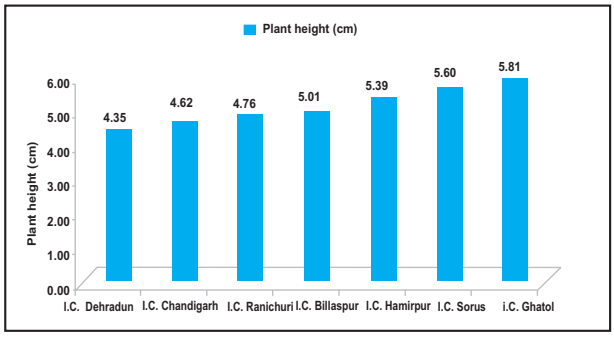


Fig. 30 : Plant height (cm) of different provenances of *Bauhinia variegata* after three years of planting.

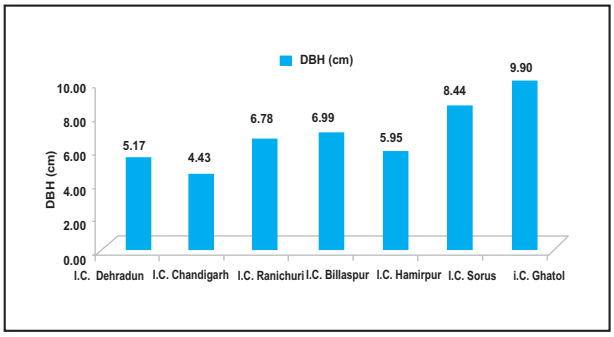


Fig. 31 : DBH (cm) of different provenances of *Bauhinia variegata* after three years of planting.

Evaluation of Bael and Olive based agro-forestry system with soil amendments in Doon Valley. (J. Jayaprakash, A.C.Rathore, D.V. Singh and Harsh Mehta - Dehra Dun).

The study was initiated in July 2015 with objectives (i) effect of agro industrial by products and stone mulching on growth and production potential of Olive and Bael (Non Timber Forest Product NTFP) trees. (ii)to exploit the change in physico- chemical properties of soil due to agro industrial by products(iii)to evaluate the soil fertility status and nutrient cycling pattern between Olive and Bael agrofoestry system. (iv) to compare the effects of yield, quality of produce, susceptibility of two different systems to pest and diseases, weed suppression and their productivity in the long term.(v) to Evaluate the performance of inter crops between the two tree species.The treatments viz; T1-Control T2-Pressmud, T3-Rice husk, T4-Oilcake, T5-FYM, T6-T2+Stone mulching T7-T3+Stone mulching,T8-T4+Stone mulching,T9-T5+Stone mulching were imposed in the month of September 2016, and effect of treatment on growth parameters viz Height and Collar diameter were measured Table 17.

In Bael plant, maximum height and collar diameter was recorded in T4 viz; Oilcake application and minimum height and collar diameter was recorded in T1 viz; control. In Olive plant, maximum height and collar diameter was recorded in T5 viz; FYM application and minimum height growth and collar diameter was recorded in T1viz; control.

Table 17: Height and Collar diameter of Baeland Olive plants under different treatment

Treatment	Average plant height(cm)	Average collar diameter(cm)	Average plant height(cm)	Average collar diameter(cm)
	Bael plants		Olive plants	
T1	130.0	3.2	120	1.3
T2	178.5	4.5	140	1.4
T3	170.0	4.3	135	1.6
T4	295.0	4.6	160	2.3
T5	190.0	4.5	165	2.6
T6	133.0	3.2	110	1.6
T7	167.5	4.2	112	1.6
T8	180.0	3.4	130	1.8
T9	170.0	3.5	140	2.1

Soil fertility restoration and carbon sequestration potential of multipurpose indigenous tree species from western Himalayas. (Vibha Singhal, Charan Singh and Trisha Roy- Dehra Dun)

The study quantifies the litter production of multipurpose agroforestry trees namely *Grewia optiva, Celtis australis*, *Bauhinia variegata* and *Ficus roxburghii* and to study the decomposition dynamics and its effect on the return of nutrients to the soil. Leaf litter was collected monthly in leaf litter trap placed randomly under the canopy of healthy trees under study . Litter decomposition study was carried out by Litterbag method. Chemical analysis of decomposed leaf litter and soil were carried to estimate C, N , P, K and Ca and Mg by standard methods. Height , diameter and biomass of trees were determined for estimating their carbon sequestration potential by non destructive method. Maximum value for leaf litter production (kg/ha/year) was observed for G. *optiva (*2548) followed by C. *australis (2250*) whereas minimum leaf litter was recorded for

F. roxburghii (1860) (Table 18). Leaf litter of C. *australis* decomposed faster than all other three tree species (Fig. 32) . Only 10.75% leaf litter on dry weight basis remained after one year in case of C. *australis* whereas 24.65% leaf litter (dry weight) didn't decompose in case of *Ficus roxburghii* even after one year. Upon chemical analysis, maximum values for Carbon, Potassium and Magnesium in leaf litter were recorded for F. *roxburghii* whereas maximum value for Phosphorus and calcium were observed for C. *australis* and *Bauhinia variegata.* In decomposing leaf litter P and Ca did not show any particular trend whereas K and Mg decreased throughout the period. Decomposition rates of single- and mixed-species litter, the litter-mixing effect and the effect of component litters in a mixture on decomposition was explored. Litter mixing had significant positive effects on litter decomposition. The decomposition rate (k) of the mixed litter was significantly different ($P < 0.05$) among the mixtures . The k of mixed litters was consistently and significantly higher than the expected k, which was calculated according to the k of single-species litter, indicating that litter mixing has a positive effect on litter decomposition.

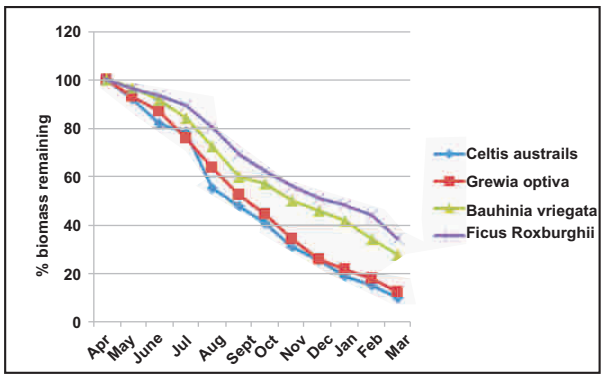


Fig. 32 : Percent biomass remaining after one year

Table 18. Growth habit and leaf litter production

Tree	Family	Age	Litter production (Kg $ha^{-1}year^{-1}$)	Growth Characteristic
Grewia optiva	Tiliaceae	20	2548	Fast Growing
Celtis australis	Ulmaceae	18	2250	Fast Growing
Bauhinia variegata	Caesalpiniaceae	22	2105	Fast Growing
Ficus roxburghii	Moraceae	25	1860	Moderate Growing

Evaluation of rooting media and rootstocks of major subtropical fruit spp. for raising quality planting materials on degraded lands (A.C. Rathore, H. Mehta, M. Sankar, Deepak Singh, J. Jayprakash, D.M. Kadam-Dehra Dun)

This externally funded HMNEH project was started for evaluating water requirement, rooting media and rootstocks for mass multiplication of papaya, acid lime, mango, litchi, guava, aonla, pomegranate, bael, etc. Seedlings of subtropical fruits like, acid lime, mango, guava and aonla were raised in pots with eight different combination of treatments comprising soil, microbes and organic manures. Growth performance of seedlings (acid lime, mango, guava, bael and aonla) were significantly better in PSB (Phosphorus Solubilising Bacteria) based treatment as compared to non-PSB treatments. Highest growth was recorded in treatment which received (10 g AZB + 10 g PSB + 25 g VAM + Soil +FYM) as compared to other treatments of mango, guava and aonla after 6-8 months. Seedlings of mango and aonla collected from different blocks of Dehradun were grown in pots to compare growth performance. Seedlings of Kalsi block attained highest root:shoot ratio as compared to Sahaspur and Vikasnagar block. Rootstocks of mango, guava, aonla and bael

Fig.33 : Performance of grafts as well as saplings under different level of irrigation based on ET in mango

have also been raised in pots with different moisture regime for assessing water requirement. Graftable diameter for mango and guava were observed in the month of May –June after 6-8 months under treatment received irrigation at 70% for guava and 80% for mango of ET (Fig.33). Water loss through evapo-transpiration (ET) in mango varied from 42.4 to 60.6 ml/day/sapling (Fig.34) among treatments with maximum and minimum ET in mango sapling received water at 100% (T_1) and 50%(T_6), respectively.

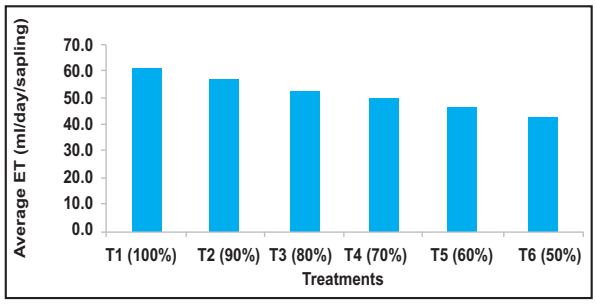


Fig.34 : Average evapo-transpiration (ET) of mango (ml/day/sapling) from August 2017 to July 2018

Promotion and extension of Lemon Grass (*Cymbopogon flexuosus*) cultivation as an alternative crop for livelihood security (J.M.S. Tomar, Rajesh Kaushal, Anand K. Gupta, Harsh Mehta- Dehra Dun)

The study was carried out at Research Farm of ICAR-IISWC, Dehra Dun. Seven lemon grass cultivars were evaluated for their performance on degraded land. Different lemon grass cultivars showed significant variations in growth, biomass and oil yield (Fig. 35 and 36). Maximum survival was recorded in Krishna cultivar (100%) followed by I/C 212721 (96.4%) and minimum survival (80.0%) was recorded in I/C 2699. Mean maximum clump height followed the pattern: I/C 2699 (2.08 m) > Krishna (1.29 m) > I/C 2700 (1.25 m) and minimum height was recorded in I/C 213933 . The mean maximum number of tillers were observed in I/C 212721 cultivar (30.0) followed by V5 I/C 2700 (28.4). Minimum tillers (18.7) were observed in I/C 2699. Maximum clump diameter was recorded in I/C 2700 (64.4 cm) followed by I/C 212825 (64.2 cm) and minimum clump diameter (27.22 cm) was registered in I/C 2699. Average maximum foliage spread (48.56 cm) was also observed in I/C 334564 cultivar followed by I/C 213933 with (44.66 cm) and minimum (38.44 cm) in I/C 212825 cultivar.

Mean maximum biomass yield (75.13 t ha^{-1}) followed the pattern: Krishna,> I/C(2699)> I/C(213933)> I/C (212825)> I/C(2700)> I/C(334564)> I/C(212721) respectively. The difference in growth parameters of different aromatic grasses is attributed to difference in genetic makeup, which is mainly governed by interaction between genetic and environmental factors. Oil yield varied from 82.5 kg ha^{-1} in I/C 212825 to 134.1 kg ha^{-1} in I/C 212721. Oil recovery varied from 0.45-0.85% with maximum values from I/C 2699.

Four villages *viz*. Devthala, Godriya, Bhud and Pasoli in Vikasnagar block of district Dehradun were selected. 20 potential farmers of SC/ST communities were selected for cultivation of lemon grass. Distillation unit was installed at Selaqui Dehradun. Biomass production ranged from 16.3-19.8 t ha^{-1} while the oil yield varied from 50.1-74.4 kg ha^{-1}. The return from the oil ranged from Rs 62600.00 to 93000.00 in different villages. The return was highest in Pasoli village (Table 19).

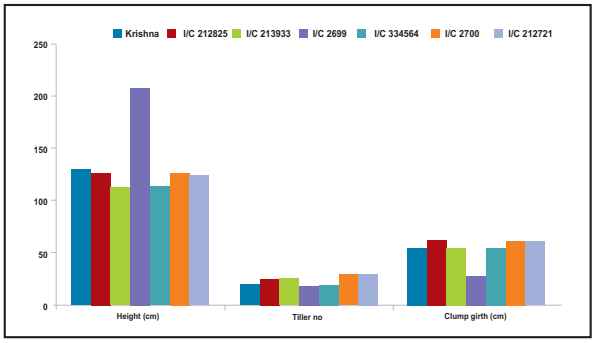


Fig.35: Variation in growth parameters of different cultivars of lemon grass

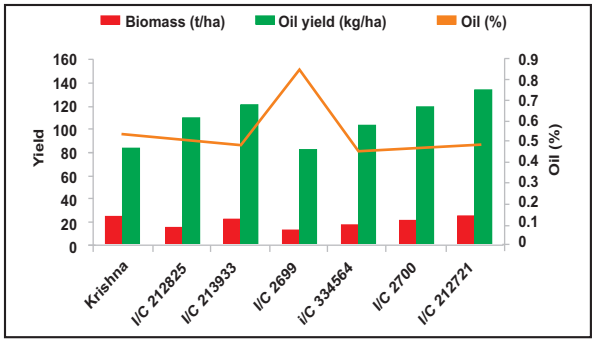


Fig.36 : Variation in biomass and oil content of different cultivars of lemon grass

Table 19: Biomass and oil yield from lemon grass on farmer's field

Village	Number of beneficiaries	Area (ha)	Herbal biomass yield t ha^{-1}	Oil yield (kg ha^{-1})	Total biomass production (q)	Total oil yield (kg)	Return ha^{-1}
Devthala	6	1.3	17.7	58.4	230	75.9	73,000
Godriya	4	0.8	17.4	58.6	139	46.9	73,250
Bhund	6	1.2	16.3	50.1	195	60.1	62,600
Pasoli	4	1.25	19.8	74.4	248	93.0	93,000

Up-scaling research on assessment of productivity, hydrological behavior, resource conservation and intangible benefits of selected commercial bamboo species in Uttarakhand (R. Kaushal, A.K. Tiwari, D. Mandal, P. Dogra, J.M.S. Tomar, D.V. Singh, Harsh Mehta, N.M. Alam and Anand Kumar Gupta- Dehra Dun)

The collaborative project funded by International Network for Bamboo and Rattan (INBAR) State Forest Department, Uttarakhand aims at generating scientific information on allometrics and environmental metrics of different bamboo species. The project also envisages capacity building of African partners under South-South institutional strengthening programme of INBAR. The data on different bamboo species is being generated from different locations in Uttarakhand. At Dhulkot research farm of ICAR-IISWC, seven different species of bamboos *viz*., *Bambusa bambos, B. balcooa, B. nutans, B. vulgaris, Dendrocalamus hamiltonii, D. strictus, D. stocksii* were planted in randomized block design in the year 2012. At Selaqui, experimental site is gravelly and bouldery marginal land (class VI based on land capability classification) where eight species viz., *Bambusa bambos, B. balcooa, B. tulda, B. vulgaris, Dendrocalamus asper, D. hamiltonii, D. longispathus, D. strictus* were planted in the year 2015 in randomized block design. At GBPUAT, Pantnagar, *Bambusa bambos, B. balcooa, B. nutans, Dendrocalamus hamiltonii and D. strictus* were planted in the year 2005 in randomized block design, Data at all the locations are being recorded for growth, biomass, root distribution, rainfall portioning, runoff and soil loss and soil properties viz., bulk density, hydraulic conductivity, organic carbon, NPK and soil microbial properties. At Dhulkot site, coarse root intensity was maximum in *B. vulgaris* (343.3) and minimum in *D.stocksii* (177.78) while, fine root (FR) intensity was highest in *B. vulgaris* (660) and minimum in *B. balcooa* (423.3). The FR contribution ranged from 58.7% in *B. balcooa* to 71.6% in *D. stocksii* (Fig.37). Coarse root biomass ranged from 0.6 Mg ha^{-1} in *B.nutans* to 2.0 Mg ha^{-1} in *B. vulgaris* and *B.bambos*. Fine root biomass ranged from 1.1 Mg ha^{-1} in *B. nutans* to 4.5 Mg ha^{-1} in *D. hamiltonii*. Distribution of coarse roots revealed that maximum concentration of biomass was observed at 10-20 and 20-30 cm soil depths (Fig. 38). These two depths collectively accounted for maximum 82% root biomass in *D. hamiltonii*. Soil physical properties revealed improvement in hydraulic conductivity, water stable aggregates and mean weight diameter. As compared to initial values, soil organic carbon, nitrogen and potassium were reduced under all the species. Soil microbial properties revealed that bacterial count was highest in *B. bambos* and least in *B. nutans*. Among different bamboo species, maximum fungal and actinomycetes count were recorded under *D. hamiltonii*. Dehydrogenase and β-glucosidase activity were maximum in control plot followed by *B. vulgaris,* and lowest values were recorded in *D. stocksii* Maximum acid and alkaline phosphatase activity was observed in control.

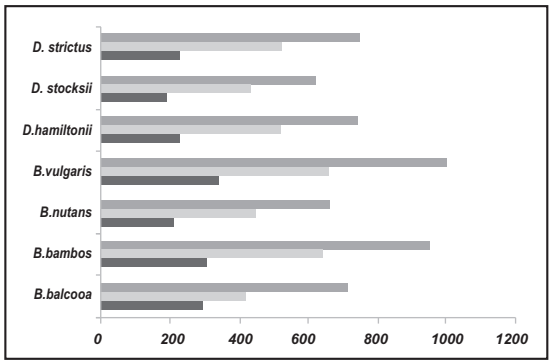


Fig. 37: Root intensity (average of 0-60 cm) in different bamboo species

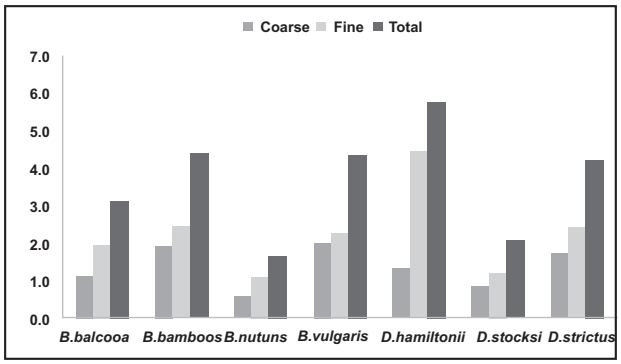


Fig.38: Root biomass (Mg ha^{-1}) in different bamboo species

Morphological features of different species affected different ecohydrological parameters. Gross rainfall (GR) versus TF (throughfall) relationship in different species indicated high TF production during high rainfall events with r^2>0.90. Average TF: GR was lowest (62.1%) in *D. hamiltonii* and highest in *B. vulgaris* (74.6%).SF: GR ranged from1.39% in *B. nutans* to 3.82% in *D. hamiltonii*. Funneling ratio (F) was highest (27.0) in *D. hamiltonii* and minimum in *B. nutans.* Canopy storage capacity was highest in *D. strictus* (3.57mm) and least in *D. hamiltonii* (1.09 mm). Interception was highest (34.5%) in *D. hamiltonii* and lowest in *B. vulgaris* (23.5%)and *D. strictus* (23.6%) (Fig.39)..

Under capacity building programme, short Term Training Course on Bamboo Allometrics and Environmental Metrics was conducted in Ethiopia, Tanzania and Madagascar in which 62 trainees from different academic, research and development institutions participated.

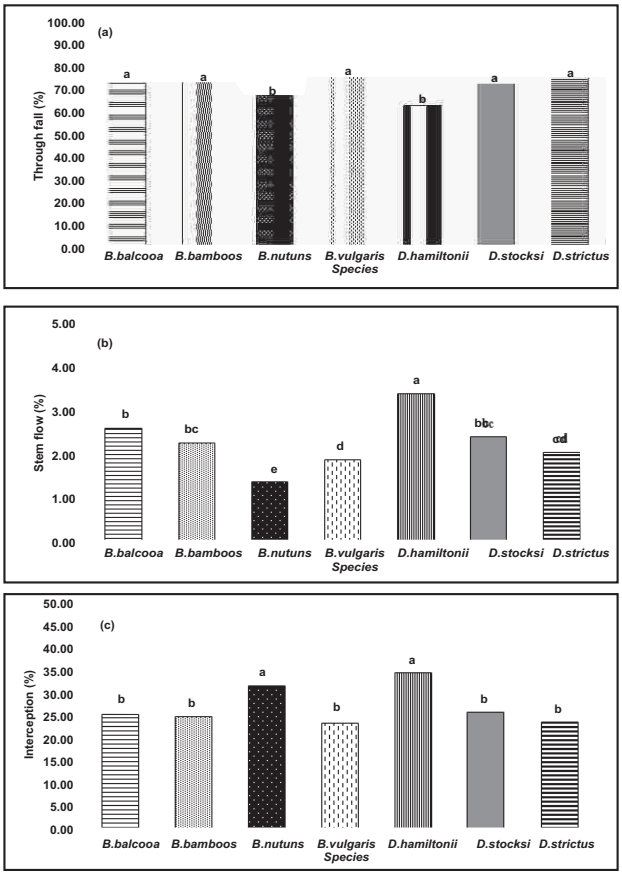


Fig. 39: Species wise percent of average relative (a) throughfall (TF/GR), (b) stemflow (SF/GR), (c) interception loss (I/GR) (Different letters are significantly different at P <0.05)

Assessment and improvement of nutritional quality of horticultural crops on sloping lands in North-west Himalayas (A.C. Rathore, M Sankar, D.V. Singh- Dehra Dun)

This study was started in 2017 with objective to assess soil quality, fruit quality of tomato / mango as well as corrective measures to improve fruit quality of tomato and mango. For tomato crop the experiment have been laid out at Pasauli village in sloping land with 9 treatments (T1-Up-slope+farmer practice (FP), T2-Up-slope+recommended dose of fertilizer (RDF), T3- Up-slope+KVK recommended dose, T4- Mid slope+RDF, T5-Mid slope+FP, T6-Mid slope+KVK dose, T7- Down slope+KVK dose, T8-Down slope+RFD, T9-Down slope+FP)**.** Initial soil sampling was done before tomato transplanting to assess the soil quality; total 27 samples were collected from 0-15 cm depth, 9 samples from each slope. Further tomato fruit sampling and nutritional quality analysis was done. Initail soil quality parameters have been given in Table 20. Tomato fruit nutritional quality shows variation with respect to slope, nutrient management practices and interaction between slope and nutrient management practices. All the quality parameters have been found better in KVK recommendation except vitamin C (Table 21). Among the three category of slope, down slope recorded best fruit quality of tomato as compared to middle an dupper slopes except acidity(Table 22)

Table 20: Initial soil chemical parameter (average)

	pH	EC(dSm^{-1})	P(ppm)	K(ppm)	Cu(ppm)	Zn(ppm)	Fe(ppm)	Mn(ppm)
Up slope	5.18	0.088	8.14	119.68	0.99	3.59	25.26	52.45
Mid slope	4.71	0.080	8.51	99.84	0.85	2.01	34.97	109.68
Down slope	4.66	0.112	6.11	81.08	0.84	1.79	36.97	128.10

Table 21: Effect of fertilizer doses on tomato fruit quality

	TSS (Brix)	Acidity (%)	Vitamin-C (mg/100gm)	Sugar (mg/g)	Lycopene (mg/100gm)	Carotenoid (mg/100gm)
Farmer Practice	5.344	0.544	18.795	0.658	5.624	5.581
Recommended dose	5.770	0.525	21.776	0.716	6.243	6.051
KVK dose	5.774	0.565	20.918	0.743	7.634	7.012

Table 22: Effect of slope on tomato fruit quality

	TSS (Brix)	Acidity (%)	Vitamin-C (mg/100gm)	Sugar (mg/g)	Lycopene (mg/100g)	Carotenoid (mg/100g)
Up slope	5.152	0.646	18.372	0.598	5.574	5.122
Mid slope	5.533	0.591	19.510	0.712	6.684	6.175
Down lope	6.204	0.398	23.607	0.807	7.243	7.348

Phyto-rehabilitation of saline-sodic Vertisols through *Prosopis juliflora* based silvi-pastoral systems (H. Biswas and A.S. Morade - Ballary)

The long-term at the Experiment Research Farm, Ballari to evaluates the phyto-rehabilitation of saline-sodic Vertisols through *Prosopis juliflora* based silvi-pastoral systems. The experiment was laid out in a spilt plot design with time replication of five years during 2015-16. The study comprises of two tree species, viz., *P. juliflora* and *P. pallida* and two grass species viz., *Leptochloa fusca* and *Cenchrus ciliaris*. The soil of the experimental field is alkaline, with pH ranging from 7.5 to 8.5 and saline, with EC rangng from 0.78 to 11 dS m^{-1}. The soil is low in organic carbon. *P. pallida* were planted at two spacings – 3×3 m and 6×6 m. Seedlings were established and maintained with life-saving irrigation during the dry season. The second replication of *Prosopis pallida* was carried out during 2018 and has exhibited an 80% survival. The growth parameters of *P. pallida* after three years of the study are given in Table 23.

Table 23: *P. pallida* growth parameters at two spacings

Spacing levels / Growth parameters	Main plots: spacing (m)	
	3×3	6×6
Height (cm)	551 ± 53	547 ± 100
Collar diameter (mm)	88 ± 20	96 ± 30
DBH (mm)	67 ± 20	64 ± 22
Canopy spread (N-S)	3.8 ± 0.9	5.8 ± 1.5
Canopy spread (E-W)	3.7 ± 0.8	5.5 ± 1.4

Regulated deficit irrigation and canopy architecture management for fig (*Ficus carica* L.) in semi-arid Vertisols (Amrut S. Morade, M. Prabhavathi, Scientist –Ballary)

Fig plants of cultivar 'Bellary' planted in July, 2016 according to experiment plan to establish orchard at Research Farm, Bellary. Pruning treatments were imposed in first week of June 2018 according treatment plan . Since annual rainfall recorded for the year 2018 is 306.9 mm, which is 40% deficit than annual average rainfall of 513 mm. Dry spells and low rainfall has delayed plant phanological stages *viz.,* bud-break, leaf expansion, shoot growth and fruiting. Moderate pruning as well as harsh climatic conditions after pruning has delayed fruiting by two months. In order to impose deficit irrigation treatments, drip irrigation facilities have been installed in orchard.

Evaluation of promising fruit species with different moisture conservation practices in red soils of Bundelkhand region (Rajeev Ranjan, Monalisha Pramanik and SP Tiwari-Datia)

The experiment was initiated in 2015-16 having three fruit species viz. custard apple, pomegranate and lemon and four moisture conservation treatments viz. sunhemp, plastic, stone and no mulch as control replicated thrice to identify the most promising fruit species for sustainable production in semi-arid region of Bundelkhand. After two years of plantation, the survival percent of pomegranate and lemon were 100 % irrespective of mulch treatments, whereas survival of custard apple plants was 90.0 %. Growth parameters of fruit plants revealed that mean maximum plant height 113 cm, 190 cm and 202 cm were observed in custard apple, pomegranate and lemon under sunhemp treatment, respectively, whereas the mean minimum plant height 81 cm, 154 and 166 cm were recorded in custard apple, pomegranate and lemon, respectively under control. Further, no definite trend was observed in collar diameter, number of branches and canopy diameter.The soil moisture data was recorded on daily basis after irrigation (Fig. 40). Trends of daily soil moisture data showed that the percent soil moisture depletion per day was highest in control (1.34 % custard apple to 1.86 % in pomegranate) and lowest in plastic mulch treatment (0.86% in custard apple to 1.26 % in pomegranate).

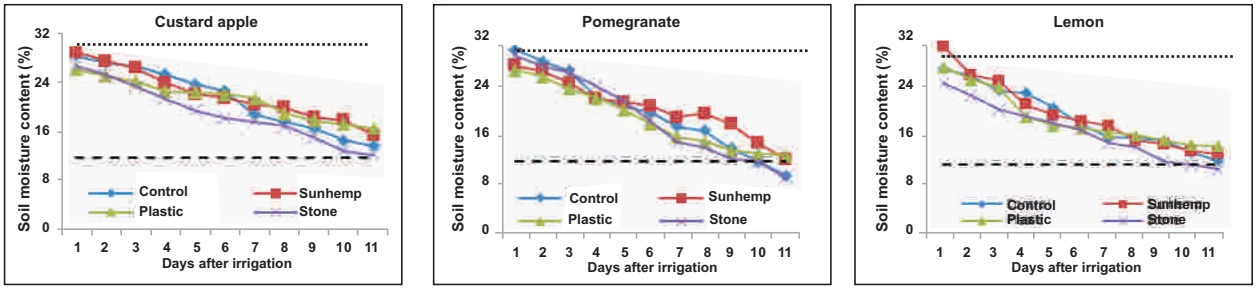


Fig. 40 : Daily soil moisture depletion in (A) Custard apple (B) Pomegranate and C) Lemon under different mulch treatments

Evaluation of cover crops under cashew and mango plantation for improving soil health and productivity in Eastern Ghats High Land Region of Odisha (M. Madhu, D.C. Sahoo, P.P. Adhikary and H. Gowda-Koraput)

Field experimentation was initiated to study the resource conservation efficiency of cover crops under cashew and mango plantation, and to study the impact of cover crops on soil properties, carbon sequestration and global warming potential of the system. Mango and cashew grafts were planted in 8 mX 8 m spacing on sloping field of 8-10%. Eight treatments comprising seven cover crops and one plot without cover crops laid out in RBD design. Cover crops seeds were sown during July,2016 as per the treatment details both in mango and cashew plantation. During this period runoff, soil loss, initial soil properties, canopy cover of cover crops and growth performance of mango and cashew were recorded. Canopy of different cover crops measured at 24 months after planting showed that the maximu canopy cover of 97% in *Mucuna bracteata* followed by *Mimosa invisa* (94%) and *Pueraria javanica* (92%) under mango plantation (Fig. 41). Similarly maximum canopy cover was found in *Mucuna bracteata* (98%) followed by *Mimosa invisa* (95%) and *Pueraria javanica(88%) under cashew plantation.*

The total annual rainfall during the year 2018 is 1897 mm. About 1044 mm of runoff producing rainfall was received from 13 rainfall events. Runoff under mango with different cover crops and control was varied between 50.4 and 134.3 mm which account about 4.8 to 12.9% of the runoff producing rainfall of 1044mm. Similarly, Runoff under cashew with different cover crops was varied between 53.3 and 125.2 mm which account about 5.1 to 12.0% of the runoff producing rainfall of 1044 mm (Fig. 42). Soil loss varied between 260-1114 kg/ha under different treatments under mango and 609.0-1300.0 kg/ha plots in mango and cashew plantation respectively (Fig.43). However, soil loss was the lowest in all the cover crops compared to control plots. Soil conservation efficiency of cover crops varied between 24.9-76.6% for mango and between 24.2-53.2 % for cashew over control plot.

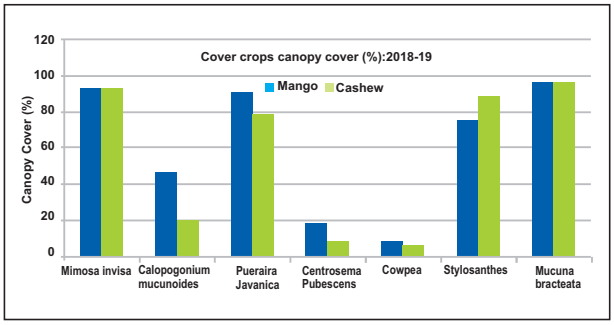


Fig.41: Cover crops canopy cover in mango and cashew during 2018

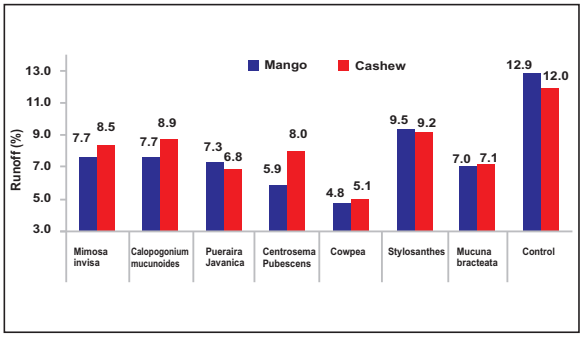


Fig.42 : Runoff under different cover crops in mango and cashew during 2018

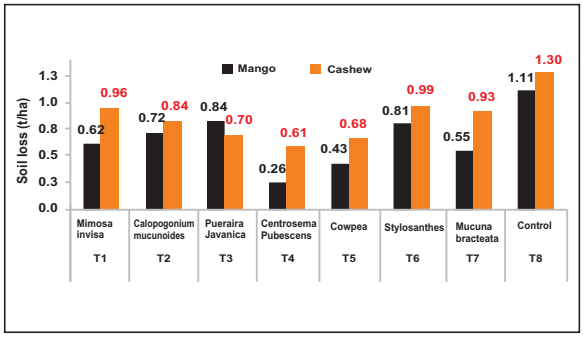


Fig.43 : Soil loss under different cover crops in mango and cashew during 2018

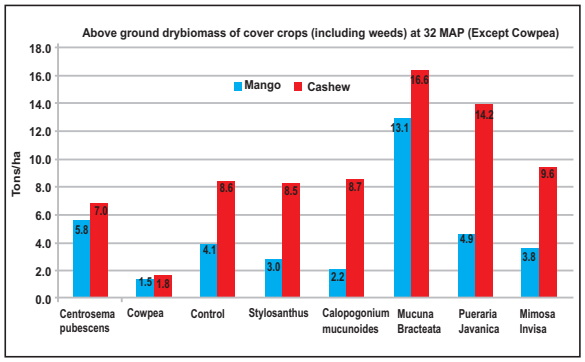


Fig. 44: Above ground dry biomass of cover crops in mango and cashew plantation during 2018

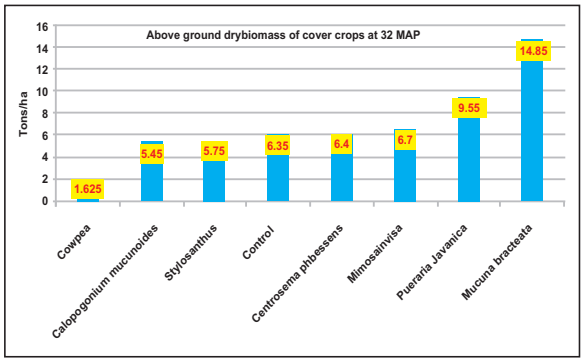


Fig.45 : Average above ground dry biomass of cover crops in mango and cashew plantation during 2018

Fig. 46 : Growth of different cover crops.

Above ground dry biomass production of cover crops varied between 1.5 and 16.6 t/ha/yr which contributed total NPK nutrients of 290 to 1041 kg/ha to soil. Highest biomasses were obtained in *Mucuna bracteata* plot of about 13.1 and 16.6 t/ha at mango and cashew plantation, respectively. Whereas the lowest biomass was obtained in *cowpea* of about 1.5 and 1.75 t/ha in mango and cashew plantation, respectively (Fig.44 and 45). Growth of different cover crops depicted in Fig.46.

Evaluation, characterization and development of elite genotypes for cultivation under arid and semi-regions (S. Kala, H. R. Meena, and I.Rashmi-Kota)

C.auriculata is one of the imperative multipurpose medicinal plant and it has yet not been utilized effectively so for. The objective of the above project is to identify potential *Cassia auriculata* genotype for high density cultivation and resource conservation in non-arable lands. The objective of the current year is to

identify the superior genotypes/ seed source of *Cassia auriculata* under field condition using plant morphometric and biometric traits. Basic plant, flower and pod biometric traits were regularly observed and recorded for genotype characterization. The assembled genotypes were shows highly significant variation in morphological and biometric traits. The pod and seed quality also have ambient variation among genotypes which were given here for each parameters viz., pod length (avg. mean range varies from 7.65 t9o 16.33 cm), pod width (avg. mean range varies from 0.92 to 2.49 cm), 10 pod weight (avg. mean range varies from 7.21 g to 12.36 g/pod) and no. of seeds/pod (range varies from 6.17 to 14.33 seeds/pod). Plant physiological and biochemical observations are under progress for further stress tolerance analysis on genotype characterization through progeny evaluation trial under field condition.

Resource utilization and productivity of Dragon fruit based horti-silviculture system under rainfed agro eco-systems of Central Gujarat (V. Kakade, P.R. Bhatnagar and D. Dinesh-Vasad)

An experiment was initiated in June 2016 to analyse the resource utilization and productivity of Dragon fruit (DF) and *Melia dubia* (MD), to evolve the suitable cropping system under rainfed agro ecosystems of central Gujarat. Two experiments were initiated with 9 (Experiment 1) and 7 treatments (Experiment 2). The experiment one initiated with planting of Dragon fruit and *Melia dubia* in pure and mixed cropping system at 3x3 m and 4x4 m with and without in situ moisture conservation measure ((ISMCM) (Half-moon system)). In this experiment, plant growth parameters such as plant height, number of cladodes, length of individual cladode and total length of cladodes, survival % were measured in case of Dragon fruit, whereas plant height, DBH and survival % were measured in case of *Melia dubia* during the month of December-January 2018-19. The highest values for avg. height of plant, avg. length of cladode, total length of cladode per plant and plant survival percentage was observed in Dragon fruit grown at 3x3 m treatment whereas, highest avg. number of cladodes were recorded in Dragon fruit grown at 3x3 m spacing with in situ moisture conservation measure, but not much variation in the treatments was observed (Table24).

After replanting of *Melia dubia* during the month of July 2018, the survival percentage was recorded in the month of March, 2019 and it was observed that, 100 percentage of survival was observed in case of *Melia dubia* in most of the treatments. Lifesaving irrigation was given to plants of Dragon fruit and *Melia dubia* as per need. The water used for life saving irrigation was from the harvested rainwater.

Table 24: Growth parameters and survival percentage of Dragon fruit

Treatment	Treatment details	Avg. no. of cladode/ plant	Avg. height of plant (cm)	Avg. length of cladodes	Total length of cladodes/plant	*Plant survival (%)
T1	Natural vegetation	-	-	-	-	-
T2	DF+MD+ ISMCM (3x3m)	5.66	77.96	17.42	107.8	84.64
T3	DF+MD (3x3m)	6.45	86.00	14.99	104.2	81.75
T4	MD (3x3m)	-	-	-	-	-
T5	DF (3x3m)	6.23	117.1	20.98	125.3	95.45
T6	MD+ISMCM (3x3m)	-	-	-	-	-
T7	DF+ISMCM (3x3m)	7.60	94.36	15.29	123.9	93.87
T8	DF+MD (4x4m)	6.64	105.8	17.17	118.2	85.31
T9	DF+MD+ISMCM (4x4m)	7.42	111.7	15.53	119.6	88.98

* Plant survival was calculated by taking plant survival percentage of December 2017 as a base

In experiment 2, the planting of Dragon fruit cuttings at 3x3 m spacing was done in the month of December, 2018 under 7 different treatments. The treatment includes no fertilizer application or without Manure & fertilizers, FYM only, RFD from other places, soil test based RFD, 50% of RFD, 150% of RFD and RFD + Bio-fertilizer treatments. The planting of Dragon fruit was done with uniform application of FYM (5 kg per pole) in all the treatments except no fertilizers treatment. Fig.47 through 54 presents the view of plants under different treatments and other activities under the project

Fig. 47 : DF+MD+ISMCM (3x3m)

Fig. 48 : DF+MD (3x3m)

Fig. 49 : DF (3x3m)

Fig. 50 : DF+ISMCM (3x3m)

Fig. 51 : DF+MD (4x4m)

Fig. 52 : DF+MD+ISMCM (4x4m)

Fig. 53 : A view of Dragon fruit project experiment 2

Fig. 54 : Replanting of Dragon fruit

P- 3: WATERSHED HYDROLOGICAL FOR CONSERVATION PLANNING

3.1: Hydrological Behaviour of Land uses and management practices

Hydrologic systems analysis across multiple spatial scales and its implications on hydro-logic processes in sub-humid catchment of Eastern Ghat High Land Region of Odisha (Ch. J.P. Dash and P.P. Adhikary-Koraput)

Due to the importance of scale effects on runoff and soil erosion, the definition of scale relationships, as well as the knowledge of the dominant processes and factors governing surface runoff and soil loss at each scale, is fundamental for resource management. Emphasis here is given to identify the pattern and relationship between runoff and soil loss process over a range of spatial scale in Eastern Ghats High Lands Region of Odisha. The study area is Sakirput watershed, Semiliguda block, Koraput district, having an area of 125 ha and slope varying from 1 to 62% was used for this study (Fig. 1). The watershed consists of three types of land use such as Agriculture, Forest, and Scrub (Fig. 2).

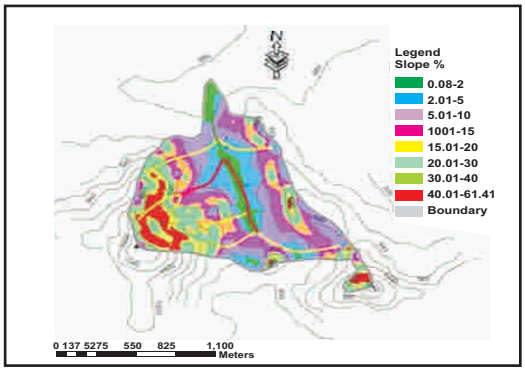


Fig. 1 : Slope map of Watershed

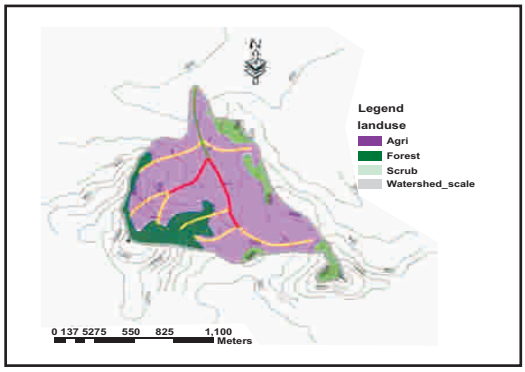


Fig. 2 : Land use map of Watershed

Agriculture is the dominant land use (94.2 ha), followed by forest (18.3 ha) and scrub (13.1 ha). Runoff and soil collected from 3 different size plots (P_{10}= 5 × 10 m^2, P_{20}= 5 × 20 m^2, P_{60}= 60 × 10 m^2) under five land uses. Apart from that one watershed consisting three micro-watersheds were gauged.

The study area is a 3rd order watershed, having mean bifurcation ratio of watershed is 3.13 which indicates that the watershed has less structurally less distributed. . Form factor is 0.24, which indicaly longer duration flow. Moderate drainage density of watershed is indicating moderate permeable sub-soil and thick vegetative cover. The cumulative runoff obtained from different plot length and different land uses for the hydrologic year 2018-19 is presented in Table 1.

Table 1: Cumulative runoff and sediment yield for different plot length (m) under different land uses (Summary of 40 events)

Land uses	P_{10} (10*5 m^2)		P_{20} (20*5 m^2)		P_{60} (60*5 m^2)	
	Runoff (mm)	Sediment yield (g/m^2)	Runoff (mm)	Sediment yield (g/m^2)	Runoff (mm)	Sediment yield (g/m^2)
Agriculture	225.8	496.4	139.9	272.3	49.1	73.4
Scrub with small pebbles	43.8	117.4	5.38	31.2	2.81	8.5
Scrub with stony surface	318.6	218.9	202.7	164.4	18.3	12.4
Forest	18.5	92.4	14.3	26.7	5.3	6.9
Fallow	343.2	345.9	207.7	258.2	62.9	61.2

Both unit area runoff and sediment yield declined with increased plot length (Fig 3 and Fig. 4). Highest runoff obtained for fallow land use, followed by scrub with stony soil, agriculture, forest and scrub with small pebbles respectively. The average runoff coefficient ranged from 6.1 to 26.1% for agricultural land use, 1.4 to 9.42% for scrub (pebbles), 1.5 to 6.2% for forest land use, 8.5 to 48.7% for fallow land uses (Fig. 5).AMC plays an important role in producing runoff, and it was observed that 6.0 mm, 6.8 mm, and 20.5 mm rainfall required to produce runoff under fallow, agriculture, scrub and forest land use respectively (Fig. 6).

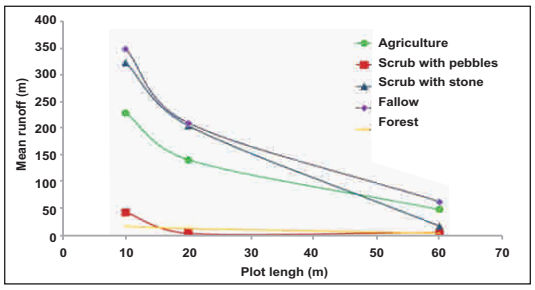


Fig. 3: Variation of unit area runoff with plot length under different land uses

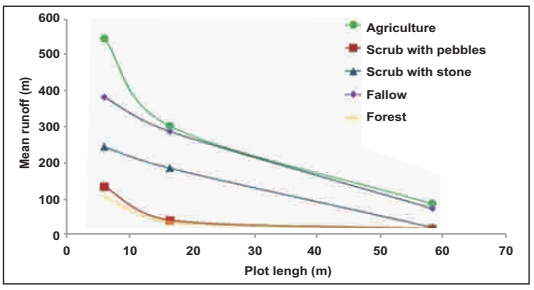


Fig. 4: Variation of unit area sediment yield with plot length under different land uses

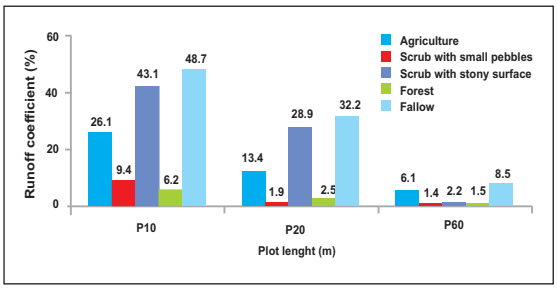


Fig. 5 : Average runoff coefficient for different plot length under different land uses

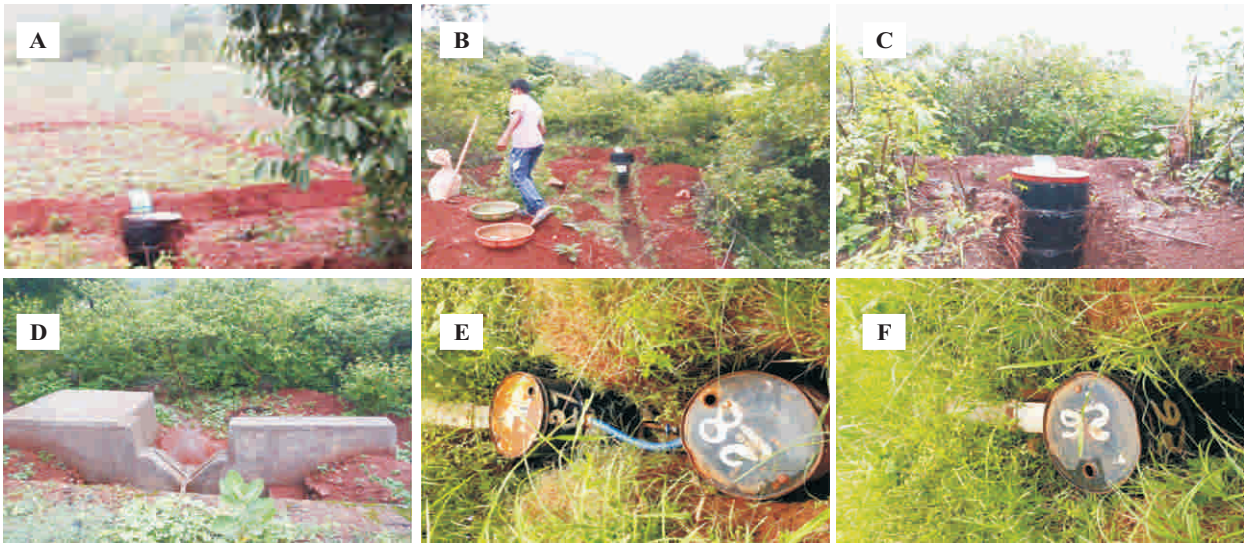


Fig .6: (A) Agriculture field, (B) Forest (C) Scrub (D) Gauging Station for Micro Watershed, (E and F) Agriculture field

3.2: Water Harvesting, Groundwater Recharge and Management

Development and rejuvenation of natural springs through soil and water conservation measures (U.K. Maurya, Ambrish Kumar, Santosh Kumar Rai and S.K. Bartarya-Dehra Dun)

Field traverses were conducted during 2018-19 to the experimental sites in Semalta watershed of Kalsi and Chakrata Block, DehraDun to study the hydrological behaviour of natural springs. Different engineering measures such as construction of recharge pits/trenches (staggered/contour), recharge ponds, check dams,

check wall, catch water drainage wall, embankment treatment to check bank erosion, and bioengineering measures such as staggered/contour trenches with plantation and geo-jute conservation with plantation were identified for the different springs based on their position/location, geological formations, geomorphological characteristics, altitude, land use and land cover characteristics. The details of each intervention sites with their intervention measures are shown in Fig.7. Based on the observations of isotopic study as well as local geology and geomorphology, Uplatal spring located near the village Damta was selected for intervention of SWC measures and accordingly 300 staggered trenches of dimensions (3.0 m x 1.5ft. x 1.0 ft.) were prepared in the sloppy mountainous land of 1.22 ha area following standard procedure (Fig. 8: a, b, c, d & e). The effects of moisture retention by these trenches and their effects on spring discharge are under observation.

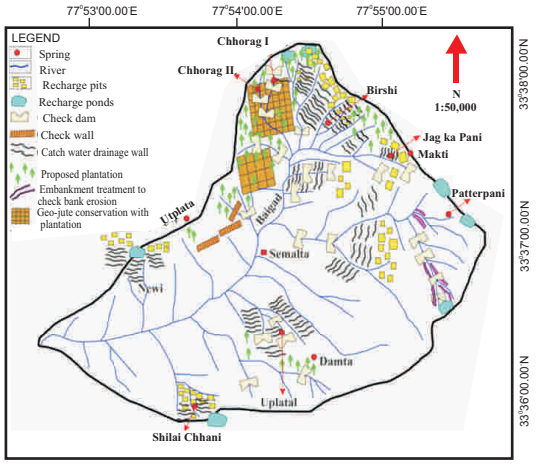


Fig.7: Site locations for engineering and bioengineering interventions in Semalta watershed, Kalsi and Chakrata Block, Dehradun.

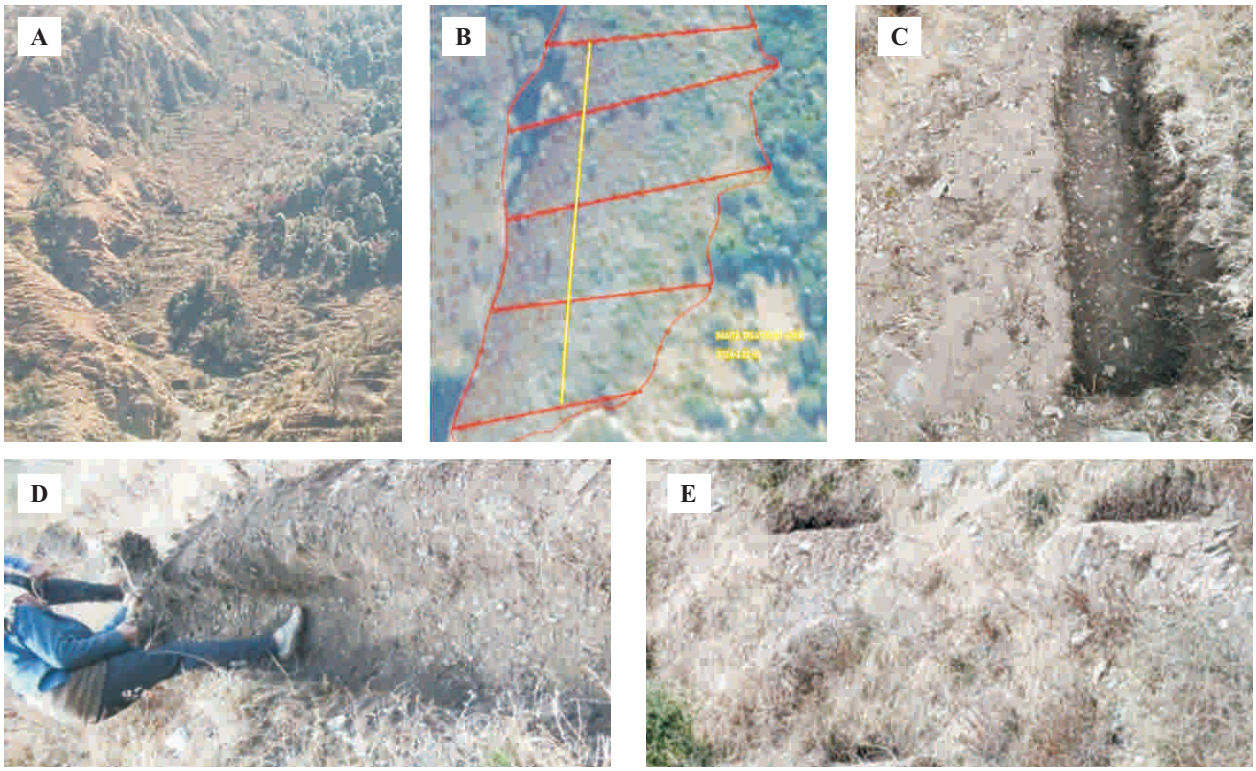


Fig. 8 : (A, B) Intervention area of Uplatal spring near the village Damta; (C, D) Digging operation of one of the trench, (E) Staggered trenches.

CRP on Water (Theme 1): Development and Management of Integrated Water Resources in Different Agro-ecological regions of India (P.R. Ojasvi, Deepak Singh, S.S. Shrimali, K.K. Sharma, R.B. Meena, A.K. Singh, B.S. Naik, H. Biswas, V.K. Bhatt, Sharmishtha Pal, Pankaj Panwar, MonalishaPramanik, Manish Kumar, Rajeev Ranjan, D.C. Sahoo, Jyoti Dash, M. Madhu, G.L. Meena, R.K. Singh, S. Manivanam, V. KasturiThilagam, OPS Khola)

This project is being implemented by a consortium of seven Institutions covering a country wide study on different aspects of RWH. Assimilation and development of national data base on design rainfall, DEM, LU/LC, hydrologic soil group is being done. Rainwater harvesting potential at the design rainfall of 75% probability (the criteria used in semi-arid regions for estimating runoff volume) has been worked out for nine states (Bihar, UP, Rajasthan, Maharashtra, Telangana, AP, Kerala, Karnataka, Tamilnadu) (Fig. 9). This data

can be directly used for various decision making related to harvestable runoff volume, size of structure and its design.

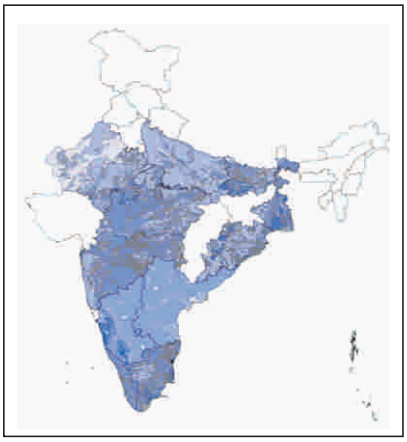


Fig. 9 : States covered for developing RWH potential database

A system of solar powered micro irrigation system (Fig.10) is also being standardized for efficient utilization of harvested water in different agro-ecological zone of the country. Earlier used diesel pump was replaced with an energy efficient DC Solar pump system of 3 HP capacities during March, 2017 at the farm pond site having total storage capacity 5407 m^3 with catchment of 24 ha area. The runoff collected in farm pond was used for life saving irrigation through drip system over traditional flooding method followed by the farmer. During rabi (2018-19), through this advance technology, the farmer had cultivated chilli in 2.25 acres and tomato in 0.75 acre lands and realized 3150 kg of chilli from 2.25 acres and 1950 kg of tomato from 0.75 acre with higher total net income of Rs 2, 74,125/- and B: C ratio of 4.43 over traditional method of cultivation where in farmer realized total net income of Rs 1, 37,000 and B: C ration of 2.57 during 2016-17. It has been computed that by using solar pump with drip irrigation method, 545 kWh of energy is saved, Rs. 7603/- is saved towards energy (fuel) cost, 357 Kg of CO2 emission is avoided and net return is increased by 99% over farmers' practice during 2018(Table2).

Table 2 : Comparison of benefit from vegetable cultivation with drip irrigation using solar pump, and farmers practice

Crops grown	Area covered (acre)	Total yield (kg)	Input cost (Rs)	Gross returns (Rs)	Net income(Rs)	BC ratio
Advance technology (2018-19)						
Chilli (Bydagi variety)	2.25	3150	60750	315000	254250	
Tomato (hybrid)	0.75	1950	19125	39000	19875	
	3.00		79875	354000	274125	4.43
Farmer's practice (2016 17)						
Chilli (Bydagi variety)	1.75	1750	52500	175000	122500	
Tomato (hybrid)	1.25	2500	35000	50000	15000	
	3.00		87500	225000	137500	2.57
*Chilli at Rs. 100 kg^{-1} and tomato at Rs 20 kg^{-1}						

Fig.10 : A solar powered irrigation system for farm pond at farmers field in Bellari, Karnataka

Employing system approach for energy efficient drip irrigation in farmers field in Barrackpore region

(Deepak Singh, P. R. Ojasvi, A.C. Rathore- Dehra Dun)

To study moisture distribution pattern for developing irrigation scheduling in hilly region under different terraces with low cost drip tap. Drip tape was installed at bench terraces field in such a way that every terrace was receiving irrigation water independently. In 2018-19, the five vegetable crops were planted in the experimental field such as cabbage, brinjal, tomato, capsicum and chilli in the month of December, 2017 and Okra in the month of June, 2018. Yield and growth parameters of the crops are being taken. The drip system performance at a beginning of crops was calculated in the form of uniformity coefficient, distribution

uniformity and moisture distribution. Yields of the different crops are shown in Fig 11. In among all crops tomato crop showed the highest yield followed by cabbage. Gross income is highest of okra crop followed by tomato as shown in Fig 12.

Variations in uniformity coefficient (UC) and distribution uniformity (DU) are presented in Fig 13 and Fig 14, respectively. Highest UC and DU was observed in the terrace number 4 which was 8 meter below the water source. As pressure head was reduced, UC and DU decreased considerably and the decreasing head trend was observed from terrace 4 to terrace 1. However, performance of drip system under different terraces was more than 90 % that could be rated as good. Results showed that at the beginning of the drip laterals, the uniformity coefficient and distribution uniformity values were more as compared to at the end of the drip laterals within the same lateral line. The maximum discharge was obtained in the terrace number 4 followed by terrace number 3. Whereas, dripper discharge variation was also followed the same decreasing trend from terrace 4 to terrace 1. The two indices UC and DU assume different meanings. The DU shows the condition of the smallest emitter discharge as compared to that of the average discharge, whereas the UC represents the deviation of discharge from its mean value.

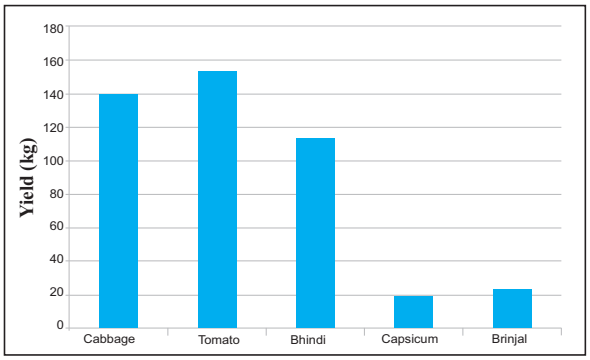


Fig. 11 : Yield of vegetable crops in year 17-18

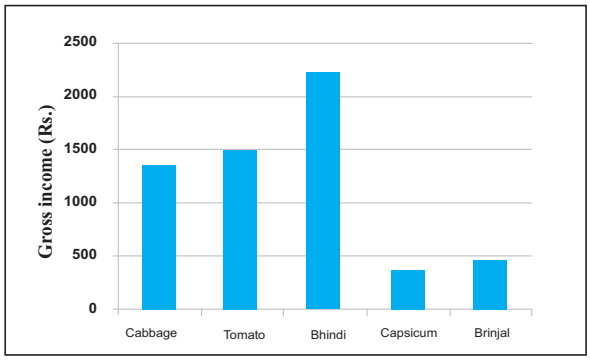


Fig. 12 : Gross income of vegetable crops in year 17-18

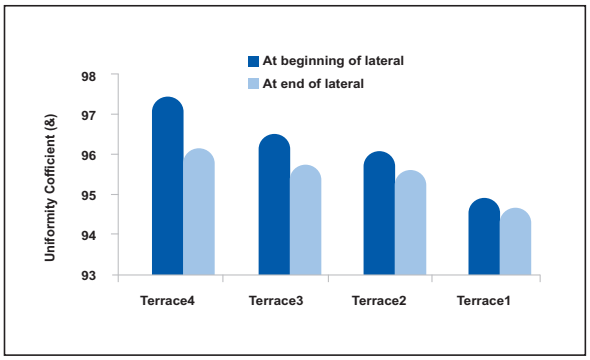


Fig. 13 : Uniformity coefficient of drip system

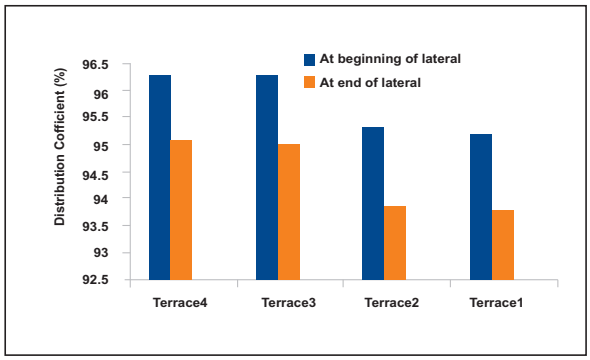


Fig. 14 : Distribution uniformity of drip system

Efficient groundwater management for enhancing adaptive capacity to climate change in sugarcane based farming system in Muzaffarnagar district (Ambrish Kumar, U.K. Maurya and Anand K. Gupta-Dehra Dun)

Two innovative water harvesting masonry structures (Fig.15) in a series are constructed in Harsauli drain near the selected project site in Muzaffarnagar with dimensions: 8.86 m (span) and 2.16 m (height); 10 m (span) and 1.50 m (height), respectively. Second structure (WHS-II) is in upper reach of the same drain at 7.36 km apart from first one (WHS-I). Average bed slope and width of the drain is about 0.03 % and 7m, respectively. The capacity of water storage of WHS-I and WHS-II is 35021.88 and 11812.5 cum, respectively and surface area of water spread is 32427.6 and 15750 m^2 respectively. It is expected that back water could extend upto 3.66 km and 1.5 km behind the WHS-I and WHS-II. Villagers staying along the Harsauli drain shared their experiences about less possibility of water flow in the drain even in rainy season. On this account, project team discussed the issue with District Irrigation Department, Muzaffarnagar and Chief Development Officer for releasing the water into the Harsauli drain from Baghra Minor (as its tail end is connected to Harsauli drain) to impound water in the drain for recharging groundwater when there is surplus water in the

canal. With continuous pursuance, Irrigation department (canal) of District - Muzaffarnagar (UP) agreed to release excess canal water into the drain through Baghra minor.

Fig.15 : Overview of chakdam I (L) and II(R)) and water impounding in the checkdam-II

Infiltration study at every one km interval in a total 5 km stretch of Harshauli drain was conducted to know the infiltration rate of the expected water storage area created by the two water harvesting structures in the drain. Initial and final infiltration rate varied from 100 to 200 mm/hr and from 3.5 to 5.3 mm/hr, respectively. The soils of stream bed in the selected stretch vary from silt to silty loam, showing wide heterogeneity in surface soils of stream bed. While Infiltration rate in cultivated land varied from 6.9 to 10 mm/hr. Information on private tube wells owned by the farmers of Rashulpur Jaton village was collected and information were triangulated with other farmers and cross checked scientifically. Presently total 141 tube wells equipped with submersible pump and electric motor are operational in the village, having average irrigation command area - 2.36 ha and spread over 333.97 ha agricultural land of the village. In the vicinity of village, the depth of tubewell varies from 80 to 320 ft and power of pumps equipped with the tube wells varies from 7.5 to 15 hp. For irrigation, water from tube wells to the farms is conveyed through open water courses which are on an average 0.6 m wide and 0.3 m deep. Analysis of data shows that around 0.65% (2.18 ha) of the total cultivated lands of the village is under water courses made for irrigation by the tube wells. By considering 0.15 to 0.3 m strip along either side of the water courses normally lying uncultivated, the effective area covered under watercourses gets around 1% of the total cultivated land of the village.

Four piezometers were installed at various locations along the line which is perpendicular to the drain and intersecting near the innovative water harvesting masonry structure (WHS-II) constructed closer to Harsauli village in vicinity of the adopted village – Rasulpur Jaton, Data on water table from all the four piezometers are being collected and analysed with an objective to observe the impact of water harvesting structure on ground water table in proximity of the structure. Analysis of groundwater samples collected from 12 locations from Muzaffarnagar district indicate that the quality parameters taken for this study were well within the permissible limits of drinking water and are as per with BIS standard (IS 10500:2012). Some variations within the parameters were observed, that may be due to anthropogenic/geogenic additions only.

Study on pollution status of Yamuna River and its impact on soil and crop health in Western U.P. (Rama Pal, S.K.Dubey, R.K.Dubey –Agra)

The analysis of heavy metals (Fe, Pb, Cd, Zn, Cu and Mn) in Yamuna river water at Akbara site (S3/A1) in Agra district (U.P.) was carried out for the winter season (Table 3). Except the concentration of Mn, all the heavy metals analysed were below their permissible limit for irrigation water given by FAO, 1994.

Table 3: Heavy metal content in Yamuna river water for winter season at Akbara site, Agra (U.P.)
The assessment of effect of irrigation with Yamuna river water enriched in various nutrients was carried out

Heavy metal	Yamuna river water (µg/l)	Permissible limit for irrigation water (µg/l)
Fe	252	5000
Pb	1	5000
Cd	0.0	10
Zn	1440	2000
Cu	100	200
Mn	220	200

on grain and straw yield as well as yield attributes of wheat crop under field conditions at Akbara area of Agra district in UttarPradesh, India. The results revealed that number of plants/m^2, number of ears/m^2, length of ears, plant height (cm) and yield (q/ ha) were higher in crop irrigated with Yamuna river water over crop irrigated with groundwater (Table 4). The study further showed that mean grain and straw yield of wheat crop was enhanced by 30% and 42% on irrigation with Yamuna water over the irrigation with groundwater, respectively. Therefore, irrigation with Yamuna river water was quite promising in wheat crop that can to a large extent reduce the exploitation of depleting valuable groundwater in an stretch of about 200 Km from Agra toEtawah.

Table 4: Effect of Yamuna river water irrigation on productivity parameters of wheat crop.

Irrigation source	Plant height (cm)	No. of mother shoots/m2	Number of ears/m2	Length of ears (cm)	Test weight (1000 seeds)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
YW	87 ± 3.3	65.34 ± 2.10	275 ± 4.2	9.6 ± 0.45	38.9 ± 0.34	21.11 ± 1.12	28.86 ± 1.34
GW	70 ± 2.1	48 ± 1.56	176 ± 3.2	6.7 ± 0.67	32.3 ± 0.27	16.24 ± 1.23	20.33 ± 2.22

The content of heavy metals in wheat grains (Table 5) were found below the permissible limits prescribed in Indian Prevention of Food Adulteration Act (PFA, 1954).

Table 5. Heavy metal analysis of wheat crop (mg/g) irrigated with Yamuna river water

Heavy metal	GW irrigated	Yamuna river water irrigated	Permissible limit (PFA, 1954)
Fe	ND	0.58 ± 0.003	-
Pb	ND	ND	2.5
Cd	ND	ND	1.5
Zn	0.23 ± 0.004	1.65 ± 0.012	50
Cu	0.32 ± 0.003	1.23 ± 0.02	30
Mn	0.10 ± 0.006	0.25 ± 0.006	-

Evaluation of direct recharge filter for revival of defunct and low yielding bore well vis-à-vis augmentation of ground water table in semi-arid region of Karnataka (B.S. Naik and S.L. Patil-Ballary)

This project was initiated during 2017-18 to rejuvenate the drying and low yielding bore wells in the semi-arid region of Karnataka. Till 2018, out of the seven recharge filters consisting of 4 nos. of Type 1 (5 m × 5 m × 1.5 m) and 3 nos. of Type-2 (3 m × 3 m × 3 m) were constructed for selected bore wells in farmers' fields at Netranahalli and Meramanahalli villages in Molakalmur taluk in Chitradurga district, only 4 bore wells are presently working and remaining 3 are dried up. The drying and low yielding of 3 bore wells are attributed to continuous drought and occurrence of low rainfall of 273.5 mm, 425.4 mm and 254.4 mm during 2016, 2017 and 2018 respectively, followed by excess extraction of ground water. During 2018, the ground water level in bore well 1, 3 and control-1at Netranahalli, varied from 60.96 to 74.1 m, 51.81 to 67 m and 63 to 76.8 m, and at Meramanahalli in bore well 6, 7 and control-2, it varied from 17.67 to 28 m, 25 to 39 m and 26 to 41 m, respectively. During 2018, in all bore wells, the water levels improved from June after receiving 79 mm rainfall in May and it continued up to October and then started depleting due to cessation of rainfall. Higher bore well yields of 33, 50, 28, 45, 50 and 28 lpm were

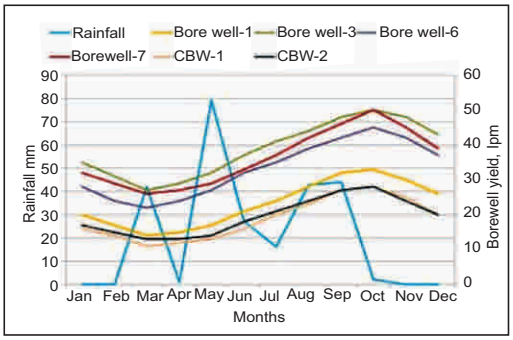


Fig. 16 : Rainfall trend and bore well yield during 2018.

observed in bore well 1, 3, control-1, 6, 7 and control-2 in the month of October. The trend of rainfall and bore well yields in all the selected bore wells during the year 2018 is presented in Fig.16.

During 2018, the total area irrigated under bore wells 1, 3, 6 and 7 with recharge filters was 5.75 acres. The daily pumping hours during 2018 in the above bore wells varied between 2 to 4 hours compared to 4 to 6 hours during 2017. During 2018, maize grain yield of 5 q from 0.5 acre, and 10.50 q of sorghum yield from 0.5 acre was produced under bore well 1, wherein it was 32 q of sorghum from 1.5 acre under bore well 3. In bore wells 6 and 7, the farmers produced tomato and chilli yields of 11.50 q and 5 q from 1.5 acre, and 12.20 q and 8.50 q from 0.75 acre and 1 acre, respectively. The lower crop yields during 2018 compared to 2017 was due to low rainfall and decreased ground water level that resulted in reduced quantity of water application during irrigation.

Estimation of water budget components for predominant land uses of South-Eastern Rajasthan for conservation planning (G.L. Meena, R.K. Singh and H. R. Meena-Kota)

Predominant six land use systems i.e.T_1- Agriculture- Rainfed soybean, T_2- Agri-horticulture: Soybean+ Sapota (*Manilkara achras*), T_3-Horti-Pastoral: *Emblica officinalis* +*Cenchrus ciliaris,* T_4-Pasture: *Cenchrus ciliaris*,T_5-Silviculture: *Acacia nilotica* plantation, and T_6- Silvi-pasture: *Acacia nilotica* + *Cenchrus ciliaris of the study area were studied over* 0.81 ha *area in three replication fashion.* During 2018, the area received total seasonal rainfall of 798.0 mm ,which occurred in 42 events. During the reporting period, total 15 runoff producing events were recorded with 475.30 mm rainfall. The runoff generation pattern of the selected land use systems was T_6 (10.42%) < T_4 (8.26%) < T_1 (6.96%) < T_6 (6.61%) < T_2 (6.35%) < T_3 (4.92%) while the sediment yield from the selected land use systems revealed the trend as T_3 (0.37 ton/ha) < T_6 (0.44 ton/ha) < T_5 (0.54 ton/ha) < T_2 (0.69 ton/ha) < T_4 (0.97 ton/ha) <T_1 (1.75 ton/ha) which follow near about same temporal trend.

Strategies for rainwater harvesting and its multiple uses in rainfed agriculture in Central Gujarat (P.R. Bhatnagar, D. Dinesh, V.C. Pande and V. Kakade-Vasad)

Harvesting of rainwater in different topo sequences and its efficient utilisation for maximising benefits are a challenge, especially, in semi-arid regions where less amount of rainfall occurs in intense storms with intermediate long dry spells. strategies were made for rainwater harvesting in top portion of this sequence where only direct rainwater is available to be stored. Second topographic condition pertains to mid-lands where overland flow is available in addition to direct rainfall. Two rainwater harvesting interventions were developed under the project viz. 1) Techniques for collection of rainwater in small water tanks (Jalkunds) for establishment of upland horticulture, 2) both plastic film lined ponds that harvest storm water with provisions of multiple commodity production in spatially temporally. The interventions were meant to sustainable water availability for better production and income.

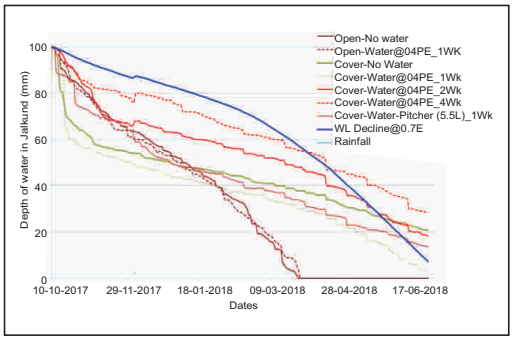


Fig. 17: Water level in Jalkunds under different treatments during 2017-18 period.

The study on Jalkund evaluation was started in 2016-17 with construction of 24 numbers of "Jalkunds" for eight treatment of water application modes to target custard apple crop. The LDPE (low density polyethylene) lined Jalkunds of 3.0 x 1.5 x 1.0 m size were constructed to collect rainwater. The peripheral bunds around the Jalkund were designed to increase the catchment area by 50% to collect 1.0 m depth of rainwater after allowing losses due to evaporation.

A grass thatched bamboo frame with an LDPE film cover was constructed over Jalkhund with provision of a small opening (50x50cm) to allow eventual irrigation as & when required. The treatment includes water application at 0.40 times of pan evaporation, while in no irrigation means application of 1.0 L of water as lifesaving irrigation. The water application interval one, two or four week over the availability of water. Fig.17 &18 indicates that if the Jalkunds area is kept open, the entire water gets evaporated by 12th March over no withdrawal. While under covered condition, the water availability extends upto end of June. On the

Fig. 18 : Jal kunds with grass thatch cover and open condition.

other hand, the expected water level worked out considering water withdrawal at (IR/PE=0.4) weekly and evaporation at IR/PE=0.7 PE level as referred in literature indicates complete removal of water by end of June.

Field evaluation of ground water recharge filters developed by ICAR-IISWC, Vasad (Gaurav Singh and V.C. Pande- Vasad)

The different types of groundwater recharge filters designs developed by ICAR-IISWC, RC-Vasad have been constructed in farmer's field under different watershed programs and under transfer of technology. The groundwater recharge filters were evaluated in the laboratory with limited field data. Therefore, this project was taken in 2017 to evaluate various designs of recharge filters developed by ICAR-IISWC, RC-Vasad.

- to evaluate designs of groundwater recharge filter constructed by ICAR-IISWC, RC-Vasad under field condition in terms of efficiency and working life
- to workout appropriate recommendation for existing design under varying field and hydrologic condition

The anti-gravity filter concept based two stage upward-downward flow type recharge filter design as shown in Fig. 19 was evaluated in field conditions at research farm Vasad. Seven runoff generating rainfall events were observed during 2018. The peak recharge rate through the recharge filter was 2.43 l/s. The average sediment filtering efficiency was 93.64%. The maximum deposition was observed in the top 5-10 cm of sand layer in downward flow section of the recharge filter design. This resulted in the formation of hard layer which restricts the downward movement of runoff in this section of the recharge filter.The anti-gravity concept based single stage upward flow type recharge filter design is shown in Fig. 20 was tested with artificially prepared runoff water at different discharge rates of 4.2, 3.3, 2.5 and 1.7 litres per second and sediment concentration of 3, 2.5, 2.0, 1.5 and 1 gram per litres. The peak discharge capacity of the one stage upward flow recharge filter was 1.3 litres per second, which was 53% less as compared to two section upward-downward flow type recharge filter.

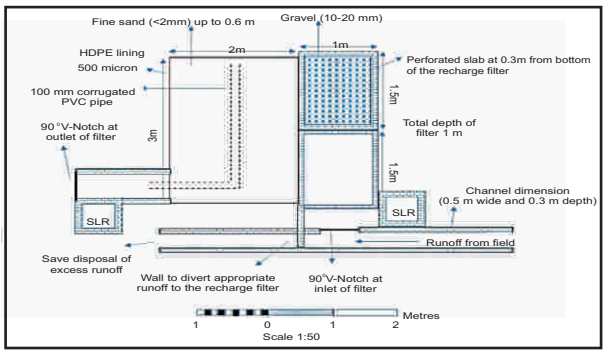


Fig. 19 : Anti-gravity concept based two stage upward-d ownward flow type recharge filter design (top view)

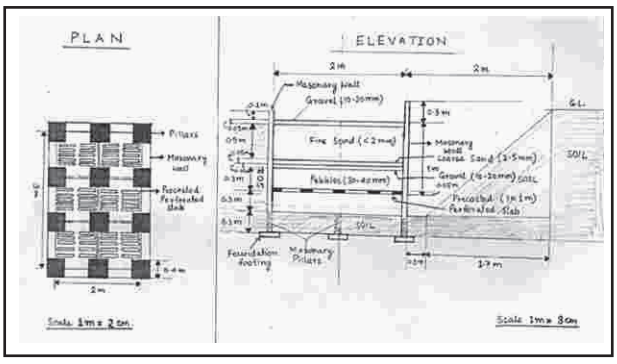


Fig. 20: Anti-gravity concept based single stage upward flow type recharge filter design

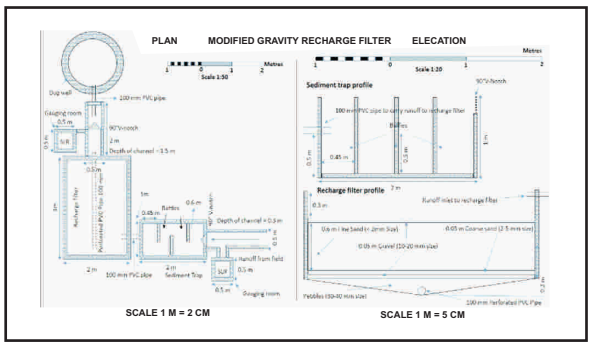


Fig. 21 : Gravity concept based single stage flow type recharge filter design

The gravity concept based one section flow type recharge filter design as shown in Fig. 21 was constructed for field evaluation at Village Navagam, Taluka Halol and District Panchmahal in farmer's field during 2018.

Design and evaluation of HDPE Embedded Gabion Checkdams for Water Harvesting in North-West Himalaya (Ambrish Kumar, Rajesh Kaushal and Gopal Kumar-Dehra Dun)

The project was initiated in 2018 after realizing the results of observation trials done in previous years. Gabion checkdams (GCD) are used to slow the velocity of concentrated runoff or to stabilize stream bed and bank slopes but they are not effectively used for water harvesting due to its permeable nature. Studies reveal that GCD acts as a partially water harvesting structure (WHS) after 2 to 3 years by filling up the voids of the stones packed in the wire crate. Meanwhile, the upstream water storage area gets silted up and there is rare possibility of water storage. In the backdrop of the above issues, the project is formulated with the objectives, *viz;* i) Design and development of HDPE sheet embedded gabion checkdams for water harvesting structures, ii) Evaluating the efficacy of HDPE material as impervious barrier in gabion checkdams, and iii) Assessing the economical variability of the system. A general view showing sub & super structure of the ECD is presented in Fig-22.

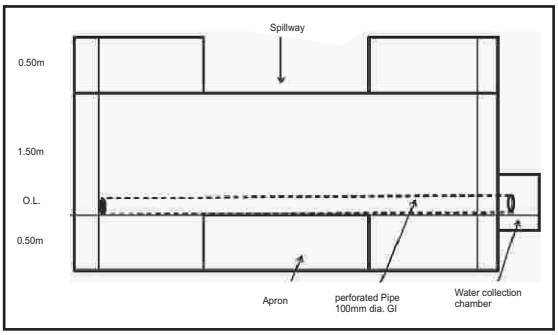


Fig. 22 : A general elevation of the embedded check dam

Sites for construction of two embedded check dams (ECD) were selected at different streams in Dharkot village in district- Dehradun adopted under model watershed development programme executed by Uttarakhand State Watershed Directorate. Both of the ECDs were designed befitting with the stream size and scope of the sites, comprising dimensions – 4.5 x 2.5 x 2.0 m (Dharkot-1) and 7.50 x 2.5 x 2.0 m, Dharkot-2), respectively. HDPE sheet (750 Micron) is embedded in both the ECDs vertically in the gap made between two gabion walls and it has been well packed with sand that functions like cushion between gabion walls & sheet. First ECD (Dharkot-1) is equipped with outlet chambers connected with 3 inch delivery HDPE pipeline for irrigation to adjoining cultivated fields (plat-1). Second ECD is connected with masonry tank constructed down the ECD and suitably located to irrigate the down slope cultivated fields (Fig.23). Third site was selected at Satyon village, District- Tehri Garwal for construction of ECD and active flash flood zone of the stream is marked with layout for *salix* plantation, aiming to protect the cultivated land lying either sides of stream from erosion.

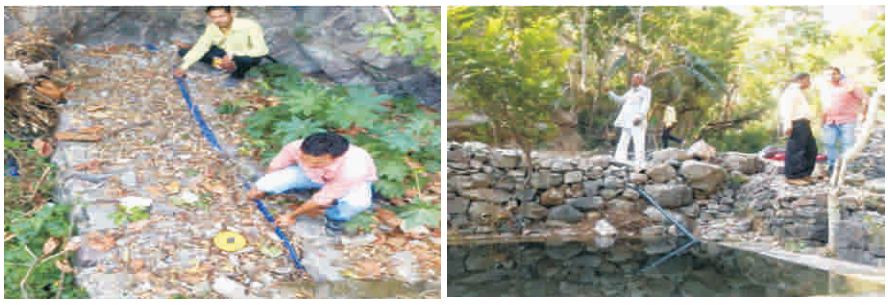


Fig.23 : Embedded checkdams: Dharkot-1 (L) and Dharkot-2 (R) constructed at Dharkot, Dehra Dun

02 RESEARCH ACHIEVEMENTS

P- 4: REHABILITATION OF AREA AFFECTED BY MASS EROSION

4.1. Development and refinement of technologies for rehabilitation of ravines, landslides, mine Spoils, riverbed mining, stream banks, torrents etc.

Ecological restoration of stone mine spoil areas in south eastern Rajasthan (B.L. Mina, S. Kala, H.R. Meena, Shakir Ali and Ashok Kumar-Kota)

Of the 11 tree species, the best performing four tree species identified at nursery stage during 2015, viz., *Acacia nilotica, Inga dulce, Syzygium cuminii and Pongammia pinnata* were transplanted in main plot and subplots for field evaluation at Laxmipura stone mine spoil mines area at Ramganjmandi in Kota district of Rajasthan in July 2016. Among the four tree species highest survival rate of plant was recorded with *Karanj* and lowest with Jamun. Among the different rooting media treated plot, highest survival rate of *Karanj*(93.3%) and *Jungle jalebi* (66.7%) was recorded under Soil + FYM with gunny bag plot. While, the highest survival rate of *desi babool* (80%) and Jamun (28.3%) was recorded with Soil and soil + FYM treated plots, respectively. Among four tree species, highest survival rate of *Desi babool (Acacia nilotica*) and *Karanj* (Pongamia pinnata) were observed in pit-1 over pit-2. While, highest survival rate of *Jungle Jalebi* and *Jamun* was observed in pit -2. The growth performance of different plant species was monitored at six month intervals.The growth performance of tree species in terms of plant height and collar diameter was recorded at the end of 30 months after planting of tree species. Among four tree species, *Desi babool (Acacia nilotica*) and *Jungle Jalebi(Inga dulce*) were performing better in terms of plant height and collar diameter at stone mine spoil site. Among the different tree species highest plant height and collar diameter was recorded with *Desi Babool* followed *Jungle jalebi, Karanj* and lowest with *Jamun*. Planting techniques which involves pit size and rooting media did not show any clear trend with respect to growth performance among the tree species. Among the different rooting media, Soil + FYM with gunny bag treated plot support the higher plant height of *Karanj, Jungle jalebi* and *Jamun*. While, Soil + mulching treated plot support the higher plant height of desi babool. Similarly, higher collar diameter of *Karanj* and *Jungle jalebi* was recorded with Soil + FYM with gunny bag treated plot. However, higher collar diameter of *Desi babool* and *jamun* was recorded with Soil + Mulching and Soil + FYM, respectively. Among the four tree species, highest plant height of *Karanj* and *Jamun* was recorded in pit size-1. However, highest plant height of *Desi babool* and *Jungle jalebi* was recorded in pit size-2. Similarly, highest plant collar diameter of *Karanj, Jungle jalebi* and *Jamun* was recorded in pit size-1, while higher collar diameter of *Desi babool* was recorded in pit size-2 at laxmipura mine spoil site.

Field evaluation of design of trenches under different agro-climatic regions

Vasad (P.R. Bhatnagar and D. Dinesh)

In order to optimize the design of trenches, a core project was started at 7 centres of the institute to cover different Agri-eco zones of the country. The design storm was worked out after analysis of maximum daily rainfall data for 2 years of return period. Four small watersheds were selected and imposed three treatments of staggered trenches with 30, 50 and 80% retention of runoff from design storm, and fourth as control. The four watersheds were gauged for calibration during 2011-14. However, no specific trend was observed between rainfall and runoff for the watersheds as R^2 was found to be non-significant. As a result rainfall-runoff relationship could not be established even with all the events combined from 2011 to 2014. Hence, watershed response before and after implementation of treatments, may be used for evaluation of treatments. Comparison of watersheds indicate no trend between WS (control) with any other treated watershed (non-significant R^2). But, watershed WS (30%) has good correlation with watersheds (WS 50% and 80%) .as shown in Fig 1. Morphologic parameters indicate that WS (Control) is relatively more circular (circularity ratio Rc 0.849) and compact, while WS (30, 50, 80%) are relatively elongated (Rc 0.68, 0.59, 0.66,

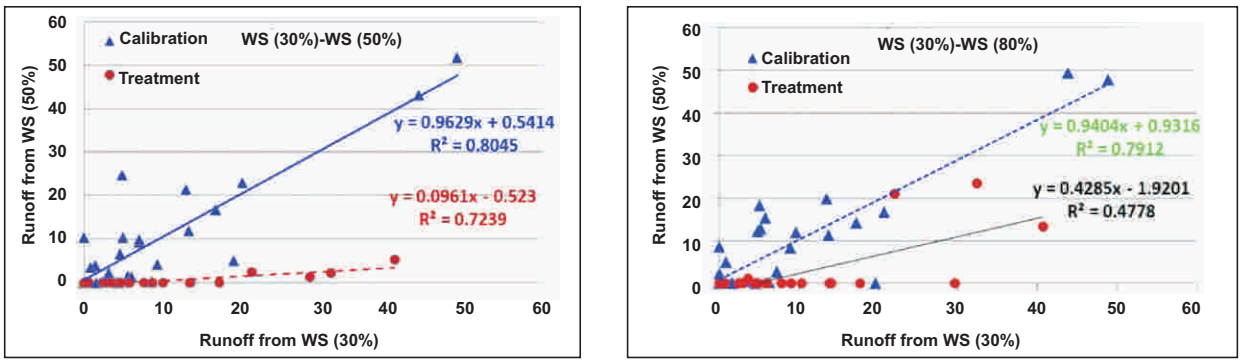


Fig.1 : Comparison of Watersheds (50% and 80%) with Watershed (30%) during calibration period (2011-14) and treatment period (2015-18)

respectively). This may be the reason for different behaviour of WS(Control) as compared to other watershed, while other watersheds have good correlation among them.

The effect of trench densities on runoff, sediment yield and vegetation was started for monitoring from 2015 to 2018. But, due to subnormal rainfall occurred during the three years viz. 2015 (406.2mm, 48% of normal), 2016 (559.8 mm, 65% of normal) and 2017 (654.6 mm, 77% of normal) recorded negligible runoff from control and 30% treatment only and other had no runoff (Fig 2). During 2018, a rainfall of 826.5 mm rainfall occurred that resulted insignificant runoff and sediment flow. The runoff reduction due to treatment is clearly shown in Fig 3. A substantial reduction in runoff was observed for treatments with higher trench densities (50% and 80%) as compared to 30%. The sediment loss observations are given in Fig. 4.

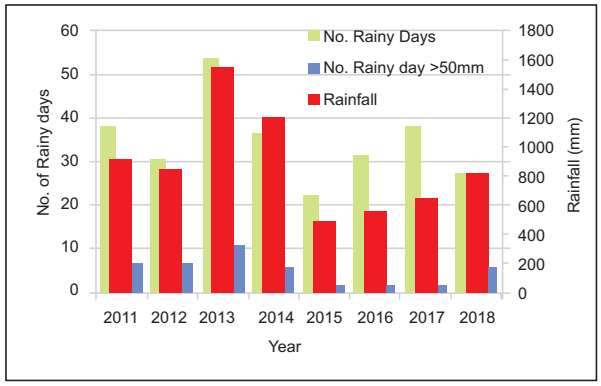


Fig. 2 : Rainfall and Rainy days during 2011-18

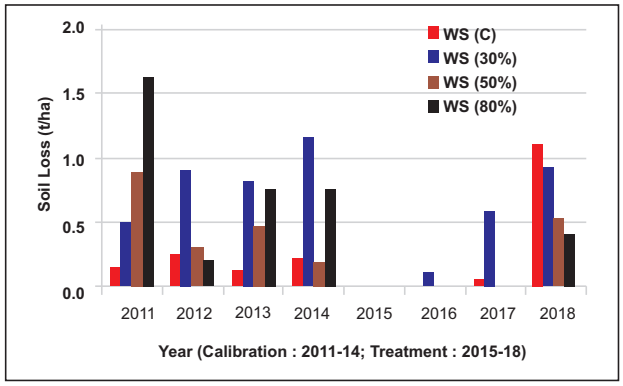


Fig. 3 : Soil loss from different watersheds during Calibration and treatment period

Azadirachta indica (Neem) was planted in July 2014 at 6 x 6m spacing in the watersheds and data on sapling survival was collected regularly during the month of December. The survival in 2014 was good, however, mortality of tree saplings increased during summer due to moisture stress over the subsequent periods. Therefore, mortality replacement was done during monsoon every year thereafter. Though, there were some damages due to wild life interferences, the temporal survival trend followed, by and large, the rainfall pattern in the study site from 2015 onwards. Except for the year 2015, the post monsoon data of *neem* sapling survival also followed the trend of trench intensity in the four watersheds (Fig. 4). It can be, therefore, interpreted that trenching in the catchment helped survival of tree saplings. But the low survival (less than 50%) over the years suggested that life

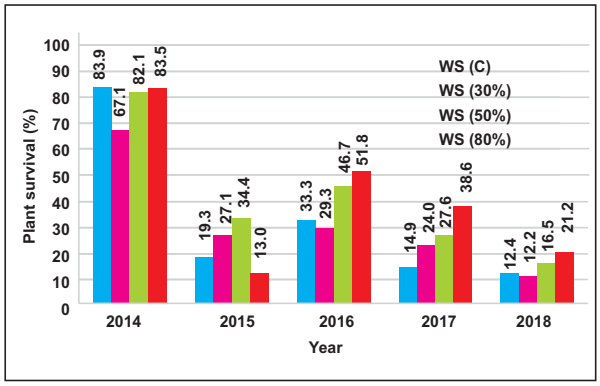


Fig. 4 : Survival of Azadirachta indica (Neem) under different treatment of trench densities in watersheds

saving irrigation should be given to saplings to withstand the high moisture stress conditions during summer period prior to onset of rains.

Agra (A.K. Parandiyal, K. K. Sharma and R.B. Meena)

This project aims at assessing the impact of different trenching densities (trenching for 0 %, 30 %, 60 % and 80 % runoff trapping capacity) on survival and growth of seedlings of *Pongamia pinnata* planted in Yamuna ravines. The study also aims to identify design storm, size and trenching intensity, to quantify resources conserved, to suggest optimum option by devising a DSS and to promote better design of trenches and transfer it to field. Four watersheds having an area of 0.206, 0.290, 0.197 and 0.155 ha have been selected under degraded Yamuna ravines with slope ranging from 8.5 to 15.4 % at research farm of the centre. During 2018 the total rainfall of 767.8 mm was recorded, out of which 711.5 mm occurred during June to October. During this period 19 storms of more than 10mm rain, 13 storms of >20mm rain, 5 storms of >30 & 40mm and 3 storms of >60mm rain were recorded. The distribution of rainfall during monsoon year 2018 in research farm is presented in Table-1. Maximum runoff was recorded in control watershed while the watershed treated with trenches having 80% runoff trapping potential generated minimum runoff (2.94% of runoff causing rainfall). Similarly the soil loss from control watershed was highest and lowest soil loss (0.09 t/ha) was recorded in watershed HF4 (80% runoff trapping potential). The runoff conserved by trenches was calculated as 91.18% against 80% runoff conservation potential in HF4, 87.52% against 60% runoff conservation potential in HF 3 and 57.30% against 30% runoff conservation potential in HF 2 respectively. One year old seedlings of *Pongamia pinnata* were planted in three watersheds namely AGA FS-10, AGA FS-11 and AGA FS-12 during July 2015. One watershed (AGA FS-9) was not planted and is being treated as control. The survival of seedlings was affected adversely due to low rainfall and high biotic pressure of blue bull during first planting season and ranged from 55.1% to 62.82% six months after planting. Replacement of causalities was carried out during monsoon. The survival during 2018 ranged from 86.1% to 94.52% in the three watersheds. The current annual increment in the planted seedlings both in collar diameter and height was highest in HF 3 (treated with trenches having 60% runoff trapping potential) among the three watersheds. The survival and growth parameters of *Pongamia pinnata* are presented in Table 2.

Table 1:- Distribution of Rainfall during the monsoon year -2018 of Agra district

Months	Rainfall (mm)	Rainfall storm (Runoff producing rainfall)				
		> 10.0 mm	> 20 mm	> 30 mm	> 40 mm	> 60 mm
June	38	36.8	0	0	0	0
July	370	341.8	278.3	231.5	231.5	178.5
Aug.	216.6	61	119	119	119	67
Sept.	86.9	47.2	47.2	0	0	0
Oct.	0.0	0	0	0	0	0
Total	711.5	486.8	444.5	350.5	350.5	245.5

Table 2:- Survival and growth parameters of *Pongamia pinnata* during two seasons after Planting in Yamuna ravines

Watershed	(AGA FS-10)	(AGA FS-11)	(AGA FS-12)
Survival % till Jan. 2019	86.1	92.72	94.52
Height (m)	1.18	1.78	1.36
CD (cm)	9.38	11.95	11.49

Status of pre-monsoon and post monsoon soil basic properties were assessed at four watersheds. Trenches in Ravine watershed are depicted in Fig.5. In the control watershed maximum moisture retention was recorded at ravine bottom followed by ravine slope and least at the ravine top throughout the observation period and at both soil depts. In the three treated watersheds, three trenches, located at top and bottom were selected in each watershed. Soil moisture was recorded at thee points near each selected trench *viz.* at 1meter distance above the selected trench, at 0.5m, 1m and 1.5m distance, on the downstream side of trench. Monthly monitoring of soil moisture was carried out during pre and post monsoon as well as during monsoon. The highest soil moisture was recorded at 0.5 m distance from trenches in all locations on all months which

Fig. 5 : Trenches in Ravine watersheds

progressively declined with increasing distance from the trenches. This clearly indicates the impact of trenches in improving soil moisture regimen. The basic soil fertility data of the experimental site was recorded. The EC varied from 0.13 to 0.22 dsm^{-1} 0.13 to 0.43 $dsm^{-1}$and 0.16 to 0.36 dsm^{-1}at top, middle and bottom respectively. Similarly, pH of experimental site found normal (8.03 to 8.54) in range whereas organic carbon ranged from 0.28 to 0.78 percent. Available nitrogen, phosphorus and potassium recorded low (87.81 to 175.62 kg/ ha), low (3.25 kg / ha) to medium (14.48 kg/ha) and medium (145.60 to 268.80 kg/ ha) respectively.

Chandigarh (V.K. Bhatt, Pankaj Panwar)

Three micro watersheds were selected within the research farm of centre for evaluation of different intensity of trenches. Land use of these watersheds is sparse mixed deciduous forest. Slope of these micro watersheds varied from 35.8 to 52.5%. These micro-watersheds are equipped with gauging structures and recorder houses. Runoff is being gauged through 0.3 m deep 90^{0} sharp crested weirs supported with water stage recorders. Three treatments were imposed in all the micro watersheds. Areas of micro-watersheds vary from 750 to 1225 sq.m. Three treatments with 30, 50 and 80% retention of runoff from design storm were used in order to determine number of staggered contour trenches in each micro watershed. Runoff was recorded during monsoon season of 2014 to 2018 from all the four micro watersheds. Calibration of all the watersheds was done during monsoon of 2014. Year wise runoff analysis indicates that runoff varied from 8.3 to 16.8 % of rainfall (Table 3) in all the micro watersheds. Micro watershed MWS 39 having trenching intensity of 80% produced minimum runoff. Average soil loss varied from 22 to 98 kg/ha.

Soil moisture percentage varied under different micro watersheds. It ranged from 2.03 to 8.55 % in MWS-36, 2.23 to 9.97 % in MWS-37 and 3.32 to 12.3 % in MWS-39, respectively, during monsoon season. Soil moisture was found highest near MWS 39 micro watershed having trenching intensity of 80%

Table 3. Runoff (mm) and from three micro watersheds during 2015-2018

Year	Rainfall, mm	Runoff, mm		
		Micro Water Shed 36	Micro Water Shed 37	Micro Water Shed 39
2015	532.3	126.9	122.4	65
2016	552.4	109.98	91.16	51.311
2017	665.1	170.1	106.1	88.5
2018	750.1	12.16	10.93	3.47
Total	2499.9	419.14	330.59	208.281
%		16.8	13.2	8.3

Datia (Monalisha Pramanik and SP Tiwari)

The field evaluation of design of trenches under different Agri-ecological zones was continued in sixth year with objective to determine optimum design of trenches in Bundelkhand region. One day maximum rainfall of two years return period was computed for the design purpose. Experimental site consist of four micro-catchments W1, W2, W3 and W4 of 0.70, 0.23, 0.27 and 0.40 ha area, respectively having variable slope of up to 3.00 %. Event wise rainfall and runoff under different watersheds is shown graphically in Fig. 6. Runoff and soil loss (Table 4) were observed maximum in W1 (397 mm and 10.2 t ha^{-1} respectively), while minimum runoff and soil loss in W4 (60.3 mm and 1.10 t ha^{-1} respectively). The continuous and high intensity of rainfall during the monsoon have significant effect on the runoff and soil loss.

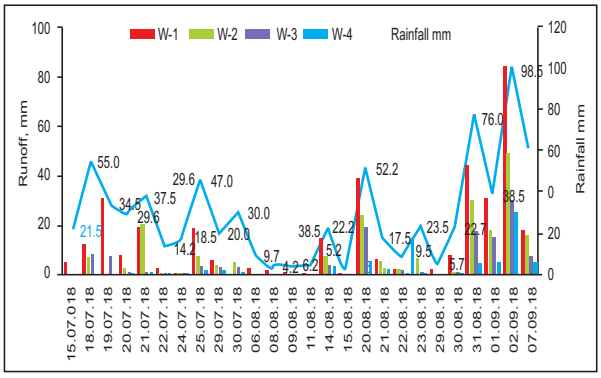


Fig. 6 : Event wise rainfall and runoff recorded in different micro-catchments during 2018

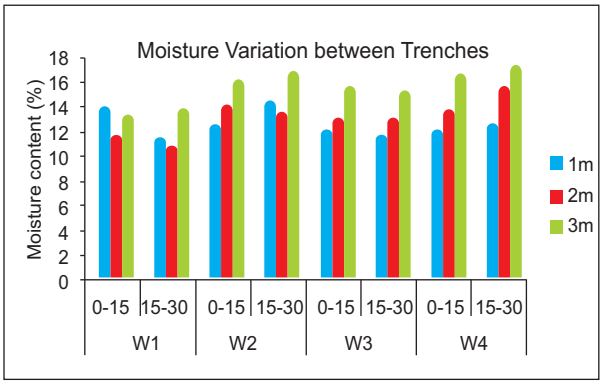


Fig. 7 : Moisture content at 0-15 and 15-30 cm soil depth at 1 m HI from trench to trench

Table 4: Runoff and soil loss in different watersheds during the year 2018

Watershed	Catchment Area (ha)	Runoff (mm)	Runoff (%)	Soil Loss (t ha^{-1})
W-1	0.70	397	51.8	10.2
W-2	0.23	212	27.6	6.30
W-3	0.27	135	17.6	3.40
W-4	0.40	60.3	7.87	1.10

Table 5: Plant growth parameters of *Pongamia pinnata*

Year	W-2 (30 % runoff retention)		W-3 (50 % runoff retention)		W-4 (80 % runoff retention)	
	CD (cm)	Height (cm)	CD (cm)	Height (cm)	CD (cm)	Height (cm)
Jan. 2018	3.00	217	2.10	168	2.80	148
Jan. 2019	4.20	267	2.70	210	4.10	252
Current Annual Increment	1.20	49.7	0.60	41.9	1.30	104

The trench design and density in different catchment was estimated using the DSS software. Accordingly, a number of 53,109, 198 trenches have been constructed to retain 30, 50 and 80 % runoff in W2, W3 and W4 micro catchments, respectively keeping W1 as control without trenching treatment in 2015. Karanj (*Pongamia pinnata*) was planted at 6 × 6 m spacing during monsoon 2015. The growth parameters (Plant height, collar diameter) of randomly selected 15 plants of each micro-watershed were recorded during 2017 & 2018 and found maximum current annual increment in W4 followed by W2 and W3 (Table 5). The current annual height incremental varied between 41.9 to 104 cm and collar diameter increment varied from 0.600 to 1.30 cm.

The soil moisture samples were taken from 0-15 and 15-30 cm depth with 1m horizontal interval from one trench to another trench in the upper, middle and lower reach of each micro-watershed. The highest soil moisture content was recorded at 3 m from trench due to the effect of slope and moisture movement from the adjacent trench (Fig. 7). Also the similar moisture pattern was observed in 1m interval from trench to trench distance.

Koraput (D.C. Sahoo, H. Gowda and P.P. Adhikary)

A field evaluation of design of trenches under different agro-climatic regions has been initiated as a core project during 2011-12 with the objectives (a) to identify design storm, size and trenching intensities, (b) to quantify resources conserved, and (c) to suggest optimum options by devising a DSS. The experimental site consisting of four watersheds W-1, W-2, W-3, W-4 has been selected having area of 0.1708, 0.1748, 0.1722 and 0.1702 ha respectively in the degraded land having 8.0 % of average slope.

The total runoff producing rainfall was 1383.3 mm during the year 2018 from 30 rainfall events. Runoff obtained from W-1 (80%), W-2(50%), W-3(30%) and W-4 (control) watersheds are 12.2 %, 12.7%, 17.6% and 29.9%, respectively (Fig.8). There is reduction in runoff as a result of trenching by 59.3%, 57.4% and 41.0 % in W-1, W-2 and W-3, respectively over the control watershed. Average runoff from watersheds before trenching (2012-2014) were in the range of 28.9-33.3 % of rainfall. After trenching followed by plantation of *Acacia Mangium*, the average runoff (2015-18) reduced to the range of 8.0-13.2 % of rainfall in the treated watersheds with minimum runoff of 8.0% in the watershed W-1(80%) followed by 9.8 % runoff in W-2(50 %) and 13.2 % runoff in W-3(30%). In the control watershed W-4(0), there is little reduction from earlier quantity may be due to the plantation effect. The average runoff reduced to 72.5 %, 70.7%, 55.8% and 26.5% after trenching followed by plantation in comparison to the respective runoff before trenching in the watershed showing the treatment effect during the project period. The soil loss in all the watersheds are very less irrespective of any treatments may be due to the undisturbed surfaces over the years covered with good grass/weeds during monsoon. However, the annual soil loss observed as 4.1, 4.5, 5.3 and 11.5 t/ha from W-1, W-2, W-3 and W-4, watersheds respectively. The reduction in soil loss as a result of runoff reduction due to trenches are 64.7%, 61.0 and 53.7% in W-1, W-2 and W-3, respectively over the control watershed (Fig.9).

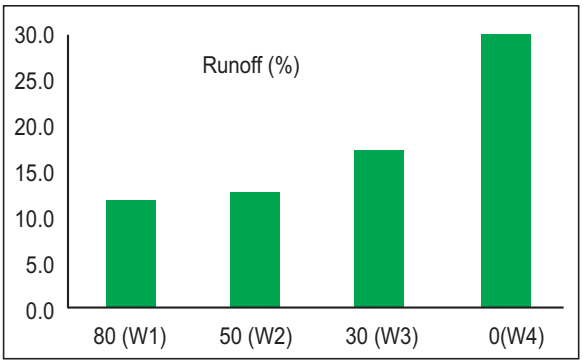


Fig. 8: Runoff (%) under different watersheds

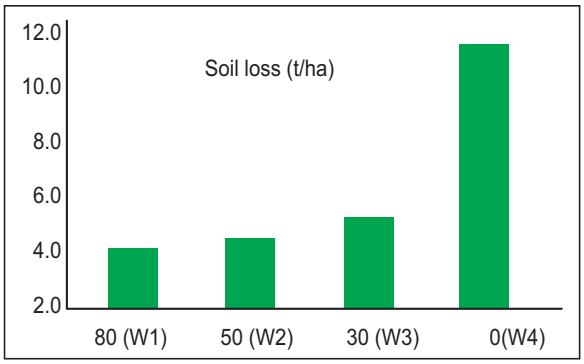


Fig. 9: Soil loss under different watersheds

Post monsoon soil moisture monitored at the soil depth of 0-20 cm and 20-40cm. The watershed size is being small, there is only within 1 % soil moisture variation in lower to middle and upper reaches. Slight increase in the soil moisture was found in the soil depth of 20-40 cm in all the watersheds. Minimum soil

moisture is found in control watershed in comparison to treated watersheds may be due to high runoff combined with poor vegetation cover. The average soil moisture varied in the range of 14-24 % in all watersheds. There is minimum variation in soil moisture among treated watersheds with maximum of 23.6-24.1 % in W-1(80%) followed by 22.2-22.4 % in W-2(50%) and 19.8-20.3% in W-3(30%) watershed. However, wide difference in soil moisture (14.2-14.9 %) between control watershed and treated watersheds (Fig.10).

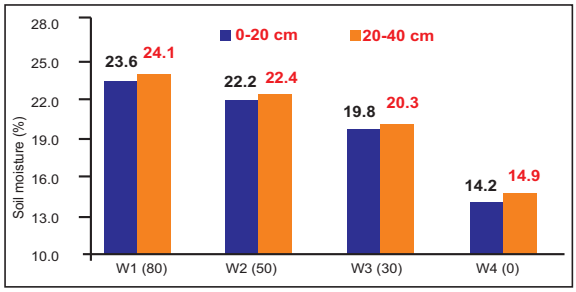


Fig.10: Soil moisture (%) at 0-20 and 20-40 cm depth

Kota (Shakir Ali and S. Kala)

The project was initiated in April, 2011 with the objectives of identifying design storm, size and trenching intensity; quantifying resources conserved; and suggesting optimum option by devising a decision support system (DSS). The three micro-watersheds namely; W_1 W_2, W_3 and W_4 located in Dhoti watershed was monitored hydrologically for the calibration purpose. The area of the watersheds W_1, W_2, W_3 and W_4 are 0.75, 0.50, 0.45 and 1.00 ha. The calibration prediction equations for runoff and soil loss have already been established utilizing the runoff and soil lossdata for the period 2012-14. *Acacia nilotica* seedling at spacing of 4.5 m x 4.5 m and *Cenchrus ciliaris* grass at 50 cm x 50 cm spacing in interspaces between *Acacia nilotica* were planted uniformly in all trenching treatments in July 2014. During the year under report, the area received 1045.4 mm rainfall through 32 events. Runoff producing events were recorded 9 with rainfall amount of 911.8 mm. The runoff generating potential of the W_1, W_2, W_3 and W_4 micro-watersheds was recorded of 17.1, 12.9, 10.3 and 4.7% of monsoon rainfall and respective sediment yields was of 10.546, 7.459, 6.784 and 2.104 t $ha^{-1}yr^{-1}$, respectively. The calibration prediction equations for runoff and soil loss were established. The height & CD of the W_1, W_2, W_3 and W_4 were recorded to be 3.1 and 6.1; 3.5 and 7.1; 3.6 and 7.3; 4.1m and 7.8 cm, respectively.

Udhagamandalam (S. Manivannan, K. Kannan and K. Rajan)

A study on evaluation of design of trenches have been undertaken from 2012 to 2019 with the objectives of to identify design storm, size and trenching intensity, quantify resources conserved and suggest optimum option by devising a Decision Support System. The study was conducted in four equal size (75 m X 15 m) plots and resources conserved were quantified by gauging stations. One day maximum rainfall was calculated based on 55 years daily rainfall data using Gumbel distribution and it was found that one day maximum rainfall in 5 years retention period is 101.7 mm which was taken for design of trenches. Experimental plots of this project were under calibration from 2012 to 2014 and treatments have been imposed with three different specifications of trenches and pear was planted as test crop during the year 2015. Runoff, soil loss, soil moisture retention and growth of test crop have been monitored. Minimum mean runoff of 20.9 mm was observed under 80 % runoff retention plot followed by 50 % runoff retention plot (26.2mm) and 30 % runoff retention plot (36.1 mm) against maximum annual runoff of 64.6 mm under control plot. The runoff is reduced maximum (67.6%) in 80 % runoff retention plot followed by 59.4 % and 44.1 % in 50 % and 30 % runoff retention plots respectively. Mean annual soil loss is minimum under 80 % runoff retention plot (0.4 t $ha^{-1}y^{-1}$) followed by 50 % runoff retention plot (0.8 t $ha^{-1}y^{-1}$) and 30 % runoff retention plot (1.5 t $ha^{-1}y^{-1}$) against maximum soil loss in control plot (4.0 t $ha^{-1}y^{-1}$). Maximum soil moisture retention was observed in 80 % runoff retention plot followed by 50 % runoff retention plot. The highest plant height (63.0 cm) and number of leaves per plant (29.6) was observed under 80 percent runoff retention plot followed by 58.0 cm height and 28.0 number of leaves under 50 % percent runoff retention plot. Similarly, The highest grass biomass (6.2 t/ha) was observed under 80 % runoff retention plot which was followed by 50% runoff retention plot. The lowest biomass (2.72 t/ha) was observed under control plot due to less population and growth of grass species. Overall, runoff and soil loss were minimum with maximum soil moisture retention under 80 % and 50 % runoff retention plots. Similarly, maximum growth and biomass were also observed under 80 & 50 % runoff retention plots. However, there is no significant difference on impact among 80 % and 50 % runoff retention plots. Hence, it is recommended that one day maximum rainfall with five years retention period will be appropriate for design of trenches. It is also recommended that the trenches can be designed to harvest only 50 % runoff of maximum one day rainfall.

Enhancing productivity of non-arable ravine lands by plantation of *Achras sapota* L. with

intercropping system (V. Kakade, Gaurav Singh, V.C. Pande and D. Dinesh-Vasad)

An experiment was initiated to enhance the productivity of ravine land by plantation of Sapota (*Achras sapota* L.) with intercropping systems during the year 2008. Five treatments namely; CCBT (Cowpea + Castor in bench terraces); SCCBT (Sapota + Cowpea + Castor in bench terraces); SBT (Sapota alone in bench terraces); SSTS (Sapota + Staggered trench on slope) and SS (Sapota alone on slope) was executed each in a 72m x 24m size plot. The spacing between trees was 8x8 m, while cowpea and castor were grown in 2:1 ratio at 30 spacing between each line. The regional recommended cultivation practices were followed for the crops and the trees. In this regard, the data on various aspects of plants (crop and tree) growth and yield, and runoff and soil loss were recorded and analyzed during the year 2018-19. In this year the tree height was recorded higher in SCCBT (4.1 m) and it was lowest in SS (3.68m). Stem diameter was recorded highest in SSTS (12.87cm) without differing much from SCCBT and SBT, whereas it was lowest in SS (11.33 cm). In addition, fruit yield was recorded in the order of SCCBT (132 Avg. number of fruits/tree)> SBT (109.63)>SSTS (78.67)>SS (59.44) respectively (Table 6). In this year, the yield Cowpea in CCBT (1.80 q/ha) was recorded almost equal to the yield in SCCBT (1.79 q/ha). The reduced yield of was recorded in cowpea due to Yellow vein mosaic virus infestation . The yield of castor was recorded as 6.53 q/ha in CCBT treatment and 4.54 q/ha in SCCBT treatment (Table 7). The grass was harvested from SBT, SSTS, and SS treatments and maximum grass was harvested from SBT treatment (10.04 t/ha) (Table 8).Annual runoff was recorded lower in SCCBT (89.53 mm) whereas it was highest in SS (145.2). However, soil loss was recorded highest in CCBT (1.61 ton/ha/year) while it was lowest in SSTS (0.90 ton/ha/year) (Table 9). Soil chemical properties analysis shows not much variation in pH and EC under different treatments. The pH and EC was ranging from 8.33-8.30 and 0.17-0.24 (dsm^{-1}) respectively. The highest OC (0.67 and 0.64 %) and OM (11.50 and 11.00 g/Kg) at surface and sub-surface respectively was recorded in SCCBT whereas it was lowest in SS. Available P_2O_5 was recorded highest in CCBT (17.29 and 15.94 Kg/ha at surface and sub-surface respectively) and Available K_2O was highest in SSTS (206.46 and 126.97 Kg/ha at surface and sub-surface respectively), whereas lowest values for these parameters were recorded in SS (Table 10). Fig.11 through 15 presents the view of crop under different treatments.

Table 6 : Growth and production parameters of Sapota under different treatment during 2018

Treatment details	Number of fruits per tree	Plant height (m)	Stem Diameter (cm)	Crown spread (m)	
				EW	NS
CCBT (T1)	-	-	-	-	-
SCCBT (T2)	132.00	4.1	12.78	4.33	4.36
SBT(T3)	109.63	3.87	12.83	4.55	4.37
SSTS (T4)	78.67	3.77	12.87	3.90	3.93
SS(T5)	59.44	3.68	11.33	3.79	3.61

Table 7 : Yield of Cowpea under different treatments during 2018

Treatment details	Cowpea (q ha^{-1})	Castor (q ha^{-1})
CCBT (T1)	1.80*	6.53
SCCBT (T2)	1.79*	4.54

*Reduced yield of cowpea is due to YVMV.

Table 8: Yield of grasses under different treatments during 2018

Treatment details	Grass yield (t ha^{-1})	
	Fresh weight	Dry weight
SBT (T3)	10.04	3.05
SSTS (T4)	8.01	2.23
SS(T5)	7.63	2.09

Table 9: Runoff (mm) and Soil loss (ton/ha/year) Under different treatments during 2018

Treatment details	Runoff (mm)	Soil Loss (ton ha^{-1} $year^{-1}$)
CCBT (T1)	97.17	1.61
SCCBT (T2)	89.53	1.10
SBT(T3)	108.8	1.07
SSTS (T4)	125.6	0.90
SS(T5)	145.2	1.05

Table 10: Soil chemical properties under different treatments during 2018

Treatment details	Depth (cm)	pH	EC (dsm^{-1})	OC (%)	OM ($g\ kg^{-1}$)	Avl. P_2O_5 ($Kg\ ha^{-1}$)	Avl. K_2O ($Kg\ ha^{-1}$)
CCBT (T1)	0-15	8.30	0.24	0.60	10.36	17.29	186.59
	15-30	8.33	0.18	0.58	10.08	15.94	92.30
SCCBT (T2)	0-15	8.27	0.24	0.67	11.50	12.75	144.90
	15-30	8.34	0.18	0.64	11.00	15.15	124.24
SBT(T3)	0-15	8.30	0.21	0.59	10.21	9.98	141.99
	15-30	8.34	0.17	0.64	10.97	3.80	98.36
SSTS (T4)	0-15	8.28	0.21	0.59	10.25	3.93	206.46
	15-30	8.29	0.17	0.61	10.53	5.79	126.97
SS(T5)	0-15	8.33	0.19	0.52	8.96	8.52	30.50
	15-30	8.26	0.17	0.52	8.93	5.80	97.97

Fig. 11 : Cowpea + Castor in bench terrace

Fig. 12 : Sapota + Cowpea + Castor in bench terrace

Fig. 13 : Sapota alone in bench terrace

Fig. 14 : Sapota + Staggered trench on slope

Fig. 15 : Sapota on slope

02 RESEARCH ACHIEVEMENTS

P-5: INTEGRATED WATERSHED MANAGEMENT FOR SOCIO-ECONOMIC GROWTH AND POLICY ADVOCACY

5.1: Participatory Watershed Management and Integrated Farming System (IFS)

Evaluation of criteria and techniques for prioritization and assessment of fisheries-sensitive watersheds (M Muruganandam and AK Gupta-DehraDun)

Scoring ranges, weights, and rationalization of selected evaluation attributes such as land uses, watershed features and river flow characteristics, including critical water quality parameters arrived at based on field surveys and expert judgment over extent of the individual attribute's contribution to health of the watersheds for scoring and classification of Fisheries Sensitive Watersheds (FSW) have been analysed. The sub-watersheds of Aglar watershed delineated using ArcGIS tools for landuse classification, other parameters of interest including size, slope, shape, aspects, DEM, drainage and confluence density besides the river characteristics (width, depth, velocity), water quality at selected points were consolidated and analysed based on scoring ranges, weights, rationalization etc. in order to bring out prioritized FSW.

Socio-Economic analysis of farming/livelihood systems of farmers across different land categories in Yamuna ravine area (D.C. Meena and A.K. Parandiyal-Agra)

The collected data from Agra district have been analysed highlights of results are given below:

- The cropping intensity was observed to be 170, 150 and 142 percent in marginal, small and medium categories of farmers.
- The net profit over cost A was found maximum in mustard (27049 Rs/ha) among all crops, followed by wheat and bajra. Whereas in case of vegetables, maximum net profit found in onion seedling (101023 Rs. /ha) followed by carrot, coriander green leaf, potato and chilli.
- Farmers of crops- horticulture – livestock farming system were more dependent on farm income then farmers of crops –livestock farming system.
- Percentage of migrated population for private work was observed to be less in crop-horticulture –livestock farming system as compared to crop –livestock farming system
- Livestock is the important component of farming system across all categories of farmers. Therefore, there is need to promote agro-forestry system.
- Horticulture (vegetables) is the most important component of farm income in case of marginal farmers. Therefore, there is ample scope to promote horticulture through timely supply of horticulture inputs as well as SWC measures.
- The contribution of mule rearing was maximum (47%) in total net income of livelihood system of landless.

Refining methodologies for data validation, planning, monitoring and evaluation of watershed [S.L. Patil, H. Biswas, B.S. Naik, A.S. Morade and M. Prabhavathi (Bellary); P.R. Ojasvi, P. Dogra and S.S. Shrimali -DehraDun)

Sujala-III watershed Project, based on land resource inventory-based watershed planning and implementation, is being monitored by ICAR-IISWC, Ballari since April, 2016. The sub-watersheds monitored are Harve in Chamrajanagar district, Raipalli in Bidar district, Lingapurahalla in Tumkur district and Bedwatti in Koppal district. The major activities that are being monitored/validated are (a) LRI information generated, (b) use of LRI information for preparation of DPRs, digital library and decision support systems, (c) hydrological monitoring in watersheds and generation of hydrological atlases, (d) capacity building activities undertaken, and (e) implementation of watershed plan, demonstrations, etc. as per LRI recommendations. Following are the achievements of the monitoring and evaluation team of Ballary centre and ICAR-IISWC, DehraDun during April to September, 2018.

A total of 372 surface soil samples (at 500 ×500 m grids) collected from the four sub-watersheds as above were analysed for their characteristics in order to validate the information generated by different project partners assigned with the LRI-generation targets for the watersheds. The fertility and suitability maps prepared by the partners and the recommendations were verified both in the field and laboratory for their accuracy. A set of 23 indicators were identified, and weights, assigned for the purpose of comparing the accuracy of LRI information generated. The methodology followed by the LRI partners were in line with the standard procedure and the accuracy levels across soil properties and sub-watersheds ranged from 82% to 90%, which is reasonably accurate given the sampling time lag, sampling and estimation errors and application/non-application of fertilizers/manures, cultivation of different crops by the farmers, etc.

Analysis of data collected from 2200 farmers in structured schedules from the twelve micro-watersheds of the four sub-watersheds, another twelve of IWMP watersheds adjacent to the Sujala-III sub-watersheds, and four control micro-watersheds is in progress. Validation of different parameters covered in the baseline report prepared by the LRI partner for Raipalli sub-watershed of Bidar district was completed. Inputs were given for preparation of hydrology atlas and on the requirements for LRI-based decision support systems on nine modules related to crop production and soil and water conservation. Four of the 14 micro-watersheds selected for intensive hydrological monitoring were visited by the M&E team, and observations were made with respect to the instruments installed and operational structures constructed, and their verification with respect to site suitability, design and cost-effectiveness.

Validated watershed implementation plans for Raipalli, Harve, Bedwatti and Lingapura halla watersheds as provided in their DPRs. Monitored different LRI-based activities such as crop demonstrations, soil conservation structures such as trench-cum-bund, gully plugs and check dams, and water harvesting structures such as farm ponds, percolation tanks, etc. and verified the site suitability, design and quality of structures. Similarly, plantation sites containing block plantations and agri-horti systems, roadside plantation, block plantation of forestry species, bund plantation with cucurbits, etc. were verified in the three sub-watersheds. Survival was observed to be 70-90 per cent in respect of different planted species. The content of training programmes and feedback of participants in respect of training programmes conducted at DATC, Mysore, Davangere, Vijayapura and Kalaburgi for ADAs, AOs, AAOs, watershed committee members, WDT members, watershed assistants and watershed committee representatives were evaluated and feedback/suggestions for improvement were provided.

While 75-90% of the recommendations provided by LRI data were adopted during the preparation of DPRs by different PIAs, 60-80% of the planned activities could be implemented in the fields mostly due to reluctance of some farmers who were not convinced of the LRI concept. Capacity building on LRI among field functionaries and watershed farmers have picked up considerably during 2018-19, due to which the level of acceptance of LRI (for field adoption) by farmers has picked up from the baseline value of 50% to about 75% (based on the interviews held with 400 farmers across four watersheds). A one-day interactive workshop to work out the costs of LRI- vs Non-LRI-based watershed planning was conducted by the Centre at Bangalore on 12.6.2018. A comprehensive format for computation of cost and time effectiveness of LRI-based planning was developed for LRI partners and project implementing agencies, and they have provided their inputs. After analysis of information sent and several rounds of discussions with the concerned stakeholders, it was concluded that the total duration of watershed programmes developed on the lines of LRI information can be reduced to about 3-3½ years from the conventional 4-7 years.

Economic Impact Assessment of Water Harvesting Structure-Farm pond in the Semi -arid regions of Karnataka (Ravi Dupdal, S.L.Patil, B.S.Naik and A.S.Morade-Ballary)

Water is the most crucial resource for sustainable agricultural production in the rainfed areas and the excess runoff that occurs is not being utilized. Considering the importance of water under the present climate change situation in SAT regions of Karnataka, this project was initiated during 2018-19 with objective of assessing the economic impact of farm ponds in the semi-arid regions of Karnataka constructed under Krishi Bhagya scheme. In this study impact of farm ponds on crop productivity, income, employment and other livelihood activities in northern dry zone of Karnataka will be studied in Ballari and Vijaypur districts. During the period under report, review of literature was collected and questionnaire/interview schedule was finalized for primary data collection. The developed schedule will be further pre-tested for refining and finalization. A total of 13,718 and 11,399 farm ponds were constructed (2014-15 to 2018-19) in Ballari and Vijaypur districts, respectively by beneficiaries in both black and red soils under Krishi Bhagya scheme. Three

different dimensions of farm ponds viz., 21×21×3, 18×18×3 and 15×15×3 that were constructed in the farmers field with 80 to 90% subsidies.

Valuation of ecosystem services from natural resource conservation and management interventions in different agro-ecological regions in India

Agra (D.C. Meena, S.K. Dubey, K.K. Sharma, A.K. Parandiyal, R.K. Dubey, R.B.Meena and Rama Pal), **Ballary** (Ravi Dupdal, B.S.Naik, A.S.Morade and M. Prabhavathi), **Datia** (MK Meena, R.S.Yadav, R. Ranjan, M. Pramanik**), Koraput (**M.Madhu, H. Gowda**) Kota** (Ashok Kumar, R.K. Singh, A.K. Singh, Kuldeep Kumar, S. Kala and G.L. Meena).

Vasad (V.C.Pande, P.R. Bhatnagar, Gaurav Singh and V.Kakade)

Ecosystem Services are the benefits which accrue to human being as producer or consumers of final goods (food, fodder, fibre, water and livestock products), commonly called as provisioning services. These may also include hydrological/soil processes which maintain the ecological and life support systems (Regulating Services), soil processes and plant as well as animal biodiversity that support the other services (Supporting services) and opportunities for cognitive development (Cultural services). While the agro-ecosystems provide for some of these services, these agro-ecosystems themselves use some of these services

Type of ecosystem service	Description	Probable ecosystem services flow from watershed management interventions
Provisioning Services	Provision of physically measurable outputs specifically for human needs	i) Production/productivity (Agriculture, Livestock, Horticulture, Forestry/ Agro-forestry, Fisheries for food, fodder, fuel wood, fibre) ii) Medicinal and non-timber forest produce iii) Water (drinking, domestic use) iv) Water (irrigation) v) Livelihood/ income generation/ entrepreneurship vi) Employment generation
Cultural Services	Non materialistic/ intangible benefits (recreational, educational, inspirational, institutional, aesthetic, capacity building activities)	i) Aesthetic/ recreational service ii) Awareness creation/ capacity building/ educational service (excluding academic) iii) Inspirational service iv) Linkage/ convergence creation v) Institutionalization
Regulating Services	Regulation/retention/mitigation/filteration/accumulation/detoxification of natural resources and services by humans	i) Reduction in soil loss/ sedimentation ii) Reduction in runoff iii) Groundwater recharge iv) Surface water storage v) In-situ water conservation vi) Water purification/quality maintenance vii) Flood/drought mitigation viii) Nutrient loss reduction ix) Carbon sequestration x) Air quality xi) Soil health - Soil biota, physical properties xii) Biodiversity augmentation xiii) Micro-climate regulation
Supporting Services	Regulation/retention/mitigation/filteration/accumulation/detoxification of natural resources and services by nature for supporting all other services; Ecosystem functions	i) Soil formation / depth and mineralization including Nutrient recycling ii) Biodiversity

for their sustenance. However, the natural resource management/ soil and water conservation interventions undertaken to combat land degradation process and enhance production affects the two way flow of these ecosystem services. Integrated Watershed management programs envisage restoring the degraded land in rainfed regions to increase their capacity to capture and store rainwater, reduce soil erosion, and improve soil nutrient and carbon content. The improved production base helps enhance agricultural production and other benefits for the majority of India's rural poor, who live in these regions and are dependent on natural resources for their livelihoods and sustenance. At the same time, these interventions affect the flow of the ecosystem services, thereby, affecting the human well-being.

With this understanding, the project was initiated to identify ecosystem services of Integrated Watershed Management/ SWC Interventions, develop framework for ecosystem services estimation from WSM/SWC interventions and finalize methodology for quantification and monetization/ valuation of ecosystem services in selected watersheds. During the year 2018-19, literature review on ecosystem services was done and a workshop was conducted to identify the ecosystem services, their possible indicator(s) and valuation method in watershed programme. The list of ecosystem services is as under

Chandigarh (S.L.Arya, V.K.Bhatt, Pankaj Panwar, Sharmistha Pal, Sathiya, K and Ram Prasad)

Sukhomajri watershed located in Panchkula district has been selected purposively for the study as bench mark data is already available for most of the aspects to be evaluated under Eco-system services. The detailed socio-economic data has been collected. The fodder requirement and availability from forest, grazing lands and agricultural lands was calculated both before and after the watershed implementation. Using travel cost approach, it was estimated that monetary value of total time saved in lieu of bringing fodder from forest as a result of increased fodder on agricultural lands was Rs. 16.57 lakhs. Similarly, total energy (fuel) requirement of the watershed people was worked out both before and after project implementation. People dependency on fuel wood decreased as a result of increased dung production and agricultural wastes. Using both productivity and travel cost approach methods, it was calculated that the monetary value of total time saved in bringing fuel wood from forest and increased value of dung and agricultural wastes worked out as Rs 7.91 lakhs per annum.

Gobar Gas Production and prospectus of its potential use in power generation in Sukhomajri watershed.

- Total dung production in the year 2018 = 1866975 Kg per annum
- Assuming 70 percent available for biogas = 1866975 X 0.70 = 1306882 Kgs. (30% used in dung cakes and other from one kg dung = 1.3 cft. (Kamanth *et,al* 2002)
- Biogas generated from 1306882 kgs of dung= 1306882 X 1.3 = 1698947 cft. Or 48541 cum
- One cum of biogas is equivalent = 2.1 KWh (Green brick eco-solutions, 2012), Hence 48541cum X 2.1 = 101936 KWh.
- Assuming rate of power @ Rs 4 per unit, the total monetary value of power generated through biogas was calculated worth Rs 407744 or Rs 4.07 lakhs in the village.

Biogas sherry may be considered as a good quality organic fertilizer in sustainable agriculture for maintaining quality of produce. Residual slurry is environmental friendly, has no toxic or harmful effects and can easily reduce the use of chemical fertiliser up to 15-25%. Its manurial value (on oven dry basis) is as follows: 1.7 percent Nitrogen, 1.15 per cent P_2O_5 and 1 percent K_2O. The nutrient contents which are added to the soil worked out as per above mentioned estimates were worth Rs. 4.87 lakhs.

Watershed management approach with people's participation strengthens the knowledge about planning, execution and monitoring of the water and soil resource management and utilization. This knowledge helps sustainable management of these precious resources and, thus, agricultural production. Primary survey to assess the change in number of local people who acquired natural resource management knowledge before and after the watershed programme was done. Valuation was done on the basis of number of people acquiring the knowledge multiplied with average opportunity cost of gaining knowledge elsewhere. As per standard norms being adopted at IISWC for short training of the duration of four days for capacity building, expenditure per person works out to be about Rs 10235. For 616 persons who gained natural resource management knowledge, the total monetary value worked out was Rs 6304760 or Rs 63 lakhs.

02 RESEARCH ACHIEVEMENTS

P-6: Human Resource Development and Technology Transfer

6.1 Capacity development approaches and information and communication technology (ICT)

Exploring the potential of mKRISHI(R) to disseminate the knowledge about soil and water conservations technologies to the stakeholders: An innovative approach to reach the unreached (Madan Singh, D. C. Meena, Amrut Morade, Sharmistha Pal, M. K. Meena, Kuldeep Kumar, Jyotiprava Dash, V. Kasthuri Thilagam and D. Dinesh-**Dehra Dun**)

This network project was initiated during 2018-19 with the specific objective of knowledge sharing among farmers about soil and water conservation, agricultural and allied aspects. The present study is being carried out in nine states namely Uttarakhand, Chandigarh (UT), Uttar Pradesh, Rajasthan, Madhya Pradesh, Odisha, Karnataka, Gujarat and Tamil Nadu where IISWC, Dehradun and its eight (8) regional centres are located. Among the ICT tools, the rise in no. of the mobile phone users has been one of the most spectacular changes in the developing world over the past decade. Mobile phone, because of its affordability, accessibility, minimum skill requirement, widespread network etc., has emerged as important tool for the smallholder farmers. The increase in use of mobile phones across the globe and India has impinged on agriculture in various ways. Mobiles are being used to help farmers' to raise thier incomes, making agricultural marketing more efficient, lowering information costs, reducing transport costs and providing a platform to deliver services and innovate. A MoU was signed between ICAR-IISWC, Dehradun and Tata Consultancy Services (TCS), Mumbai for creating platform (mKRISHI PAWS app) for sending messages to the farmers through registered mobile phones. From each Centre 100 farmers and 10 officials farm line departments are to be registered for sending the messages. Process of registration is being completed by TCS.

6.2: Participatory Technology Dissemination and Adoption

Assessing Farmers Knowledge, Vulnerability and Adapting Capacity of Soil and Water Conservation Technology under Changing Climatic Scenario

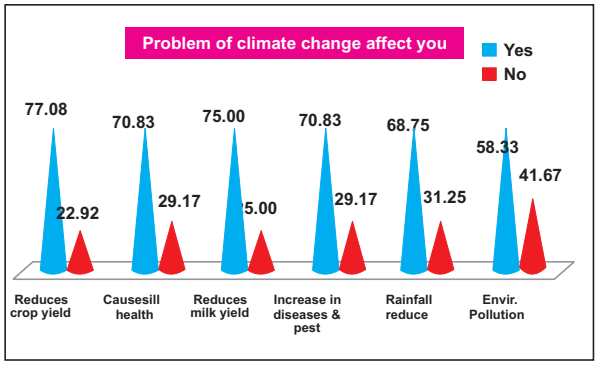
Dehra Dun (Bankey Bihari, Madan Singh and Indu Rawat)

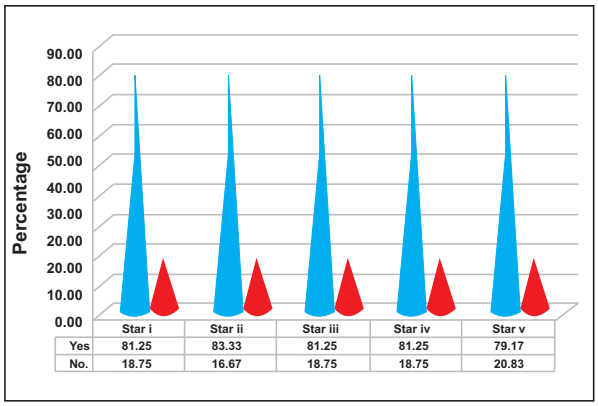
The project was initiated with the following major objectives.

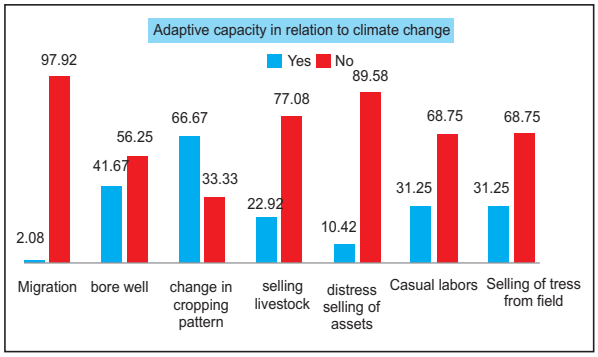
- To examine the perception, awareness and extent of knowledge of farmers on climate change and their perceived adverse impact on crop production.
- To determine the attitude of farmers and officials and determine the factors influencing knowledge and attitude of farmers towards soil and water conservation technologies under the changing climatic scenario.
- To determine the vulnerability and adaptive capacity of farmers towards various soil and water conservation technologies to changing climatic scenario.

The present study was carried out in Vikasnagar block of DehraDun district in Uttarakhand with the aim to examine the perception, awareness, and extent of knowledge of farmers on climate change and their perceived adverse impact on crop production and also to determine vulnerability and adaptive capacity of farmers towards various soil and water conservation technologies under changing climatic scenario. Data were collected from 105 farmers by using simple random sampling technique. The study revealed that 99.05 per cent farmers heard the term climate change. 80.95 per cent farmers were aware about the different impacts of changes in the temperature, rainfall, wind velocity etc. About 34.29 per cent farmers felt that deforestation was major cause of climate change while 52.38 per cent felt that industrialization was a major cause of climate change. 76.19 per cent farmers felt that air pollution was a major cause of climate change. As far as impacts of climate change is concerned, 81.90 per cent farmers felt that due to climate change crop yield is reduced.

Nearly 75.0 per cent farmers agreed that ill health is also due to climate change. 65% said that it reduces amount of rainfall and 64% agreed that if causes pollution in the environment. Regarding perception of farmers towards climate change, results showed that 58.85 per cent farmers perceived that monsoon rainfall now starts little early. 78.47 per cent farmers perceived that climate change is affecting agriculture in their region. Regarding knowledge level of farmers, about climate change, study revealed that 57.14 per cent of the respondents had knowledge about the fact that heavy use of fossil fuels is the main cause for climate change. Majority of the respondents (59.05 per cent) knew that biomass burning have also impact on present climate change. As much as 29 per cent farmers felt that due to climate change there is heavy loss of nutrients from soil and 34.29 per cent farmers reported loss of crops yield due to climate change. Regarding adaptive strategies in changing climate scenario, study revealed that 31.43 per cent of the respondents agreed that crop insurance may reduce the climate change risk in agriculture. Around 30 per cent of farmers told that watershed management is the better option to reduce the risk of water stress in rainfed agriculture and it will also help in mitigating the overall climate change scenario.







Agra (D.C. Meena, R.K. Dubey and Rama Pal)

The project was initiated during 2016 with the aim of examining the perception, awareness and extent of knowledge of farmers on climate change and their perceived adverse impact on crop production; determining the attitude of farmers and officials and determine the factors influencing knowledge and attitude of farmers towards soil and water conservation technologies under the changing climatic scenario; and analysis of the vulnerability and adaptive capacity of farmers towards various soil and water conservation technologies to changing climatic scenario. To achieve the objectives of study, three villages *namely:* Jalapur, Surera and Beelpura from Agra district were selected purposively because they were predominantly rainfed. Thirty five respondents from each village were selected randomly. Ten officials from different government departments working on soil and water conservation from Agra district were also interviewed. Data was collected through reconnaissance survey and focal group discussion, key informants interview, transect walk and field observations. Furthermore, detailed information on farmers' perception on climate change and adaptation measures practiced were collected from respondents by using schedule. The collected data have been compiled and analysed by using suitable statistical tools. Some results are presented below:

Stat i Are you aware about any long-term changes in the average temperature of your locality over the last 20 years?

Stat ii The number of hot days in your area has been increased

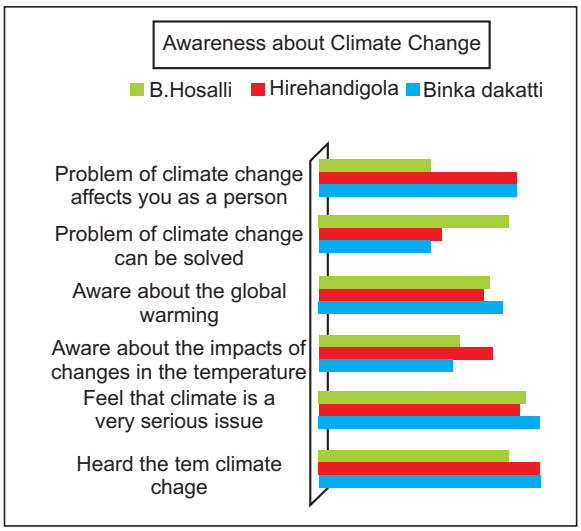
Stat iii Do you know about any long-term changes in the total number of rainfall days over the last 20 years?

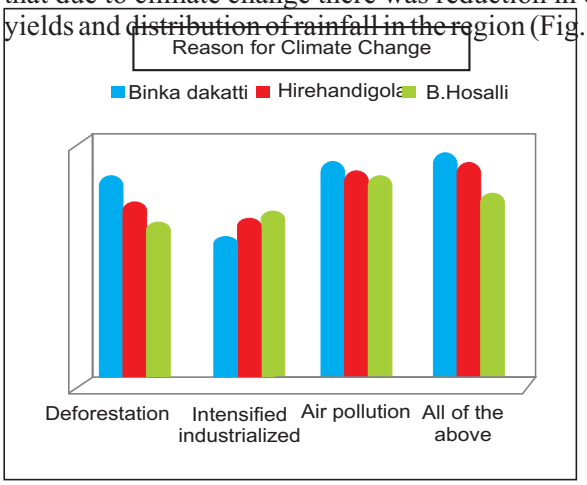
Stat iv Are you aware about any long term changes in the yearly total rainfall over the last 20 years?

Stat v Do you know about any long-term changes in post-monsoon season rainfall in your locality?

Ballary (S.L.Patil, Ravi Dupdal, B.S. Naik and A.S. Morade)

Core project was initiated during 2016-17 in order to assess the farmer knowledge, vulnerability and adapting capacity of soil and water conservation technologies under changing climatic scenario. During the period under report, Gadag district was selected for primary data collection and a total of 105 (35 from each village) respondents were identified from three villages namely Binkadkatti, Hirehandigol and H. Hoshalli. Data was also collected from 10 field functionaries viz., AOs, AAOs, AHOs, and PDOs with respect to institutional measures taken in response to climatic variability. The results revealed that majority farmers in were villages the selected aware about climate change and its reasons. Farmers also perceived that due to climate change there was reduction in crop yields and distribution of rainfall in the region (Fig.1).





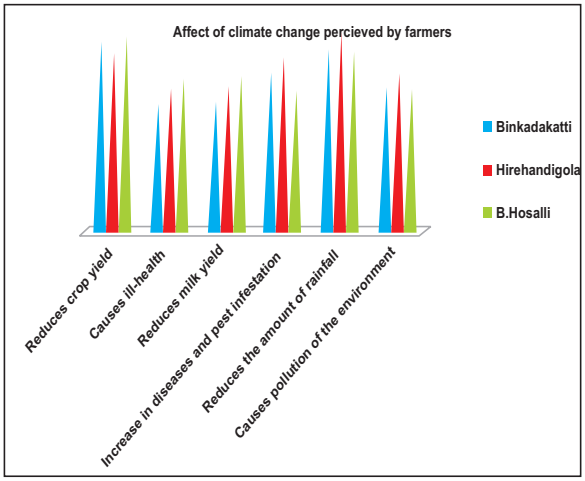


Fig. 1 : Farmers' awareness, reasons and perception about climate change

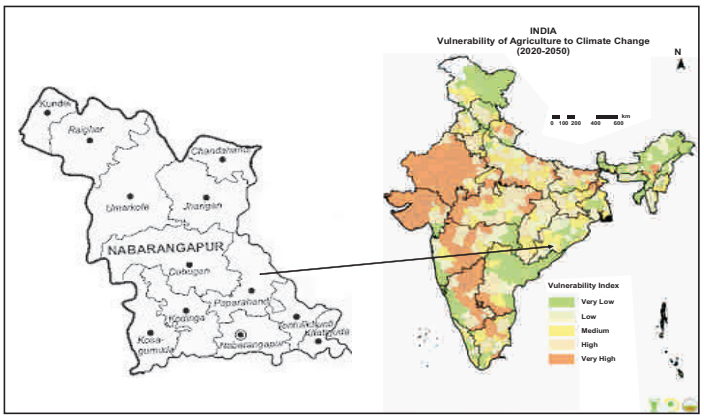
Chandigarh (S. L. Arya, Sharmistha Pal, and K. Sathiya)

Data was collected from 109 respondents from three villages in Panchkula district of Haryana State to gather detailed information on farmers' perception on climate change and adaptation measures practiced. Ninety two per cent of the respondents expressed negative impacts of climate change in terms of reduction in crop yield followed by decreased milk production (66%) and environmental pollution (63%). Sixty one percent of the respondents also reported increase in incidents of pest and diseases among crops due to change in climate. Farmer's awareness about how to overcome the problem of climate change was adjudged where 90 percent of respondents replied that this problem can be solved by making sacrifices to Gods. Nearly eighty percent were of the view that we cannot do much to overcome this problem. We should be prepared to face it. Seventy percent were of the opinion that we should intensify research efforts to get a permanent solution to this problem. Climate change is a real and already underway had been strongly endorsed by about 26 per cent and was agreed affirmatively by 58 per cent of the respondents. The statement obtained a mean score of 3.4 out of 5. More than 79 per cent of them had favourable disposition with the fact that climate change is a serious problem and affecting agriculture in their region. While 71 per cent were of agreement that nature and intensity of rainfall have become unusual in the region and in the next 10-20 years they foresee that both livestock and crops will be adversely affected. For 57 per cent of the respondents, the future was too

uncertain to make serious plans and it didn't make much difference if people elect one or another political candidate, for nothing would change. Fifty three per cent felt that life was like a lottery. About 31 per cent of them agreed that they had very little control over their life and about 48 per cent believed that there was no use worrying about public affairs and they could not do anything about them anyway.

A majority of respondents (about 68 per cent) were fully dependent upon cultivable land for livelihood and nearly 58 percent of them were highly dependent upon CPR for irrigation water to their fields. About 14 per cent were dependent to greater extent and about 28 per cent to a lesser extent on common property resources such as water for irrigation. About 49 per cent had dependence upon forest area for fuelwood and fodder. Their dependence upon village institutions and Panchayat land was minimal. With regard to adaptation of coping strategies to meet out the adverse affects of climate change, majority of respondents (73 percent) replied that they will earn their livelihood by doing labour. Sixty one percent would try to bring change in cropping pattern, while 36 percent sell their livestock and other 28 percent try to cope up by selling their assets.

Koraput (P.Jakhar and M.K. Meena)



The research study was initiated as network project during 2016-17to assess Farmers Knowledge, Vulnerability and Adaptive Capacity of Soil and Water Conservation Technologies under Changing Climatic Scenario. Selection of Nabrangpur district in Odisha state was done based on the climate change vulnerability map developed by ICAR-CRIDA (2013). A survey cum interview of 150 farmers in different blocks (Umerkot, Kosmaguda and Papdahandi) of the district was carried out to assess the impact of climate change on agriculture was done. Major achievements of the project are following:

A majority of the sampled farmers (70%) have heard the term climate change and feel that it is a very serious issue. But the half the farmers were unaware of the impacts of climate change on temperature, rainfall and wind velocity. The common reason for the climate change responded were deforestation, intensified industrialisation and air pollution. But when the term was changed to global warming farmers showed ignorance. Farmers told that as individual they do not feel any harm with climate change. Among different affect the major affect expressed was decline in crop yield and environment pollution. The steps suggested to overcome the problem of climate change were intensify research efforts and stopping air pollution. Respondents down played the role of prayers and religious ceremonies. During the survey 80% of the farmers strongly agreed over the feeling that the climate change is real. Majority of the farmers' perception was that along with rapid industrialization and large scale deforestation is responsible for the comate change. The major impact of climate change can be seen in shift in monsoon pattern and retreat. Farmers expressed concern over the increasing frequency of the drought but remained undecided over the heat waves in Nabrangpur district. Fifty percent of the farmers feel that change in climate have decreased their crops yield. Seventy percent of the framers feel that in coming years more area will be under desertification.

During the survey, farmers expressed concern about the loss of flora and fauna of the area and believed that human being can find out the ways and means to make adaptive changes to tackle climate change particularly they showed confidence in scientists. The ITKs of the particular area are the potential source in dealing with the climate change. They believed that the greed of the human beings is responsible for ill treatment of the Nature. Farmers agreed that climate change need priority equivalent to the livelihood issue. The respondents remained undecided over time and effort needed to become environment friendly. But they believed that their profession and lifestyles is bringing the change in climate as well as loss of the biodiversity. Farmers disagreed on putting all burden on government and emphasized on community approach for climate change management as well as mitigation.

Kota (Ashok Kumar, H.R. Meena and I. Rashmi)

Study was conducted in Baran District of Southeastern Rajasthan with the aim to understanding the perception, awareness, and extent of knowledge of farmers on climate change and their perceived adverse impact on crop production alongwith information on what adaptation measures they are using to mitigate the effects under changing climatic scenario. Using responses from a questionnaire survey conducted in three villages namely; Kadaiya Nohar village (Chabra block) Bijora (Anta block) and amlavada (Kisan ganj Block) of Baran district with a randomly selected sample of 150 farmers indicate that majority of the farmers (89%) fell in the age group of 25-75 years and have good farming experience. Landholding pattern revealed that majority of the farmers (58.7%) were marginal farmers followed by small (21.3%) and medium (14.7%) categories. The results further revealed that 82 % of the respondents perceived climate change as a problem and 50 % of the respondents disagreed with the contention that this problem is not in their region. 54% of the farmers perceived that frequency of drought has increased in the last 10-20 years while 67 % of the farmer respondent agreed in positive with the question whether this frequency will reduce in future. 80% of the respondents also foresee that the availability of water will reduce in future while 78% have the opinion that monsoon, when compared to past, receded earlier due to changing climate scenario in the region. 59% of the respondent has the opinion that maintaining ecological balance is the duty of the government while 31% respondents suggested that community has a more significant role than government in taking initiatives for checking ecological degradation in the area. About 74 % of the respondents have the opinion that scientists are capable to find solutions to the problems of climate change. However, 83% (34% strongly agreed) with the statement "I do worry about the loss of flora and fauna of my area" which is a positive sign for them that they are aware of the possible loss as a result of climate change. In contrast, 28% & 66% of the respondents disagreed with the statement that it is hard to change their habits for more environments friendly and affects of climate change are too far in the future to worry them. To increase productivity and risk bearing ability some of the farmers adopted soil and water conservation measures especially Bunding (37%) followed by loose boulder checkdam (11%) either with the help of watershed programme implemented long back or construction by themselves for enhancing moisture conservation in the field. To escape climatically bad years the farming community has been using a wide range of inbuilt coping mechanisms which were not specific to the climate change. Farmers' most important strategy to cope with the erratic rainfall and the occurrence of frequent droughts were to install Borewell (57%) and Change in cropping pattern (75%). Besides, other coping strategies included, to work as Casual labour (69%), Selling of field trees (40%), selling livestock (38%), migration for work (44%) by the farming community in the study area. Study also collected data from 10 field functionaries (AEN, JEN) working in Baran District through mailed questionnaires on the same parameters included in farmers schedule apart from institutional measures they are taking for tackling climate variability in the region.

Udhagamandalam (P. Sundarambal, K. Kannan, P. Raja and O.P.S. Khola)

Three villages (Varapatti, Vadavalli and Vadambachery) were selected from Sultanpet block of Coimbatore district in Tamil Nadu which is one of the vulnerable districts to climate change. Data were collected from 105 farmers (35 from each village) and from 12 field functionaries and analysed results are presented in Table 1and 2:

Table.1: Distribution of respondents according to their adaptive capacity in relation to Climate change (n=105)

Coping strategies	Frequency (n=105)	(%)
Migration	83	79
Bore-well	97	92
Change in cropping pattern	99	94
Selling Livestock	75	72
Distress selling of assets	14	13
Casual labours	33	31
Selling of tress from field	24	23

As far as adaptive capacity is concerned, most of the farmers have dug more than two bore wells to a depth of 1000 to 1200 ft to rescue their grown up coconut plantations and to raise irrigated vegetable crops at least to a smaller extent. There is a complete change in cropping pattern from tobacco-cotton –vegetables to maize-pulses/vegetables.

Table.2: Soil and water conservation practices adopted/constructed

Conservation structure	Govt./Private	Self	Extent to which helpful		
			Fully	Some What	Not at All
			Frequency (%)	Frequency (%)	Frequency (%)
Bunding	-	89	-	89(85)	0
Farm Pond	-	6	-	6(6)	-
Summer Ploughing	-	79	-	79(75)	-
Drip irrigation	4	44	-	48(46)	-
Trenching	-	6	-	6(6)	-
Mulching	-	34	-	34(32)	-
Check Dam	10	-	-	45(43)	-

The major SWC technologies adopted by the farmers on their own were bunding, summer ploughing, drip, mulching which could help them to some extent. Very few farmers have adopted farm ponds for water harvesting and trenching in coconut. Most of the field functionaries were also aware about climate change, type, reasons and impacts. Most (48%) of the respondents were falling in the medium category with respect to knowledge and the average e-knowledge level. They got climate change related information regularly mainly through newspaper (58.3%) followed by television (50%) and internet (50%). As reported by majority (83.3%) of the respondents, regular pest & disease forecasting is one of the activities, which is being carried out by the department in the villages/farmer fields to combat climate change factor. As perceived by majority of the field functionaries the central government is responsible for financing climate change adaptation measures. Water harvesting structures, plantation of trees, capacity building & institutional strengthening are some of the adaptation practices/policies currently in place to reduce the vulnerability of water resources to climate change impacts as reported by more than 75 % of the respondents.

Vasad (V. C. Pande)

Agriculture sector is quite vulnerable to climate change and the rainfed areas are, in particular, more affected due to stressed resource conditions. Vulnerability to climate change is subjective as the impact on individuals and the households depends, largely, on their perception about the risks to which they are subjected and their capability to confront said risks. Further, capability to withstand the risk of climate change not only depends on the resource endowment but also the knowledge base of the community and this encompasses both the knowledge about climate change and coping mechanisms including the technological backup available. To comprehend these perspectives in Western India, the present study was conducted in the state of Gujarat. Vadodara district of Gujarat (Fig 2) was selected because of its high vulnerability to climate change, high net sown area (70-80% of the geographical area) and 15-20% probability of drought proneness (ICAR-CRIDA, 2013). Taluka and village selections in Gujarat were done based on the groundwater availability and the net sown area. In addition one village viz., Nana-rampura was selected in Kapadwanj district. Personnel surveys were conducted with 105

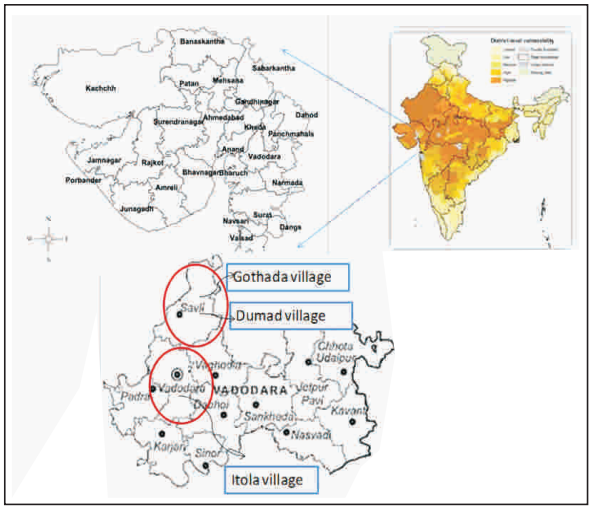
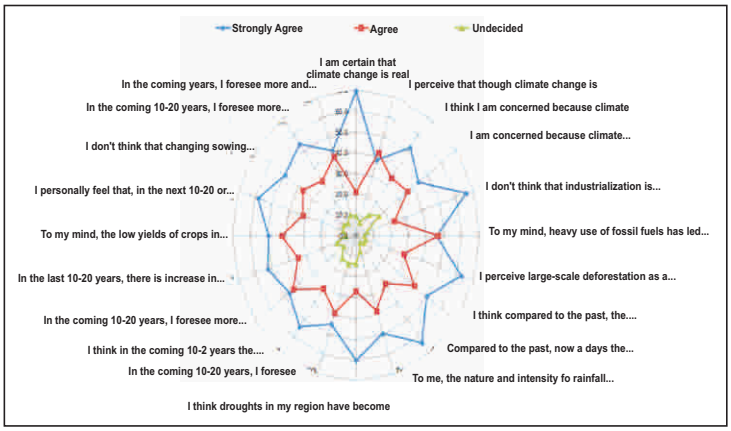


Fig. 2 : Study locale, Gujarat

farmers selected randomly. Descriptive methods were employed to assess farmers' knowledge, perception of climate change and types of adaptation measures adopted to cope up with the effects of climate change. Econometric models were used to analyse the process of adaptation to climate change. These models suggested the determinants of farmers' perception about climate change and the adaptation measures.



Less than half of the respondents were sure about knowing any farming practice which was helpful in coping with climate change variability, though majority (80%) of them responded that they could adapt to climate change by adopting such practices if known to them, for example, early and late planting. Similar was the trend for agro-forestry practice to adapt to changing climate. 74% respondents responded in favour of crop insurance to minimize and manage the climate change risk. Similarly, 72% farmers responded that the practice of watershed management could be helpful to reduce the risk of climate change related water stress. The determinants of perception about climate change included factors like age and education of household head apart from the climate change information, frequency of drought, change in temperature and rainfall in the model. Age of household head and climate change information were significant at 5% and 1% level of significance, respectively. The frequency of drought variable did not turn out to be significant in determining the perception.

The repressors for adaptation in the econometric model included apart from age and education of household head, variables such as income from crop and livestock, non-farm income, extension agency contact, climate information of respondent, land holding size and mass media contact. Education and age of household head, non-farm income and climate information turned out to be significant factors (P<0.05) in determining the adaption to climate change. The results suggested that age of household head was crucial factor affecting perception and adaptation process. Older head of the household perceived the climate change and its effect better and quickly adapted to the change by adopting water and moisture conservation practices. Similarly, climate change information determined not only farmers' perception but also adaptation. While crop and livestock were not crucial determinant, non-farm income was significant in adaptation decision of farmers. These factors have serious policy intervention. Information about the climate change and its different dimensions must be communicated to farmers in all possible manners. Information and Communication Technologies may be employed for awareness raising and advocacy (particularly through the use of the Internet), as well as for providing adhoc on and off-line training for facing climate change challenges. The non-farm income determined adaptation significantly, which suggests that income earned outside is likely to be spent in climate change adaptation.

The process of adaptation to climate change begins with farmers' perception about changing climate and is followed by the response to the change by adopting appropriate practices. The analysis suggested that the farmers in Central Gujarat perceived about rainfall variability and climate change related water stress. Farmers' age and climate change information significantly affected their perception and decision to adapt to it. The adaptation was also significantly influenced by non-farm income. The water conservation practices were adopted by farmers with high non-farm income either through state help or themselves. The number of such farmers, though, was less (27%), yet this suggested that while on-farm crop and livestock income earned by farmers supported livelihood and might not be spent on climate change adaptation, the additional income earned outside farm was partly spent on farm operations including moisture conservation measures such as field bunding. The state intervention in execution of moisture conservation practices, including water harvesting through watershed management programme or any other land based programmes such as Mahatma Gandhi National Rural Guarantee Act (MGNREGA) is crucial in deciding farmers' adaptation to changing climate in the region.

Assessment of Sustainability factors for Soil and Water Conservation Projects (Madan Singh**,** Indu Rawat and Bankey Bihari-Dehra Dun)

Project was initiated during 2016-17 to identify the different factors responsible for participatory and sustainable management of soil and water conservation projects after the withdrawal of the implementing agencies. Project sites namely, Kalimati under IVLP, Langha under TDET, Almas under NATP and Sainji under NATP, implemented by ICAR-IISWC, Dehradun were selected for the study. Different factors of sustainability were identified in terms of technological sustainability, economical sustainability, institutional sustainability, social Sustainability and political Sustainability. The contribution of each factor in terms of sustainability was identified through Friedman test. Factors responsible for technological sustainability of soil and water conservation projects as perceived by programme beneficiaries showed that the technologies demonstration watersheds were as per the suitable to farmers need and interest (demand driven) and it was the most effective factor (mean rank=4.39) followed by tie-up with the institute to facilitate access to improved technologies and expert advice (mean rank=4.12). The study depicted that factors responsible for economical sustainability of soil and water conservation projects as perceived by programme beneficiaries was the farm productivity that has increased by using irrigation water (mean rank=5.42) followed by overall income increase due to various horticultural and livestock based interventions (mean rank=5.33). Factors responsible for institutional sustainability of soil and water conservation projects as perceived by programme beneficiaries showed that the participatory approach followed by project staff was the most effective factor (mean rank=5.78) followed by creation of water use society/samiti (mean rank=5.36). Factors responsible for social sustainability of soil and water conservation projects as perceived by programme beneficiaries showed that the ethical and transparent dealing was the most effective factor (mean rank=6.59) followed by subordinate their conflicts for common cause (mean rank=6.57). Factors responsible for political sustainability of soil and water conservation projects as perceived by programme beneficiaries showed that the local elected representative/community leaders have been consulted/involved in the planning and implementation of projects, was the most effective factor (mean rank=5.71) followed by no political interference in the water distribution (mean rank=5.12).

Farmer Participatory Technology Application for Sustainable Resource Management and Livelihood Security in North-Western Himalaya under Farmer FIRST Programme (Externally Funded): (Bankey Bihari, S.S.Shrimali, Lekh Chand, M. Muruganandam, U.K.Maurya, Madan Singh, D.M.Kadam and Trisha Roy- Dehra Dun)

The project aims at identifying suitable location specific technologies, developing technological modules and its application through farmer-scientist interface and technical feedback based interventions. Innovation, stakeholder participation at different platforms and livelihood interventions in light of multiple realities including household resources, multi disciplinary approach and climate resilient interventions are the main focus of the project with following objectives:

- To enhance farmer–scientist interface, facilitate knowledge enrichment and providing continued technical feedback;
- To identify, integrate and assess economically viable and socially acceptable technological options for varied agro- ecological situations;
- To develop suitable technical modules for farm families to increase productivity and profitability of the farmers for their livelihood security;
- To study the farmers perception about the performance of the technological interventions in varied field situations;
- To build network of linkages among different stakeholders/organizations/agencies around the farm household for harnessing their access to information, technology, resources and market;
- To analyse the impact of the interventions under the project and suggest suitable strategies for further up-scaling and out-scaling.

Under crop based module, wheat cultivars (VL- 892 and VL-907) covering 32 ha area involving 280 farmers were demonstrated at farmers field for the second year also. VL-907 (32 q/ha) and VL-892 (22 q/ha) were found superior to local cultivar RR-21(12 q/ha). Demonstrations on high yielding varieties of Lentil (VLM-514) covering 98 farmers and high yielding verity of Mustard (Hybrid 5222) covering 94 farmers were also conducted. Demonstrations on high yielding variety of pigeon pea (Var. Pusa-992)- 64 farmers, high

yielding variety of paddy (Var. Pusa Basmati-6)- 24 farmers and high yielding variety of Black Gram (Var. PU-31)-73 farmers, were conducted to get better substitute for the local, low yielding varieties. Under Horticulture based module, keeping in view the problem of degraded lands and wild animals, plantations of Jack fruit, Bael, Drumstick and Kagzi Lime were done covering 128 farmers where average survival percentage was about 92.0 percent.In livestock based module, dual purpose (meat and egg) poultry bird (kuroiler and Vanraja-3000 chicks) were introduced to 97 farmers to address the problem of migration and unemployment in the project area. Also, distribution of veterinary medicines was done during animal health camps to control Endo and Ecto parasites in approximate 2000 no. of animals along with mineral mixtures, UMMB, vitamins and food supplements. Several field visits were made by the project team and interaction with farmers and other stakeholders was done for effective linkage and convergence. Four farmers' goshthies, three animal health camps and one field day was organized where major problems and issues related to agriculture and allied sectors were discussed for enhancing income and ensuring their livelihood security. 19 scientist-farmer interface meetings and two trainings were conducted where all the interventions were discussed and necessary modifications were made as per the requirement. To meet out the multipurpose (fruit and vegetable) nutritional requirements of the farming family, five Nutritional Kitchen Gardens were also demonstrated in the field of interested farmers. Demonstrations on pusa hydrogel for moisture conservation in Wheat Upland Paddy were conducted covering 37 farmers in the project area.

Role of women in conservation and management of natural water resources for domestic and irrigation uses (Indu Rawat, Madan Singh, Vibha Singhal and Trisha Roy-Dehra Dun)

The management of water resources is an important issue for societal health and well being. As the population is continuously growing, the need for water will grow tremendously. This research study is undertaken to develop a deep understanding about role of women in water resource management practices study was formulated with following objectives:

- Type of water resources available in the selected villages, their ownership and uses.
- Drudgery faced by the women in fetching water for domestic purposes.
- Impact of water bodies on the social wellbeing of the women.
- Water quality as affected by different conservation practices.
- Policy implications for restoration and rejuvenation of the water bodies.

The study was conducted in four villages namely Deu, Dhoira, Jutaya and Nichiya of Kalsi block of DehraDun district. From each village, 25 respondents were interviewed for details about water resources. Under traditional water resources, about 93% respondents reported that they have chasma/ naula as water resource followed by gadhera (stream) by 51% respondents. As far as conventional water resources are concerned, water tank was reported by 98% respondents followed by 67% respondents who told that pipeline is also available in the villages. In the study area, hand pumps and the ponds were not present in the villages. In all the four villages about 2-3 water resources have been dried up. The respondents (95%) identified landslide as one of the prominent reason for drying up of natural water resources. The springs/ streams may have been covered with the debris of landslide. 88% respondents reported hot weather as cause of drying up of natural resources followed by reduced rainfall (76%) and reduction in forest trees (51%). These natural resources are not only the basis of livelihood of rural people but also add to the forest eco system. There are number of impacts of drying of these resources. All (100%) respondents reported that there is no water for irrigation as a result of drying of natural water resources. It was further cited by 88% respondents that now-a-days more time is required to collect the water as compared to the previous years. In order to overcome the shortage of water, 91% reported afforestation/densification as a most popular means of overcoming water shortage. It was found out that 87% respondents reported that there are Self Help Groups in the 4 villages, however they are not doing any income generating activity. As far as employment opportunities are concerned, about 76% respondents have opined that they have been given opportunities for employment through trainings and skill development but negligible percentage of households have taken the benefits of trainings.

Documentation and validation of ITKs in Soil and Water Conservation practiced by tribal farmers in Tamil Nadu. (P. Sundarambal, P. Raja, R. Ragupathy ,K. Kannan and V. Selvi-Udhagamandalam)

Tribal communities possess good traditional wisdom and knowledge which they use in their all day to day activities. Since they live in far-flung and remote areas, people outside the tribal habitations are generally

Table 3: Details of SWC ITKs practiced by the tribes of the Selected Districts

Name of the ITK	Advantages
Construction of stone and earthen bunds	Erosion control, moisture conservation, reduces nutrient loss
Criss- cross ploughing	Improves soil moisture
Planting of Banana and coconut on newly formed bunds	Stabilizes the loose soil immediately after bund formation and economic use of bund portion
FYM (Cattle, cow &sheep manure) application	Improves soil fertility
Application of green leaves (Neem, Calotropis, *Veppalai, Ooanakodi, Navamaram, pungam,Avarai,Poricholanelai,Korasai wild rubber* and Vitex)in paddy	Improve soil fertility
Mixed cropping (Little millet + Red gram+ lablabi/Castor), (Chillies/Brinjal+Cowpea+Castor),(Beans+Maize+Redgram+ Greens+Mustard)	Risk minimization, effective use of resources and harvesting crop produce in different time intervals
Levelling/ *Sathuramadithal* in slopy lands with Indigenous tools *Kudinjal & Parambu*	Moisture conservation and avoid nutrient loss through rain water
Pond for water harvesting	For irrigation, fisheries and cattle drinking
Farm forestry on bunds (Silver oak, guava, mango, jack, citrus, coconut, pungam & Teak with agriculture crops)	To use the bund portion for economic production and control wind action
Raising indigenous Banana Var: Malaivazalai/Udhirampaham/Nemaran)	Grows well with limited irrigation and even under rainfed condition. Can be ratooned up to 5-8 years
Penning the field with sheep & goat in movable fence	Improves soil fertility and boost crop productivity
Raising rainfed crops like little millet for one season and leaving the sloppy land fallow for 3-4 years	To give rest to land and to recoup soil fertility To improve soil fertility & to give rest to land
Maintenance of loose boulders as barriers in small gullies	Prevents soil erosion
Irrigation from streams/ gullies through gravity	Conserves energy and reduces expenditure
Crop rotation **Rainfed:** Ragi/ liitle milet/ kodo millet/ bajra/ sorghum/ maize-beans-horse gram/ sesamum/ tapioca/ sugarcane, cotton-groundnut **Irrigated:** Paddy-Beans/Other vegetables, Ragi-Beans/Vegetable crops	Help to sustain soil fertility
Use of country plough for summer ploughing (Parambu/Kondi/ Palanku/Parali/Uruli)	Conserves moisture and reduces expenditure
Use of Jatropha , glyricidia, *nochi*, bamboo plants for live fencing	Erosion control, protects the field from animals & acts as field boundary
Crop residue recycling (Stubbles of ragi, samai, paddy and pulses)	Improves soil fertility and moisture conservation
Multitier cropping (little millet, lab lab, teak, mango, guava, jack, coconut, castor, coffee, pepper, sapota, silveroak, erythrina, turmeric, orange & banana)	Sustained income and soil conservation
Basin formation around trees	Moisture conservation
Burning crop residues and weeds for raising agricultural crops	Addition of ash to soil and improve soil fertility
Growing less water demanding crops like foxtail millet, little millet, maize in rainfed condition	To reduce water demand and expenditure
Use of Palanku, an indigenous implement in Groundnut and Ragi cultivation	Used for loosening the soil, thinning and moisture conservation
Agro-forestry (Mango/tamarind/coconut with horse gram/sorgum/paddy/ jack/guava/jammun) in rainfed areas	Effective use of resources,Sustained income and fertility improvement
Intercropping(Trees+ flowers/vegetables, (Coconut, banana+ crossandra/ vegetables), (Ragi+lab lab/paddy + red gram/cowpea, little millet + horse gram)	Effective resource use, Additional yield and income

Grass, banana/moringa on the bunds/ risers	Strengthening of bunds & fodder availability
Stone paving in the stream bank	Erosion control
Red gram on bunds of sugarcane field	Effective use of resources Additional yield and income
Mulching	Controls soil erosion Conserves moisture Improves soil fertility after decomposition
Construction of earthen well near the stream	Water source for drinking and irrigation
Pulses on the bunds of paddy field(black gram/cowpea)	Effective use of resources Additional yield and income
Planting/sowing across the slope	Erosion control Moisture conservation
Indigenous paddy varieties(*Sariganel, vellanel, karunel, puluthikar*)	No need of chemical fertilizers, drought resistance, pest disease, resistance suitable for direct sowing under rainfed condition.
Formation of trenches/drains for pepper& Coffee	Erosion control Safe disposal of excess rain water

unaware of this valuable traditional knowledge. Their wisdom and practices in the genre of soil and water conservation need to be documented and their efficacy validated. Documentation of ITKs on SWC practiced by Irulas and Malayali tribes of Salem, Namakkal, Villupuram and Thiruvannamalai district were done through interview schedules, group discussion and field visits (Table 3). Also, validation of three ITKs documented during previous years have been initiated.

Validation of 3 important ITKs *viz .,* incorporating Eupatorium with FYM, burial of pruned tea leaves and branches in trenches in tea estates and planting of Erythrina in the tea estates were carried out.

a. Eupatorium incorporation: Soil fertility status and yield data were recorded. The average yield obtained in the treatment plot was 25.47 t/ha which is 11.85 % higher over control (22.77t/ha).As per farmers view this practice helps in reducing acidity. But when pH was measured there was no much change.

Eupatorium

Incorporating Eupatorium with FYM

Application after decomposition in Potato

b. Burial or pruned tea leaves in trenches in tea: Trenches were excavated in tea plantation. Available nitrogen (262.88 Kg/ha), phosphorous(38.50 kg/ha), potassium(600.13 kg/ha) and organic carbon (2.7 %), higher in the trenches filled with crop residues. Enhanced soil moisture was observed in the trenches filled with leave residues as compared to without leave residues (control).

c. Planting of Erythrina in the tea estates with multitier system for better moisture conservation and increasing pepper yield: Validated in existing system in farmers field by taking tea+ silver oak+ pepper as control and tea + Erythrina + pepper as treatment. Higher values of soil moisture, SOC, N and P were observed in tea + Erythrina + pepper. Higher pepper yield(2.75 kg/vine/year) was obtained with tea + Erythrina + pepper system which is 22% higher than pepper yield(2.25 kg/vine/year) in tea+ silver oak+ pepper system due to better moisture availability and improved soil fertility status under Erythrina plant when compared to silver oak.

Silver oak + Pepper + Tea system

Erythrina + Pepper + Tea

Scheduled Tribe Components (Tribal Sub - Plan)

Development activities and technology demonstrations on Natural Resource conservation and capacity building in selected tribal village/hamlets in different parts of the country for upliftment of tribal communities were initiated under tribal sub plan (TSP) at institute level.

Objectives

- Ensuring that the share of resources spent for the benefit of the SCs and STs is at least in proportion to their share in proportion of the country.
- Substantial reduction in poverty and unemployment among the SCs and STs.
- Creation of productive assets in favour of the Scheduled Castes and Scheduled Tribes.
- Human resource development of the Scheduled Castes and Scheduled Tribes through specifically providing adequate educational and health services, and
- Provision of physical and financial security against all types of exploitation and oppression.

Headquarters/Centres	Districts	State
Headquarters, DehraDun	DehraDun	Uttarakhand
Research Centre, Ballari	Chitradurga	Karnataka
Research Centre, Kota	Baran& Bundi	Rajasthan
Research Center, Koraput	Koraput	Odisha
Research Center, Udhagamandalam	The Nilgiris	Tamil Nadu
Research Center,Vasad	Panchmahal	Gujarat

Financial achievements

The earmarked budget of Rs. 50.00 lakhs (25.00 lakhs capital + 25.00 lakhs operational) was allocated to our cooperating centers for the year of 2018-19 out of which more than 96 per cent was utilized for implementation of approved activities in selected tribal areas of different districts of the different states adopted by our cooperating centers.

Centre	Budget	
	Budget allocation	Expenditure
Ballari (Karnataka)	2.8	2.8
Koraput (Odisha)	9.5	9.5
Kota (Rajasthan)	8.4	8.4
Udhagamandalam (Tamil Nadu)	9.2	9.2
Vasad (Gujarat)	1.74	1.74
DehraDun (Uttarakhand)	18.36	16.54
Total	50.0	48.18 (96.36%)

Physical achievements

Activities	No. of beneficiaries
Head Quarter , DehraDun	
Training	25
Front line demonstrations	193
Awareness camp/exhibition/exposure visits	888
Distribution of material etc.	305
Research Center, Ballari	
Front line demonstrations	102
Distribution of material etc.	79
Research Center, Koraput	
Training	300
Front line demonstrations	178
Awareness camp/exhibition/exposure visits	60
Distribution of material etc.	306
Infrastructure development etc.	10
Research Center, Kota	
Front line demonstrations	2
Distribution of material etc.	273
Infrastructure development etc.	1
Research Center, Udhagamandalam	
Training	110
Front line demonstrations	11
Awareness camp/exhibition/exposure visits	30
Distribution of material etc.	665
Infrastructure development etc.	360
Research Center, Vasad	
Front line demonstrations	13

Demonstration on effect of balanced plant nutrition at Ballari:

The programme was launched at 79 farmers' fields in five tribal villages of Molkalmuru *taluk* of Chitradurga district,Karnataka. Bt. cotton was sown during second week of June, 2018 under irrigated condition, whereas, groundnut+redgram were sown during 2nd fortnight of August.

Groundnut+Redgram intercropping

Cotton demonstration

Distribution of Banana Saplings & Drumstick seedlings at Koraput :

1800 Banana Saplings and 1800 Drumstick seedlings were distributed to 1800 Households of 25 villages of Sarisapadar, Khudi & Kunduli Panchayat of Semiliguda Block to develop kitchen gardening.

Demonstration of vegetable crops at Koraput:

Off season vegetables cultivation has been demonstrated at Lenji Kunduli & Kandha Srimunda, Semiliguda Block of Koraput district and Bayaguda, R. Udayagiri of Gajapati District.

Distribution of Diesel Water Pump at Koraput:

5 HP water pumps & pipes were provided to the tribal farmers of the region for irrigation in off season vegetable crops.

Capacity building programme at Udhagamandalam

Four training programmes were conducted on various topics viz. Water harvesting sharing and efficient utilization, Soil and water conservation measures for plantation crops and vegetables, organic farming practices for Plantation Crops and Vegetables in The Nilgiris, Value addition in Plantation Crops and Vegetables in The Nilgiris.

Introduction of coffee pulping machines for value addition and drudgery reduction at Udhagamandalam:

In Kotagiri region the irula and Kurumba tribes were growing coffee plantations extensively. For removing the pulps from coffee berries they were using stones and doing manually. It was very tedious, cumbersome and consuming lot of time. Even after that, the quality of coffee beans was not good. This work was mostly done by women. In order to improve the quality and reduce the drudgery coffee pulping machines (7 numbers) were introduced in four tribal villages at a cost of Rs 19152/- per machine.

Water Conservation & Water harvesting at Udhagamandalam

Three demonstrations on subsurface water harvesting through construction of shallow well with stone pitching and demonstrations on tapping spring water and using it for irigation and drinking purpose through conveyance pipe, one farm pond and check dam were carried out in Puidur, Anthiyarai and Kandipatti villages covering 2.4 ha land and 27 tribal family's drinking water needs. This intervention reduced the drudgery of bringing drinking water from far off places for women and children in the tribal areas.

Mera Gaon Mera Gaurav Programme:

The Mera Gaon Mera Gaurav programme was successfully executed by the institute and its eight research centres located in different agro-climatic regions of the country. The teams of scientists constituted at institute Head Quarters and its research centres conducted bench mark survey in the selected villages. Brief descriptions of various activities under taken are as under.

- Soil health management and site-specific use of fertilizers.
- Packages of practices for annual crops, vegetables and horticultural crops.
- Demonstration of conservation measures.
- Capacity building on rainwater harvesting and recycling.
- Training programmes on natural resource management.
- General awareness for *Sawchh Bharat* programmes and other schemes of centre and state Government.
- Interaction meeting (Kisan Gosthi etc) with the farmers regarding their needs for sustainable agriculture.
- Awareness on adaptation of soil and water conservation measures, agricultural mechanization, rainwater harvesting and recycling, adaptation of high yielding pulses, vermin composting and integrated nutrient management.

In addition other technical services were also provided to farmers as per their requirements/needs. A good numbers of farmers took part in the proceedings and got benefitted. Also activities like Linkages development and Facilitation for new varieties; seeds, technology etc were also pursued.

Swachch Bharat Abhiyan (Clean India Movement):

The programme is the largest ever cleanliness drive with the participation of Government employees, and school and college students from all parts of India, in the campaign. The Institute at its level contributed towards the drive by organising various programmes i.e. Swachchta Pakhwada, Swachchta divas etc at institute Head Quarters at DehraDun as well as at its Research Centers.






Activities carried out under MGMG and Swachch Bharat Abhiyan at IISWC Head Quarters and Research Centers

03 TRAINING AND EDUCATION

Regular Training Programme for Officers:

During the year 2018-19, two batches (118th & 119th Batches) of regular four months Certificate Courses on Soil and Water Conservation and Watershed Management were organised at Institute Head Quarters, Dehra Dun. A total number of forty three (43) officers, including fourteen women, attended the training programme. Up to March 2019, 2956 officers have been trained at Head Quarters., Dehradun, its regional centers at Bellary, Kota and Udhagamandalam.

Short course training programmes:

To cater the need of capacity building of different type of stakeholders engaged in soil and water conservation activities in different states across the country a series of training courses, eight in number, were organised. In these programmes, 239 participants were trained in soil and water conservation and watershed management. Seven sponsoring agencies were enrolled for organisation of training programmes. The major focus was laid on practical exposure, skill development and participatory approaches.

Detail of Short courses/training programmes conducted during 2018 -19

Name of Training Course	Sponsoring Agency	Date	No. of Participants	
			M	F
Exposure of progressive farmers on soil and water conservation and watershed management techniques for skill enhancement (Officers)	ICAR-New Delhi	28.5.18 to 1.6.2018	17	03-
Collaborative Training programme on Watershed Concept Planning and Management (Officers)	MANAGE, Hyderabad	18.6.2018 to 27.06.2018	16	07
Soil & Water Conservation (Farmers)	Director of Agriculture, UK	19-20 July	19	03
Soil and Water Conservation approached (Staff)	Forest Department, Uttarakhand	23-25 July,	12	-
Collaborative Training programme on Integrated watershed management (Officers)	MANAGE, Hyderabad	10.09.2018 to 19.09.2018	19	03
Collaborative Training programme on Advanced Engineering Measures for Drainage Line treatment (Officers)	MANAGE, Hyderabad	03.10.2018 to 12.10.2018	28	-
Collaborative Training programme on Climate Change and Doubling Farmers Income (Officers)	MANAGE, Hyderabad	12.11.2018 to 21.11.2018	16	01
Administrative Training on E-procurement, ERP and Administrative training (Staff)	ICAR-IISWC, Dehradun	7-10, January 2019	22	10
Collaborative Training programme on Advanced Engineering Measures for Drainage Line treatment (Officers)	MANAGE, Hyderabad	12.02.2019 to 21.02.2019	16	02
Collaborative training programme on Motivation, positive thinking and communication Skills for Technical Officers (T5 and above) of ICAR-Institute (Officers)	NAARM, Hyderabad	13-19 March, 2019	19	05
Exposure visit cum farmers training programme on " Man Animal Conflict" (Farmers)	Farmer FIRST Project	26-27 March, 2019	21	-
Total			205	34

Other events organized by Institute and its Research Centres during 2018-19

Event	D. Dun	Agra	Bellary	Chandigarh	Datia	Koraput	Kota	Ooty	Vasad	Total
Kisan Diwas	1	1	1	1	1	1	1	1	1	**9**
Exposure visit	32	5	4	7	20	6	9	5	7	**95**
Kisan Goshti	11	4	7	5	3	6	4	3	4	**47**
Exhibitions	5	2	2	2	2	2	1	2	1	**19**
Swachchta Abhiyan	9	3	4	5	3	7	5	4	3	**43**
International Yoga Day	1	1	1	1	1	1	1	1	1	**9**
World Environment Day	1	1	1	1	1	1	1	1	1	**9**
Agril. Techno.week	-	1	-	-	1	-	1	-	-	**3**
Mahila Kisan diwas	1	1	1	1	1	1	1	1	1	**9**
Parthenium Awareness Week	1	-	-	-	-	-	1	-	-	**2**
Rashtriya Ekta Diwas	1	1	1	1	1	1	1	1	1	**9**
Hindi Saptah/Chetna Mass	1	1	1	1	1	1	1	1	1	**9**
Himalayan Day	1	-	-	-	-	-	-	-	-	**1**
Vigilance Awareness Week	1	1	1	1	1	1	1	1	1	**9**
Animal Health Camp	3	-	-	-	-	-	-	-	-	**3**
World Soil Day	1	1	1	1	1	1	1	1	1	**9**
Agriculture Education Day	1	1	1	1	1	1	1	1	1	**9**
Farmers training	9	3	4	3	5	9	4	5	3	**45**
International Trg. Prog.	1	-	-	-	-	-	-	-	-	**1**
Four months regular training programme	2	-	-	-	-	-	-	-	-	**2**
Field day	2	-	-	-	1	2	1	1	1	**8**
Van Mahotsav (Afforestation in wastelands)	1	1	1	1	1	1	1	1	1	**9**
Total	**86**	**28**	**31**	**32**	**45**	**42**	**36**	**30**	**29**	**359**

04 AWARDS AND RECOGNITION

Dehra Dun:

- Dr. Raman Jeet Singh awarded ISTRO scholarship to attend a conference organised by International Soil & Tillage Research Organization (ISTRO) in Paris, France during 24-27 September, 2018.
- Kadam D.M, Roy, Trisha., Kumar, S., Bihari, B., Shrimali S.S., Sharma S. K, Bishnoi, R., Singh, Madan., Kumar, R., Maurya U, and Chand Lekh received best poster award for the paper "Promotion of fruit based alternate land use system for rehabilitation of degraded lands in North Western Himalaya"presented during International Seminar on "Environmental Issues and Challenges in the 21" Century (EICC-2O19)", held at Bareilly College, Bareilly, U.P during 20-22 January, 2018.

- Dr. U.K. Maurya, received "Teaching and Research Excellence National Award" of IRDP Group of Journal during IRDP International Symposium on Education Excellence & Award Ceremony-2018 held at Hotel Atchaya, Chennai, on 28 October, 2018.
- Dr. U.K. Maurya received "Fellow-2017" award of Clay Minerals Society of India (CMSI) during 21st Annual Convention and National Conference of CMSI organised at National Institute of Technical Teachers Training and Research, Kolkata, on 14September 2018.

- Dr. U.K. Maurya elected as Councilor, North Zone, Clay Minerals Society of India (CMSI), New Delhi, for the year 2018-19.
- Dr. U.K. Maurya received "Distinguished Scientist Award" of Science & Tech Society for Integrated Rural Improvement (S&T SIRI), Warangal, Telangana during conference on "Doubling Farmers Income for Sustainable & Harmonious Agriculture (DISHA-2018)" at Ranchi on 12 August 2018.
- Dr.Gopal Kumar received Fellow of Confederation of Horticultural Association of India (CHAI)-2018.
- Dr.Gopal Kumar received Best Scientists award by Society for Science and Nature, Lucknow, India, 2018
- Dr.Gopal Kumar received ISER Excellent Paper Award for the paper entitled "Climate Resilience in Perennial Crops Through Soil Manipulations, A Case Study of Litchi (*Lychee Chinensis*)" during ISER International Conference held in New Delhi, India -2018.
- Dr.Gopal Kumar received *best paper award in oral category for the paper entitles* "Bamboo based intervention for averting land degradation and income generation in Mahi ravine" during "International Conference on Agriculture and Allied Sciemce: The Productivity, Food Security and Ecology" held at BCKV, West Bengal,-2018.
- Dr. Devideen Yadav, received Best Doctoral Dissertation Award in the field of Agronomy for the Doctoral Thesis entitled as 'Response of basmati rice-wheat cropping system to *in-situ* and *ex-situ* green manuring and zinc fertilization' from G.K.V. Society, Agra, Uttar Pradesh, during 08-09 December, 2018 on the occasion of national conference on "Managing Natural Resources for Sustainable Agriculture".

- Dr.Gopal Kumar got first place in discus throw in North Zone ICAR sports meet-2018-CIRB Hisar.
- Dr.Gopal Kumar got second place in shot put throw North Zone ICAR sports meet-2018-CIRB, Hisar.
- Dr.Gopal Kumar got third place in discus throw in Inter Zone ICAR sports meet-2019-IVRI, Izzatngar.
- Dr. Indu Rawat was selected as one of the Executive Editors of South Asian Journal of Food Technology and Environment, an official publication of society for World Environment, Food and Technology. ISSN 2394-5168 (Print), 2454-6445 (online) www.sweft.in
- Dr. Indu Rawat received 'Best Paper Presentation award' for the paper titled 'Impact of water crisis on women, a pillar of hill agriculture' in 7th International Conference on 'Agriculture, Horticulture and Plant Sciences' organized by The Society of Tropical Agriculture, New Delhi held at Hotel Landmark, The Mall, Shimla, during 28-29June, 2018.

- Dr. Indu Rawat received second prize in translation competition and third prize in letter writing competition held under Hindi week celebration during 14-20 September 2018.
- Dr.Trisha Roy received the Best Paper Presentation Award at International Conference on Agriculture and Allied Sciences: The Productivity, Food Security and Ecology for her presentation titled "Impact of incremental variation of N, P and S ratio on C mineralization from added wheat residue" held at BCKV, West Bengal during 13-14 August, 2018.
- Dr. M Muruganandam received 2018-19 Fulbright-Nehru Alumni Award from the US-India Education Foundation (USIEF), New Delhi in February 2019.
- Dr. M Muruganandam received Best Scientist Award and Medal from the Society of Life Sciences, Santa, MP at the International Conference on Advances in Biological and Environmental Research for Human Welfare held at DeenDayalUpadhya Gorakhpur University, Gorakhpur, UP on 16 November 2018.
- Dr. M Muruganandam received Honorary Fellowship Award from the Society of Life Sciences, Santa, MPat the International Conference on Advances in Biological and Environmental Research for Human Welfare held at DeenDayalUpadhya Gorakhpur University, Gorakhpur, UP on 16November 2018.
- Dr. M Muruganandam received Dr. K.K.Tyagi Gold Medal from Indian Academy of Environmental Sciences, Haridwar at National Conference on Environment and Biosciences held at Dehradun during 22-23June 2018.
- Dr. Sadikul Islam awarded the "Dr. GR Seth Memorial Young Scientist Award-2018" by Indian Society of Agricultural Statistics (ISAS), New Delhi in 72nd national conference of ISAS organized at ICAR-ICAE, Bhopal, Madhya Pradesh.

Agra:

- NARAKAS, Agra, awarded IISWC, Research Centre Agra for its contribution in Hindi.
- Dr. S.K.Dubey, received "SSCI National Fellow award" for the year 2017 towards his dedicated efforts and significant contribution in the field of Soil and Water Conservation, Watershed Development and Salinity Management by Soil Conservation Society of India on 25 October, 2018 at Jorhat Assam.

- Dr S K. Dubey, Head received SEE fellow award for his contribution in the field of extension education during 9th National Extension Education Congress 2018 held at CAEPHT, Ranipool Sikkim during 15-17 November, 2018.

- Indian Association of Soil and Water conservationists DehraDun awarded (in the category of Social Science) best research Paper 2018 to Sudhir Singh, Y.P.Singh, R.B.Sinha, A.K.Singh, S.K.Dubey and G.P.Verma for "Socio-economic impact of reclamation of Chambal ravines through anicuts and afforestation" published in Indian Journal of Soil Conservation (2018).
- Dr. K.K.Sharma nominated as "Editor" of Indian Journal of Soil and Water Conservation for the period of 2018-19.
- Dr. K.K.Sharma appointed as paper setter and examiner in SW-415 paper Remote Sensing & GIS application for B. Tech (AE) of MPUAT, Udaipur for academic year 2018-19.
- Dr Rama Pal, received Scientist of the year Award for outstanding contribution in the field of environmental Science by Agro-Environmental Development Society, U.P. in an international conference on "Emerging issues in Agriculture, Environmental and Applied Sciences for Sustainable Development" during 27-29 November, 2018 at Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P.
- Dr Rama Pal awarded third Prize for oral presentation in an international conference on "Emerging issues in Agriculture, Environmental and Applied Sciences for Sustainable Development" during 27-29 November, 2018 at Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P.
- Sh. B.P.Joshi awarded third prize in essay writing competition on "Jalvayu parivartan evam bharti pariveksh" organised by NARAKAS Agra.

Ballary:

- Dr. S.L. Patil was recognised as the Officer Incharge /Nodal Officer for various activities to be taken up under Krishi Kalyan Abhiyan for Yadgir district in Karnataka by Krishi Bhavan, New Delhi.
- D.C. Sahoo, B.S. Naik, P.P.Adhikari, Praveen Jakhar and Humbe Gowda received 'Best poster award' from Indian Association of Soil and Water Conservationist, Dehradun for the poster entitled "Bio-engineering measures for increasing rain water use efficiency under sloping land of red lateritic soil in Eastern Ghats Region of Odisha' by Sahoo, et al. (2019), presented in the Conference on "Farmers first for conserving soil and water resources in eastern region (FFCSWR-2019)" held during, 06-08 February, 2019 at Sunabeda, Koraput, Odisha, organized by Indian Association of Soil and Water Conservationists, DehraDun.
- Amrut S. Morade, S.L. Patil, A. Raizada, H. Biswas, B.S. Naik, Suresh Kumar, M. Prabhavathi, Ravi Dupdal and P.R. Ojasvi (2019) received 'Best Poster Award' for the poster on Land resource inventory for planning of sustainable horticulture in watersheds: Success stories from Sujala III project, in Conference on Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019)

Datia:

- Mr. MK Meena received Young Scientist National Award, 2018 of IRDP Group during one day IRDP International Symposium on Education Excellence & Award Ceremony-2018 held at Hotel Atchaya, Chennai on 28 October, 2018.
- Mr. A.K. Ahirwar received Golden award for Best worker under Administrative category for the year 2017-18 on 07 April, 2018 at ICAR-IISWC, DehraDun

Koraput:

- Dr. M. Madhu, Dr. P.P. Adhikary, Dr. D. C. Sahoo, Dr (Smt.). Ch. Jyotiprava Dash, Dr. H. C. Hombegowda, Dr. Praveen Jakhar, Sh. G. B. Naik, Dr. Karma Beer and Dr. P. K. Mishra 2018 received Nanaji Deshmukh ICAR Award for Outstanding Interdisciplinary Team Research in Agricultural and Allied Sciences 2015-16 on 05March 2019.

- Dr. Madhu received Dr K. G. Tejwani award biennial 2016-17 by IASWC- DehraDun in February, 2019.
- Dr (Smt.). Ch. Jyotiprava Dash awarded young scientist award by IASWC- DehraDun in February, 2019.
- Dr. P.P. Adhikary awarded gold medal (field functionary) by IASWC- DehraDun in February, 2019.
- Dr. Karma Beer received award for outstanding work in field of Rajbhasa Karyanayan by Nagar Rajbhasa Karyanayan Samiti, Koraput, Sunabeda on 31 January, 2019.
- IISWC-Research Centre Koraput awarded Best Centre award for the year 2017-18 by IISWC, DehraDun on 07 April 2018.
- Dr.P.P. Adhikary received 'Best Workers Award (Scientific category) of ICAR-IISWC for the year 2017-18 on 07April 2018
- Dr. D.C. Sahoo, B.S. Naik, P.P. Adhikary, Praveen Jakhar and Hombe Gowda received Best poster award during the conference on FFCSWR-2019, held at Koraput, Odisha for Bio-engineering measures for increasing rain water use efficiency under sloping land of red lateritic soil in Eastern Ghats Region of Odisha on 08 February, 2019.
- Dr. Karma Beer., Ch. J. Dash., P. Jakhar., M. Madhu., D.C. Sahoo., P.P. Adhikary and G.B. Naik received Best poster award during the conference on FFCSWR-2019, held at Koraput, Odisha for Jhola Kundi based vegetable farming for increasing profitability of tribal farmers in Eastern Ghats high land region on 08 February, 2019.
- Dr. H.C. Hombegowda, Praveen Jakhar and Karma Beer received Best poster award during the conference on FFCSWR-2019, held at Koraput, Odisha for Soil organic carbon recovery potential of shifting cultivated abandoned sites in Central Eastern Ghats, India on 08 February, 2019.

Kota:

- Dr. Hem Raj Meena received the best Ph. D.Thesis Award 2018 for quality research work of his Ph.D. thesis "Integrated nutrient management in Sapota cv. Kalipatti" in an International Conference on "Global Research Initiatives for Sustainable Agriculture and Allied Sciences (GRISAAS-2018)" during 28-30 October, 2018 held at Rajasthan Agricultural Research Institute, Durgapura, Jaipur (Rajasthan).
- Mrs. Anita Kumawat received the Best M.Sc Thesis Award 2018 for her thesis "Water and nitrogen management in direct-seeded rice" by Indian Society of Agronomy, New Delhi in the XXI biennial National Symposium of Indian society of Agronomy during 24-26October, 2018 at MPUA&T, Udaipur.

Udhagamandalam:

- Dr. O.P.S. Khola, received 'Prerak Netratva Alankaran - 2018 (Motivational Leadership Award - 2018)' from Department of Official Language, Ministry of Home Affairs, Govt. of India
- Dr. H.C. Hombe Gowda received "Nanaji Deshmukh ICAR Award for Outstanding Interdisciplinary Team Research in Agriculture and Allied Sciences – 2015-16" by ICAR, New Delhi.
- Dr. S. Manivannan, was awarded National Fellow of Soil Conservation Society of India during 28th National Conference of SCSI on Farmers' friendly soil and water conservation technologies for mitigating climate change impact held at Udhagamandalam during 31 January to 02 February 2019.
- Dr. S. Manivannan, received the Leadership Award – 2017 of Soil Conservation Society of India (SCSI) New Delhi on 25 October 2018 in the 27th National Conference of SCSI on Sustainable Management of Soil and Water Resources for Doubling Farmers' Income organised at Assam Agricultural University, Jorhat, Assam during 25-27 October, 2018.

- Dr. V. Kasthuri Thilagam, received the Prof. J S Bali Award of SCSI for the year 2018 during 28th National Conference of Soil Conservation Society of India on Farmers' friendly soil and water conservation technologies for mitigating climate change impact held at Udhagamandalam during 31 January to 02 February 2019.
- Dr. P. Raja, was conferred with National Award "B V Ramana Rao Best Paper Award in Agricultural Meteorology in 2018" by the Association of Agro-meteorologist, India, during the inaugural session of International Symposium on "Advances in Agro-meteorology for Managing Climate Risks of Farmers-INAGMET 2019 held at Jawaharlal Nehru University, New Delhi on 11 February, 2019.
- Dr. H.C. Hombe Gowda received the SADNHA Achiever Award-2018 for his contribution in the field of Agro-forestry Research in the Eastern Ghats, India by the Society for advancement of human and nature, Dr. Y.S.Parmar University of Horticulture and Foestry, Nauni, Solan, Himachal Pradesh, India.
- Dr. H. C. Hombe Gowda received the Best Oral Presentation award in the 28th National Conference of Soil Conservation Society of India, New Delhi on Farmers' friendly soil and water conservation technologies for mitigating climate change impact organised by IISWC, Research Centre, Udhagamandaam and Tamil Nadu State Chapter of SCSI during 31 January to 02 February 2019.
- Dr. H. C. Hombe Gowda received Best Poster Award in the national conference FFCSWR-2019 organised by IISWC, Research Centre, Koraput, Sunabeda during 06-08 February, 2019.
- Dr P. Raja nominated as Member of Board of Studies for Gondwana University, Gadchiroli, Maharashtra.

Vasad:

- Sh. Dinesh Jinger awarded the Doctor of Philosophy in Agronomy by IARI, New Delhi.
- Sh. Ramesh K S, was awarded "Best Worker Award" in recognition of his outstanding contribution in the Administrative Category for the year 2017-18

05 LINKAGES AND COLLABORATIONS

The institute and its Research Centres maintain linkages and collaboration with ministry of Science and Technology, State Agencies, State Agricultural Universities and sister ICAR Institutes apart from collaboration with other organisations.

Dehra Dun:

- Collaboration with Department of Science and Technology (DST)
- Collaboration with National Mission on Sustaining Himalayan Eco-system(NMSHE)
- Collaboration with National Innovations in Climate Resilient Agriculture(NICRA)
- Collaboration with NMSA-Ministry of Agriculture
- Collaboration with State Horticulture Mission for North East Hills, Uttarakhand
- Collaboration with Krishi Vigyan Kendra of ICAR

Agra:

- Professional linkage was developed with Forest Department of Uttar Pradesh in research work being executed at Manikpura village of Bah tehsil in collaboration with District Forest Officer, Agra.
- Professional linkages were developed with line departments, BSA Ram Ganga Command and ICAR institutes DRMR, Bharatpur, CIRG Makhdoom, CISH, Rehmankhera, Kakori Lucknow, IIPR Kanpur, IGFRI, Jhansi, IISS, Bhopal, IARI, New Delhi and CSSRI, KARNAL.
- Plant protection Variety Authority, New Delhi
- Forest Department Bhartpur Division
- Consultancy programme was initiated for greening of Goverdhan hillock in the Goverdhan range of the forest in Mathura on request of Conservator of Forests (Agra).

Ballary:

- Collaboration with Karnataka Watershed Development Department (Sujala-3), on Technical guidance in DPR preparation, Technical Monitoring and Evaluation of Watersheds.
- Collaborated with Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad and initiated a new Project on "Nutrient management in chickpea" as a Voluntary Centre of ICAR.
- Linkage with University of Agricultural Sciences (UAS), Dharwad, and Agricultural Research Station, Hagari, Siruguppa and Gangavathi, Krishi Vidyana Kendra Hagari, under UAS, Raichur, Krishi Vidyana Kendra Hiriyur, Chitradurga, and Zonal Agricultural Research Station under University of Agricultural and Horticultural Sciences (UAHS), Shimoga.
- Collaboration with NBSS&LUP, Benagaluru to prepare soil erosion maps of Karnataka and Andhra Pradesh and maps of watersheds under Sujala III Project.
- Collaboration with Joint Director of Agriculture, Ballari, Director of Horticulture, Ballari on Agriculture Research, Training and Extension.
- Collaboration with Karnataka Seed Corporation, for production of foundation seeds of different crops.
- Linkage with SAUs of Karnataka, Andhra Pradesh and Maharashtra, on training of B.Tech students in Soil and Water Conservation Engineering.
- Collaboration with various scientific consortia, on watershed management.

Chandigarh:

- Collaboration with Punjab Agricultural University, Ludhiana and YSPUHF, Nauni, Solan (HP) through meetings and workshops.
- Collaboration with National Institute of Technical Teachers Training and Research (NITTTR), Chandigarh, in regard to Guest Faculty.

- Collaboration with Central Institute of Temparate Horticulture, Kashmir.
- Collaboration with IVRI, Research Station, Mukteshwar.
- Collaboration with Central Agroforestry Research Institute, Jhansi.
- Collaboration with Department of Agriculture, Govt. of Himachal Pradesh.
- Collaboration with Department of Agriculture, Govt. of Haryana.
- Collaboration with State Level Nodal Agency (SLNA), Govt. of Haryana.
- Collaboration with Krishi Vigyan Kendra, Ropar, Punjab.

Datia:

- Collaboration with KVK, Datia.
- Collaboration with District agriculture office, Datia.
- Collaboration with ICAR – CAFRI, Jhansi.
- Collaboration with ICAR – IGFRI, Jhansi.

Koraput:

- Collaboration made with Odisha Watershed Development Mission, Bhubaneswar, Govt. of Odisha for capacitating functionaries on Land & Water Management under IWMP and preparation of District Irrigation Plan of southern six district of Odisha.
- Collaboration made with Odisha Forestry Sector Development Project, Ministry of Forest, Govt. of Odisha for conducting training programme on "Soil and Moisture Conservation Measures in Forest Areas" and to evaluate the Impact of SMC measures in Forest areas" and consultancy programme on "Evaluation of SMC measures at three forest ranges under Odisha Forestry Sector Development Project"
- Professional linkages with SCTI, Koraput; DRDA, Koraput; IGKV, Raipur; OUAT, Bhubaneswar; KVK, DWM, NBSS&LUP, NGOs , MSSRF, Jeypore; RSRS, Koraput;
- Collaboration made with ICAR RCER, Patna on conducting Integrated Farming System as per recommendation of Regional Workshop on Research Priorities and Reconciliation in Eastern Region" held on 28th May, 2014 at ICAR Research Complex for Eastern Region, Patna.
- Linkages made with Education Department, Govt. of Odisha for imparting training to school teachers on emerging issues of NRM and climate change.
- Linkages developed with District Administration of Southern Odisha (6 nos) for preparation of "District Irrigation Plan" under Prime Minister Krishi Sinchai Yojna (PMKSY).

Udhagamandalam:

- Collaboration with Schools / Colleges in the Nilgiris District.
- Collaboration with Horticultural Research Station (HRS).
- Collaboration with Central Potato Research Station (CPRS), Udhagamandalam .
- Collaboration with TIFR, Udhagamandalam.
- Collaboration with IARI, Regional station, Wellington.
- Collaboration with UPASI Tea Research Foundation, Coonoor.
- Collaboration with Forest department, Udhagamandalam.
- Collaboration with ICAR institutes and SAUs from different states.
- Collaboration with National Remote Sensing Agency.
- Collaboration with ISRO Department of Bio Technology.
- Collaboration with Hindustan Unilever Limited.

Vasad:

- Collaboration with ICAR- National Bureau of soil survey and land Use planning, Regional Centre, Udaipur.
- Collaboration with ICAR- DMAPR, Anand.
- Collaboration with Anand Agricultural University, Anand

06 LIST OF PUBLICATIONS

International

Dehra Dun:

Adhikary, P.P. and Dash, Ch J. (2018) Morphometric Analysis of Katra Watershed of Eastern Ghats: A GIS Approach. International Journal of Current Microbiology and Applied Sciences, 7(3): 1651-1665 (NAAS Rating 5.38)

Adhikary, P.P., Hombegowda, H.C., Barman, D. and Madhu, M., (2018). Soil and onsite nutrient conservation potential of aromatic grasses at field scale under a shifting cultivated, degraded catchment in Eastern Ghats, India, Int. J. Sediment Research, 33(3): 340-350.

Ahmed Akram, Prasad, M., Ranjan, R. and Dibyendu D. (2017) Rainfall variability and its effect on rainfed agriculture in Bundelkhand region, India. Progressive Research-An International Journal Volume 12 (Special-III): 2026-2031.(....3.84)

Dubey, R.K., Mundra S.L., Dhaker R.C, Dubey S.K. And Dubey Reena (2018) "Nutrient management and plant growth regulators for improving dry matter accumulation, it's partitioning, yield and quality of Indian mustard" International Journal of Agriculture Sciences ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 24, 2018, pp.-7682:7687 (…. 4.82)

Dubey R.K., Mundra S.L, Dhaker R.C And Dubey S.K. (2018) "Balance sheet of N and S recycling and productivity of Indian mustard under different Nutrient treatments and plant growth regulators" published in International Journal of Agriculture Sciences ISSN: 0975-3710 &E-ISSN:0975-9107,Volume10,Issue20,2018,pp.-7401:7405(…. 4.82)

K. Rajan., D. Dinesh., I. Rashmi., P. Raja and M. Ramesh. 2019. "Prospective of Tree Lucerne in Hilly Areas for Fodder, Soil Health and Carbon Sequestration a Review", Int. J. of Forestry and Horticulture, Vol. 5, no. 1, pp. 1-5, 2019. http://dx.doi.org/10.20431/2454-9487.0501001

Karunakaran, K., Duraisamy, V., Pramod Tiwary, Andrew M. Cunliffe, Padikkal Chandran, Sankar, M. and Surendra K Singh (2018). Comparison of methods for evaluating the suitability of Vertisols for Gossypium hirsutum (Bt cotton) in two contrasting agro-ecological regions. Archives of Agronomy and Soil Science, DOI: 10.1080 /03650340.2018.1542131.

Kumar Dileep., Dhar Shiva., Kumar Sajeev., Meena D.C. and Meena R. B.(2019) Effect of Zinc Application on Yield Attributes and Yield of Maize and Wheat in Maize-Wheat Cropping System. Int. J. Curr. Micro. App. Sci. 8(1): 1931-1941 (....5.38).

Kumar, G., R. Kumar., V. Nath., S.D. Pande., E.S. Marboh, and Kumar, P. (2018). Integrated Soil Management Technique for Young Growing Orchards of Litchi (Lychee chinensis). Int. J. Curr. Micro. App. Sci. 7(09): 710-722. doi: https://doi.org/10.20546/ijcmas.2018. 709. 085 (....5.38).

Kumar, S., Sharma, D. K., Singh, D. R., Biswas, H., Praveen, K. V. and Sharma, V. (2019). Estimating loss of Ecosystem services due to Paddy Straw burning in North-West India. Int. J. Agricultural Sustainability, 1-12.https://doi.org/10.1080/ 14735903.2019.1581474 (…. 8.70).

Kumar, S., Shiva Dhar, Yadav, R.S., Chandrakala, M., Kochewad, S.A., Meena, L.R., Meena, L.K., Singh, M. and Bhowmik, A. (2018). Effect of integrated K management on productivity and nutrient use efficiency of Maize-Wheat cropping system. Int. J. Curr. Micro. App. Sci, 7 (8): 1052-1061(....5.38)

Kumawat, Anita, Sepat, Seema, Vishwakarma, A.K., Kumar, Dinesh, Wanjari, R.H., Sharma, N.K. and Yadav, Devideen (2019). Management practices for enhancing resource use efficiency under direct seeded rice - A review, J. Pharm. and Phyto. 8 (2): 916-922. (.... 5.21).

Meena, H. R., Kala S, Meena R K, Meena G L and Singh R K (2018). Enhancing Firmness and Nutritional Quality of ber Fruit with suitable Packaging Materials and Waxing during Storage. Int. J. Curr. Micro. App. Sci., 7(8): 2584-2591. (....5.38)

Meena, Mukesh and Suryaprakash, S (2018). Farm Level Impact of Zero Tillage in Wheat under Rice-Wheat Production Systems. Int. J. of Agri. Sci., 10 (5):5260-5263. (....4.20)

Meena, R.K., Saroj, P.L., Adiga, J. D., Nayak, M. G. and Meena, H.R. (2018). Effect of Paclobutrazol on Flowering, Fruiting and Yield of Cashew (Anacardium occidentale L.) in West Coast Region of Karanataka. Int. J. Curr. Micro. App. Sci., 7(10): 380-391. (....5.38)

Naik, B. S., Patil, S. L., Raizada, A., Biswas, H., Kumar, S., Ramesha, M. N., Muralidhar, W., Reddy K. K., Kumar, P.M. (2018). Watershed Evaluation and Farmers' Preference – An Experience from Watershed Projects in Karnataka, India. Int. J. Curr. Micro. App. Sci. 7(9): 2661-2676. (....5.38)

Nath, V., Kumar, G., Pandey, S.D. and Gupta, A.K. (2018). Status of Litchi in India (Satus paper). Acta Hortic. 1211, 153-160, DOI: 10.17660/Acta Hortic. 1211.21 https://doi.org/10.17660/Acta Hortic. 2018.1211.21.

Pal Rama., Kaur R., Rajwar D. and Rai J. P.N.(2019). "Induction of Non-protein thiols and phytochelatins by cadmium in Eichhornia crassipes" Int.J.of Phytoremediation, DOI: 10.1080/15226514.2019. 1566881 ISSN 1522-7879(print) 1549-7879 (on line) pp1:9 (…7.77)

Pal, Rama, Dubey, R.K., Dubey, S.K. Singh, A.K. and Nitant, A.K. (2018). Assessment of heavy metal pollution of Yamuna water in Mathura region through Index Analysis approach. Int. J. Chemical Studies. 6(1): 399-402. (....5.31)

Raja, P., Bhaskar B.P., Surendran, U., Rajan, K., Santosh Kumar Sarkar, Malpe .D.B. and Nagaraju, M.S.S. 2018. Pedogenesis of spatially associated red and black soils in Purna valley from semi arid region of Central India. Published online, Chemical Geology 483; pp. 174-190; Elsevier, 0009-2541. (.... 9.35).

Rajan, K., Dinesh, D., Rashmi, I., Raja, P. and Ramesh, D. 2019. Perspective of Tree Lucerne in Hilly Areas for Fodder, Soil Health and Carbon Sequestration – A review. Int. J.Forestry and Horticulture.5 (1):1-5.

Ram, C., Singh, H. B., Patel, R. B., Singh, H. and Kumar, G. (2018). Effect of application of manures and bio-fertilizers on yield, soil fertility and economics of Groundnut (Arachis hypogaea L.) under middle Gujarat conditions. Int. J. of Chemical. 6 (2), 751-753.

Ravi Dupdal and B.L. Patil, 2019. Constraints Experienced and Suggestions by Farming Community in Adaptation to Climate Change in Karnataka: An Economic Analysis. Int. J.Curr.Micro.App. Sci. 8(2): 376-383.(....5.38)

Rawat, I., Bishnoi R, Singhal, V and Roy, T (2018) Impact of Water crisis on Women, a pillar of hill Agriculture. Int. J.Tropical Agriculture, 36 (3): 801-805.

Roy, T., Biswas, D. R., Datta, S. C., Sarkar, A., & Biswas, S. S. (2018). Citric acid loaded nano clay polymer composite for solubilization of Indian rock phosphates: A step towards sustainable and Phosphorus secure future. Archives of Agronomy and Soil Science, 64(11), 1564-1581. (….8.25).

Sarkar, A., Biswas, D. R., Datta, S. C., Roy, T., Moharana, P. C., Biswas, S. S. & Ghosh, A. (2018). Polymer coated novel controlled release rock phosphate formulations for improving phosphorus use efficiency by wheat in an Inceptisol. Soil and Tillage Research, 180, 48-62. (…. 9.82)

Somasundaram, J., Chaudhary, R. S., Awanish Kumar, D., Biswas, A. K., Sinha, N. K., Mohanty, M., Hati, K. M., Jha, P., Sankar, M., Patra, A. K., Dalal, R. and Chaudhari, S. K. (2018). Effect of contrasting Tillage and Cropping systems on Soil Aggregation, Carbon pools and aggregate associated carbon in rainfed Vertisols. European J. of Soil Science. 69(5), 879-891. doi:10.1111/ejss.12692

Surendran, U., Anagha, B, Raja, P., Kumar, V., Rajan, K. and Jayakumar, M (2019). Analysis of Drought from Humid, Semi-Arid and Arid Regions of India Using Drin C Model with Different Drought Indices. Water Resources Management, An Int. Journal – Published for the European Water Resources Association (EWRA), Springer Nature International Publishing, (.... 8.64).

Vibha Singhal, Sheeraz Saleem Bhat, Suheel Ahmad, Nazim Hamid Mir and Charan Singh 2019 Development of adoption index: A proxy measure for assessing the adoption rate of agroforestry practices in Indian Context. Int. J. Chemical Studies. 7(1): 1900-1903.

Yadav Devideen, Shivay, Y.S., Vishwakarma, A.K., Sharma, N.K., Sharma, V.K., Kumawat, Anita and Biswas, A.K. (2019). Consequence of Divergent Crop Residue and Green Manuring Practices on Soil Nutrient Balance: A Review, J. Pharmacognosy and Phytochemistry 8 (2): 903-908. (....5.21).

National

Alam, N.M., Chyana Jana, Barman, D., Sharma, Bhavika, Singh, Deepak, Mishra, P.K. & Sharma, N.K. (2018). Twentieth centuary rainfall trends of Uttarakhand, India. A Spatio-Temporal Analysis. Climate Change and environmental sustainability, 6(2): 94-103.

Arya, Swarn Lata., A.K. Tiwari., R.P. Yadav and G.L. Bagdi. (2018). Post-adoption behaviour of farmers towards soil and water conservation technologies of watershed management in Northern Shivalik foothills . Indian Journal of Soil Conservation, Vol. 46 (1): 118-124. (.... 5.20).

Arya, Swarn Lata., Pradeep Dogra., Sharmistha Pal and V.K. Bhatt. 2018. Community water harvesting structures' status, management and socio-economic impacts : Case studies in Shivaliks foothills, Northern Himalayas, India. Indian Journal of Soil Conservation. 46 (2): 206-217. (.... 5.20).

Bagadi, G.L., Mishra, P.K., Arya, S.L., Patil, S.L., Singh, A.K., Bankey Bihari, Om Prakash, Ashok Kumar, Sundarambal, P. and Meena, R.B.. (2018). Determinants of discontinuance of soil and water conservation technologies implemented in watershed management programmes in India. Indian Journal of Soil Conservation. 46(2): 233-241. (....5.20)

Bhardwaj, D.R., Sharma, P., Bishist, R., Navale, M.R. and Kaushal. R. (2018). Nutritive value of introduced bamboo species in the North Western Himalayas, India Journal of Forestry Research, doi.org/10.1007/s11676-018-0750-2

Choudhary, M., Rana, K.S., Meena, M.C., Bana, R.S., Jakhar, P., Ghasal, P.C. and Verma, RK. (2018) Changes in physico-chemical and biological properties of soil under conservation agriculture based pearl millet – mustard cropping system in rainfed semi-arid region. Archives of Agronomy and Soil Science, DOI: 10.1080/03650340.2018.1538556

Dash, CH. J., Adhikary, PP., Das, NK., Alam, NM., Mandal, U. and Mishra, PK. (2018). Comparison of rainfall kinetic energy-intensity relationships for Eastern Ghats Highland region of India. Natural Hazards, 93(1):547-558

Dash, CH. J., Adhikary, PP.,M, Madhu., Mukhopadhyay, S., Singh, S.K. and Mishra, P.K. (2018). Assessment of spatial changes in forest cover and deforestation rate in Eastern Ghats Highlands of Odisha, India. Journal of Environmental Biology, 39(2): 196-203.

Dhyani, B.L., Kumar, A., Bihari Bankey., Mandal, D., Singh, C., Muruganandam, M., Kumar ,Suresh., Sharma S.K. and Kumar Rakesh (2018). Conflict Management in Participatory Integrated Livelihood Security Project: A Case study from North Western Indian Himalaya. Indian Journal of Soil Conservation, Vol. 46, no.2, pp 242-254.(....5.20)

Dhyani, BL., Kumar, A., Mandal, D., Bihari, Bankey., Murganandam, M., Singh, C. and M, Madhu. (2018) Financial analysis of a participatory integrated livelihood security project in foothills of North Western Himalayas. Indian Journal of Soil Conservation, 46(1): 125-135.(….5.20)

Gaurav Singh, R.M. Singh, V.K. Chandola and Anupam Kumar Nema (2019) Stochastic Modeling of Water Deficit for Crop Planning under Climatic Conditions of Mirzapur District in Uttar Pradesh. Journal of Agrometeorology 21 (Special issue – "NASA 2014" Part-III) 42-48 (March 2019) (....6.56)

Gupta, G., Dhar, S., Dass, A., Sharma, V.K., Singh, R.K., Kumar, A., Jinger, D. and Kumar, A. (2018). Influence of bio-inoculant mediated organic nutrient management on productivity and profitability of pigeonpea (Cajanus Cajan) in a semi-arid agro-ecology. Indian Journal of Agricultural Sciences 88(10): 1593–6 (....6.23)

Harsh Mehta, Raj Kumar, Ayub Darr, G.P. Juyal, Sridhar Patra, Sneha Dobhal, A.C. Rathore, Rajesh Kaushal, and P.K. Mishra. 2018. "Effect of geojute technique on density, diversity and carbon stock of plant species in landslide site of North West Himalaya, J. Mountain Science: 15(9):1961-1971.

Hombegowda, H.C., Michael Köhler, Alexander Röll and Dirk Hölscher. (2019). Tree species and size influence soil water partitioning in coffee agroforestry, Agroforestry systems, DOI: 10.1007/s10457-019-00375-7

Islam Sadikul and Hukum Chandra (2019) "Small area estimation combining data from two surveys" the Journal of Communications in Statistics-Simulation and Computation.(... .6.50).

Jakhar, P., Adhikary, P.P., Rana, K.S., Dass, A., Choudhary, A.K., Choudhary, M. and Maharana, J. (2018) Resource conservation practices in Maize-mustard cropping system: Impact on energy, soil carbon and nutrient dynamics. Journal of Environmental Biology, 39(2): 440-446.

Jakhar, P., Kumar, P., Rana, K.S., Dass, A., Choudhary, A.K., Meena, M.C. and Choudhary, M. (2018) Tillage and residue retention effect on crop and water productivity of Indian mustard (Brassica juncea) under rain fed conditions. Indian Journal of Agricultural Sciences, 88 (1): 47–53.

Jakhar, P., Madhu, M., Naik, B. S., Hombe Gowda, H. C., Adhikary, P. P. and Naik, G. B.(2018). Appraisal of stream water diversion based off-season vegetable cultivation in a tribal catchment of southern Odisha. Annals of Agricultural Research, New Series. 39(4): 413-419. (....4.01).

Jat, N.K., Yadav R.S. and Kumar, S. (2018). Agronomic Evaluation of Biodynamic preparations and Panchagavya for Organic Cultivation in North Western Indo-Gangetic Plains, India. Annals of Plant and Soil Research, 20 (4): 384-390.(....4.39)

Jat, N.K., Yadav, R.S., Kumar, S., Ravishankar N. and Shamim, M. (2018). Evaluation of nutrient management practices under different cropping systems in north western Indo-Gangetic plains of India. Annals of Plant and Soil Research, 20 (4): 409-415.(....4.39)

Jat, R. L., Jha, P., Dotaniya, M.L., Lakaria, B.L., Rashmi, I., Meena, B.P., Shirale, A.O., and Meena, A.L. (2018) Carbon and Nitrogen mineralization in Vertisol as mediated by type and placement method of residue. Environment Monitoring Assessment, 190: 439-442.(….7.2)

Jinger, D., Dhar, S., Dass, A., Sharma, V.K., Joshi, E., Vijayakumar, S. and Gupta, G. (2018). Effect of silicon and phosphorus fertilization on growth, productivity and profitability of aerobic rice (Oryza sativa) Indian Journal of Agricultural Sciences 88(10): 1600–5 (....6.23)

Kala, S., Kumaran,K., Uthappa, A.R., Reeja, S., Prabhavathi, M., Rashmi, I. and Singh R.K. (2018). Clonal propagation through improved stem cutting technique in Pongamia pinnata (L.) Pierre. Indian Journal of Agroforestry, 20(2): 53-57.(....4.53)

Kar, S. K., Singh, R. M., and Thomas, T. (2018). Spatio-temporal evaluation of drought characteristics in the Dhasan basin. MAUSAM, 69(4), 589-598. (.... 6.28)

Kar, S. K., Thomas, T., Singh, R. M., and Patel, L.(2018). Integrated Assessment of drought Vulnerability using indicators for Dhasan basin in Bundelkhand region, Madhya Pradesh, India. CURRENT SCIENCE, 115(2), 338-346. (.... 6.88)

Kaushal R., J. Jayaparkash,D. Mandal, Ambrish Kumar, N. M. Alam, J. M. S. Tomar, H. Mehta,O. P. Chaturvedi. 2017. Canopy management practices in mulberry: impact on fine and coarse roots. Agroforestry Systems 93 (2): 545-556.

Kumar Manish., Narayan, D., Yadav, R. S., Kumar, Prabhat., Ranjan Rajeev., Pramanik Monalisha and Raj Kumar. (2018). Performance of Aonla with in-situ moisture conservation techniques. Indian Journal of Ecology, 45 (3): 654-658.(....4.96)

Kumar, D., Srivastava, K. K., Singh, S. R. and Rathore, A. C. (2018) Fruit production and carbon sequestration potential of rainfed apple (Malus x domestica Borkh) under various moisture conservation techniques. Indian Journal of Soil Conservation, 46 (1): 109-117.

Kumar, G., Tiwari, G., Kumar, V., Pande, S. D. and Nath, V. 2018. Climate resilience in litchi (Litchi chinensis) orchards in Bihar through soil manipulations, Indian Journal of Soil Conservation 46 (2): 190-198.

M. Sankar, S. M. Green, P. K. Mishra, J. T. C. Snöälv, N. K. Sharma, K. Karthikeyan, J. Somasundaram, D. M. Kadam, D. Dinesh, Suresh Kumar, V. Kasthuri Thilagam and T. A. Quine. 2018. Nationwide soil erosion assessment in India using radioisotope tracers 137Cs and 210Pb: the need for fallout mapping. Current Science, Vol. 115, No. 3, pp 388-390(....6.84)

Madhu, M., Dhyani, BL., HC, Hombe Gowda., Beer, Karma., Kumar, N., Muralidharan, P., Sikka, AK. and Sharda, VN. (2018).Soil erosion control measures impact on productivity of tea leaves and economics of tea plantation in South India. Indian Journal of Soil Conservation, 46(3): 320-329. (….5.20)

Maharana, J., Panda, C.M., Tripathy, P., Sahu, GS. and Jakhar, P. (2018) Disease incidence in kharif potato under Eastern Ghat highland zone of Odisha. Annals of Agricultural Research, 39(3): 304-312.

Manivannan, S., Khola, O.P.S, Kannan, K, Choudhury, P.K and Kasthuri Thilagam,V (2018). Efficacy of open weave jute geo-textiles in controlling soil erosion and its impact on hill slope stabilization. Indian Journal of Agricultural Sciences. 88 (5): 679–84. (.... 6.22).

Maurya, U.K. (2018). Assessment of Pedogenic Evolution of zeolites and associated minerals at a representative site of Baramati, Pune. Clay Research 37 (1):14-22.

Meena, B. P., Kumar, A., Lal, B., Meena, R. L., Shirale, A. O., Dotaniya, M. L., Kumar, Kuldeep, Sinha, N. K., Meena S.N., Ram Asha and Gautam, P. (2019). Sustainability of Popcorn-Potato cropping system improves due to organic manure application and its effect on Soil Health. Potato Research. https://doi.org/10.1007/s11540-018-9410-3.(....6.77)

Pande, V. C., Singh, H. B., Tiwari, S. P., Vishwakarma, A. K., Kumar, Gopal, Chandrakanth, M. G. (2018) Economic viability of drumstick based agri-horticulture system to replace tobacco in Central Gujarat: A modified partial budgeting approach. Indian Journal of Horticulture, 75(4): 639-646. (....6.10)

Pande, V.C., Rao, B K, Kurothe, R S, Kumar, Gopal, Sharda, V N, Mishra, P R, Bhatnagar, P.R., Dinesh D. (2017) Economic assessment of bamboo based soil conservation interventions for reclamation of degraded ravine lands in India: implication for policy intervention. J. Bamboo and Rattan, 16(3): 115-138 (communicated)

Panwar Pankaj., Sharmistha Pal., V.K. Bhatt., Ram Prasad., A.K. Tiwari and S. Patra. 2018. Toposequential agroforestry based land use system for soil and water conservation in sloping lands. Range Management and Agroforestry. 39 (1): 93-96 (.... 6.64).

Panwar, Pankaj., Sharmistha Pal., V.K. Bhatt., A.K. Tiwari and P.K. Mishra. 2018. Prioritizing areas for soil and water conservation in Punjab Shivaliks. Indian Journal of Soil Conservation 46(3):330-336 (.... 5.20).

Patil. S.L., Loganandhan, N., Ramesha, M.N., Adhikary. P.P. and K. Channabasappa. (2018). Energy Consumption and Sensitivity Analysis of Rainfed Chickpea Production in Vertisols of Semi-arid Karnataka. Proceedings of National Academy of Science in India, Section. B Biological Sciences. 88(2):685–694. (....4.00)

Pawan Kumar, Hoshiyar Singh, Jhabar Singh and R.N. Choudhary (2018). Estimation of Heat Stress Tolerance for Yield and its Contributing Attributes in Bread Wheat. Int. J. Curr. Microbiol. App. Sci. 7(7): 3817-3825 (.... 5.38).

Puniya, R, Palsaniya S, Chand, L Sharma, A Thakur, N.P. and Bazaya, B.R. 2018. Influence of sowing dates and varieties on the yield, heat use efficiency, energy utilization and economics of summer mungbean. Legume Research, 41(5) 2018: 710-715. (…. 6.23)

Raizada, A. Adhikari, R.N., Suresh Kumar, Patil, S.L., Ramajayam, D., Prabhvathi, M., Loganandhan, N., Mondal, B. and W. Murlidhar. (2018). Impact assessment of watershed interventions under low rainfall situations in semi-arid Karnataka. Indian Journal of Soil Conservation. 46(2): 261-271(....5.20)

Raj Kumar, H. Mehta, R. Kaushal, R. Banyal and M. Kumar. (2018). Influence of Provenance Variation on Seeding Characteristics of Celtis australis in Nursery Environment. Indian Journal of Ecology 45(4):797-801.

Rajan, K., Sanjeev Kumar, D. Dinesh, P. Raja, B.P. Bhatt and Deo Karan. 2019. Appraisal of Soil Potential to Store Organic Carbon in Old Alluvium of Indo-Genetic Plains. Int.J.Curr.Microbiol.App.Sci. 8(03): 2089-2102. (....5.38)

Ramesha, M.N., Jhenkhar M., Holscher, D., Patil, S.L., and Hombe Gowda, H. C. (2018). Essentiality of fast-growing tree species in Krushi Aranya Prothsaha Yojane. Current Science. 114(8):1595. (....6.88)

Rashmi, I., Kala, S., Pal, R., Meena, H. R. and Singh, R. K. (2019). Gully infested terrain deformed lands: extent, formation, issues and management. International Journal of Forest, Soil and Erosion, 9 (1): 1-7.(….3.73)

Rashmi, I., Mina, B.L., Kuldeep, K., Ali, Shakir, Kumar, A, Kala, S. and Singh, R.K. (2018) Gypsum-an inexpensive, effective sulphur source with multitude impact on oilseed production and soil quality: A review. Agricultural Reviews, 39(3) 2018: 218-225.(….4.37)

Rathore, A.C., A. Kumar, J. M. S. Tomar, Jayaprakash, J., H. Mehta, R. Kaushal, N. M. Alam, A. K. Gupta, A. Raizada and O. P. Chaturvedi. (2018). Predictive models for biomass and carbon stock estimation in Psidium guajava on bouldery riverbed lands in North-Western Himalayas, India. Agroforestry Systems, 92(1):171-182 DOI:10.1007/s10457-016-0023-z.

Rawat, Indu., Singh Madan., Singhal Vibha and Roy Trisha (2019). Diminishing natural water resources: a threat to hill agriculture. Journal of Pharmacognosy and Phytochemistry; SP 1:159-161.

Ritu Choudhary., Hoshiyar Singh., Pawan Kumar and Sheetal Raj Sharma. (2018). General and Specific Combining Ability Analysis for Yield and Some of Its Associated Characters in Late Sown Condition in Bread Wheat (Triticum aestivum L.em. Thell). Int. J. Curr. Microbiol. App. Sci. 7(7): 1586-1593 (.... 5.38).

Sahoo, D.C., Naik, B.S., Adhikary, P.P., Jakhar, Praveen and Hombe Gowda, H.C. (2018).Bio-engineering measures for resource conservation and enhanced productivity in sloping uplands of Eastern ghat region in Odisha. Indian Journal of Soil Conservation, 46(2): 255-260. (....5.20)

Sharma, K. K., Singh A. K. and Dubey S. K.,(2018) Rainfall trend analysis for crop planning under rainfed conditions in district Agra of Uttar Pradesh. MAUSAM, 69, 4 DOI: 633: 551.553.3 (540.27). (....6.47)

Sharma, S.R., Singh D., Pawan Kumar, Khedar O.P. and Varshnay N. (2018). Assessment of Genetic Diversity in Mungbean [Vigna radiata L Wilczek] Genotypes. International Journal of Genetics, ISSN: 0975-2862 & E-ISSN: 0975-9158, Volume 10, Issue 7, pp.-471-474 (.... 4.46).

Sharma, N.K. and Maurya, U.K. (2018). Rain water management for enhancing water use efficiency and sustainable productivity of rainfed wheat. Multilogic in Science, Vol. VIII, Special Issue (A) August-2018, pp 250-254, www.ycjournal.net.

Sharma, P., Bhakhar, S.R., Ali, Shakir, Jain, H.K., Singh, P.K. and Kothari, M. (2018). Generation of synthetic streamflow of Jakham River, Rajasthan Using Thomas-Fiering model. Journal of Agricultural Engineering, 55(4):47-56.(....5.59)

Singh, P.K., Atal S. and Dubey S.K. Assessment of Shallow groundwater quality for irrigation in parts of Agra district, Uttar Pradesh, India in Earth Science India (2018) eISSN:0974-8350v.11(III), pp133:148 .

Singh, L., Bishnoi, R., Bihari, B., Kadam, D.M., Singh, M., Malik, A.K., Shrimali, S.S., and Singh, R. J. (2019). Effectiveness of mKRISHI® Personalised Advisory on Water and Soil (PAWS) in

dissemination of agricultural information in north-western Himalayan region. Indian Journal of Agricultural Sciences 89 (2): 246-252. (.... 6.17).

Singh, S., Sahoo, D C., Tuti, MD. and Bisht, JK. (2018) Development and evaluation of weed wiper for resource conservation in hills of North Western Himalayas. Agricultural Engineering Today, 42 (2): 67-71.

Singh, S., Sahoo, DC., Singh, NK., Bisht, JK. and Thakur, TC. (2019) Feasibility Assessment of Pant-ICAR Animal Drawn Six-in-One Tillage Outfit in Kumaon Hills of Uttarakhand. Agricultural Engineering Today, (Accepted to be published in March 2019 issue).

Somasundaram, J., Singh,R. K., Prasad, S. N, Kumar, A., Ali, Shakir, Sinha, N. K, Chaudhary, R. S., Mohanty, M. ,Lakaria, B. L., Sankar,M. and Lal, R.(2018). Effect of Soil Amendments and Land Use Systems on Surface Cracks,Soil Properties and Crop Yield in a Vertisol. Agric Res https://doi.org/10.1007/s40003-018-0334-6.(….5.90)

Soumita, Mitra, S. K. Sarkar., P.Raja., J.K. Biswas and K. Murugan 2018. Dissolved trace elements in Hooghly (Ganges) River Estuary, India: Risk assessment and implications for management. Marine Pollution Bulletin, Elsevier Ltd. V.133:402-414. (....9.10).

Sudhir Singh, Y.P.Singh, R.B.Sinha, A.K.Singh, S.K.Dubey and G.P.Verma Socio-economic impact of reclamation of Chambal ravines through anicuts and afforestation in Indian Journal of Soil Conservation(2018) vol 46(2), pp225:232 (....5.20).

Sundaram, R., Kala, S and Parthiban, K.T. (2018): Genetic Variability and Divergence studies in Prosopis juliflora DC. Journal of Pharmacognosy and Phytochemistry, 7(4): 3479-3484.(....5.21)

Yadav, D.D., Shivay, Y.S., Singh, Y.V., Sharma, V.K. and Bhatia, Arti (2018). Effect of in-situ and ex-situ green manuring and zinc fertilization on growth and productivity of Basmati rice (Oryza sativa) under rice–wheat cropping system Indian Journal of Agronomy 63(4): 428-433.

Conference and Symposia Papers

International

- Ali, Shakir. Optimum sizing of recharge filter for artificially recharging the dug well. Abstract: Global Water Security for Agriculture and Natural Resourcesorganized by American Society of Agricultural and Biological Engineers (ASABE), USA during 03-06 October, 2018 at Hyderabad (Telangana), 152p.
- Amrut S. Morade., M. Prabhavathi., H. Biswas., S.L. Patil, and B. N. Seshadri, (2019). Oleification in Fig (Ficus carica L.): A Fruit Rescue Technique to Mitigate Abiotic Stress. Abstracts of 13th International Conference on Development of Drylands: Converting Dryland Areas from Grey into Green. International Dryland Development Commission and Arid Zone Research association of India, Jodhpur, Rajasthan, India, pp 225.
- Gupta, A.K., Kumar, Ambrish, Kaushal, Rajesh, Maurya, U.K., Mehta, H. (2019). Evaluation of surface water quality status of Kali River in Western Uttar Pradesh, India. Abstract, 86p. In Souvenir, International Seminar on “Environmental Issues and Challenges in the 21" Century (EICC-2O19)”, held during 20-22 January, 2019 at Department of Environmental Science, Bareilly College, Bareilly, U.P.
- Kadam D.M, Roy Trisha, Kumar Suresh, Bihari Bankey, Shrimali S.S., Sharma S.K, Bishnoi R, Singh Madan, Kumar Rakesh, Maurya U.K., Chand Lekh (2019). Promotion of fruit based alternate land use system for rehabilitation of degraded lands in North Western Himalaya. Abstract, 85p. In Souvenir, International Seminar on “Environmental Issues and Challenges in the 21" Century (EICC-2O19)”, held during 20-22 January, 2019 at Department of Environmental Science, Bareilly College, Bareilly, U.P.
- Kala, S., Parandiyal, A.K., Meena, H.R., Kumar, A., Meena, G.L., Rashmi, I., Mina, B.L.and Singh, R.K. Karanj (Pongamia pinnata) based silvipastoral system: Ideal technology for effective rehabilitation and utilization of Chambal ravines. 13th ICDD: Converting Dryland Area from Grey into Green, during 11-14 February, 2019 at ICAR-CAZRI, Jodh Pur.
- Kaushal, R., Singh I., Thapliyal, S.D., Kumar Ambrish, Mandal, D., Gupta, Anand, K., Tomar J.M.S, Alam, N.M., Dogra P., Mehta H., Singh D.V., Mishra P.K., Tewari Salil, Reza Selim and Durai J. (2018). Allometrics and environmental metrics of bamboos in Himalayan foothills: growth, biomass,

root distribution and soil properties. Abstracts of Bamboo and Rattan Papers. International Bamboo and Rattan Organization (INBAR). p 12. Paper presented at Bamboo and Rattan Congress (BARC 2018) held at Beijing during 25-27 June, 2018

- Maurya, U.K. and Krishnani, K.K. (2018). Zeolites engineered nano-material in environmental protection. In Abstract Book, ENTSED-2018, International Conference on "Environmental Nano Technology for Socio Economic Development of India" held during 28- 29 September, 2018 at DIT University, Dehradun, Uttarakhand, CP 54, 74p.
- Meena, H.R., Kaushik, R.A., Sarolia, D.K., Kala, S., Meena, G.L. and Singh, K. (2019). Efficacy of integrated nutrient management in sapota (Manilkara achras) in semi-arid region of Rajasthan. 13th ICDD: Converting Dryland Area from Grey into Green, Compendium of abstract paper, 231 p.
- Mina, B. L., Kala, S., Meena, H. R., Ali, Shakir, Kumar, A, Rashmi, I,, Meena, G. L. and Singh, R. K. (2019). Strategies for ecological restoration of stone mine spoil areas of South-eastern Rajasthan. 13th International Conference on "Development of Drylands Converting Dryland Areas from Grey to Green (13th ICDD)", held at CAZRI, Jodhpur during 11-14 February, 2019. Compendium of abstract paper, 42 p.
- Muruganandam M and P.R. Ojasvi. (2018). Revisiting impacts of culture and traditions on natural resources management. Abstract Proceedings of the International Biodiversity Congress (IBC 2018), Forest Research Institute, Dehra Dun (04-06 October. 2018). P. 353.
- Muruganandam M, P.R .Ojasvi and Janaswamy Srinivas. (2018). Nano-Technological Potential in Fisheries and Water Resource Management: A Review. Abstract Proceedings on the International Conference on Environmental Nanotechnology for Socio-Economic Development of India, DIT University, DehraDun (28-29 September 2018). P. 35.
- Muruganandam M, Steve R Chipps and PR Ojasvi. (2018). Advanced Technologies to Enhance Fisheries Production and Management. Souvenir cum Abstract Proceedings of the International Conference on Advances in Biological and Environmental Research for Human Welfare, Department of Zoology, DeenDayalUpadhyaGorakpur University, Gorakhpur, UP,. Pp. 22-23.
- Narayan, D. (2018). Soil and water conservation practices for sustainable crop production in climate change scenario in Central India. In. Abstract of Papers of the International Conference on "Rural Livelihood Improvement by Enhancing Farmer's Income through Sustainable Innovative Agri and Allied Enterprises (RLSIAAe)", 30 October to 01November, 2018, BIT, Patna.
- Rashmi, I., Mina, B.L., Kumar, K., Ali Shakir and Kumar, A. (2019). Effect of organic and inorganic amendments on soil erosion and crop productivity of soybean in table land of south-eastern Rajasthan. In abstract book- "13th International conference on "Development of Drylands Converting Dryland Areas from Grey into Green" during 11-14 February, 2019 at CAZRI Jodhpur, Rajasthan, India: 69.
- Ravi, Dupdal., S.L.Patil and H. Biswas. (2019). Weather Based Crop Insurance as Adaptation Strategy to Climate Change in Dryland Areas of Karnataka. In International Conference on Development of Drylands: Converting Dryland Areas from Grey to Green held at CAZRI, Zodpur during 11-14 February, 2019, pp.13
- Rawat, Indu presented a paper as oral presentation on the topic 'Impact of water crisis on women, a pillar of hill agriculture' in 7th International Conference on 'Agriculture, Horticulture and Plant Sciences' organized by Society of Tropical Agriculture, New Delhi held at Hotel Landmark, The Mall, Shimla, during 28-29June, 2018.
- Rawat, Indu presented a research paper entitled 'Diminishing natural water resources: a threat to hill agriculture' in an international Conference on 'Food security, nutrition and sustainable agriculture-emerging technologies' jointly organized by Baba Farid College, Bathinda and Indian Institute of Food Processing and Technology (IIFPT) held at Bathinda during14-16February 2019.
- Roy, T., Biswas, A. K., Jha, P., Sharma, N. K., Mishra, P.K. and Patra, A.K. (2018) Impact of Incremental Variation of N, P and S ratio on C mineralization from added wheat residue. In Compendium of Abstract of International Conference on Agriculture and Allied Sciences: The Productivity, Food Security and Ecology, Vol I, pp-43 (ISBN-978-93-85822-68-1) at BCKV, WB from 14-16 August, 2018.
- Vibha Singhal presented research paper entitled "Leaf liter production and decomposition dynamics in four agroforestry trees of western Himalayas" at International Conference on Food Security, Nutrition and Sustainable Agriculture–Emerging Technologies during 14-16 February, 2019 at Baba Farid College, Baba Farid Group of Institutions, Bathinda (Punjab)-151001

- Vibha Singhal presented research paper entitled "Role of religious beliefs of tribal communities in biodiversity conservation in Jharkhand" at International Biodiversity Congress (IBC-2018) during 04-06 October, 2018 at Forest Research Institute , DehraDun, India

National

- Adhikary, P.P., Madhu, M., Hombegowda, H.C., Beer, Karma., Jakhar, P., Sahoo, D.C., Dash, Ch. J., Naik,GB. and Das,N.K. 2019. Intervention of vegetable crops with integrated nutrient management for nutritional security and doubling income of tribal small landholders in Eastern Ghats highlands of East India Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, DehraDun, p155.
- Adhikary, P.P., Sahoo, D.C., Madhu, M. and Menna, Mukesh. 2019. Socio-economic analysis of tribal farming system in different topo-sequences in Koraput ,Odisha. Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, p115.
- Ali, Shakir (2019). Optimum design of recharge filters for tube wells recharging. In a compendium of abstract of papers, National Conference, Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019) organized by Indian Association of Soil and Water Conservationists, Dehradun, Uttarakhand, February 6-8, 2019 at Koraput (Odisha). 163p.
- Amrut S. Morade, M. Prabhavathi, H. Biswas, S.L. Patil, and B. N. Seshadri, (2019). Oleification in Fig (Ficus carica L.): A Fruit Rescue Technique to Mitigate Abiotic Stress. Abstracts of 13th International Conference on Development of Drylands: Converting Dryland Areas from Grey into Green. International Dryland Development Commission and Arid Zone Research association of India, Jodhpur, Rajasthan, India, pp 225.
- Amrut S. Morade, S.L. Patil, A. Raizada, H. Biswas, B.S. Naik, Suresh Kumar, M. Prabhavathi, Ravi Dupdal and P.R. Ojasvi (2019). Land resource inventory for planning of sustainable horticulture in watersheds: Success stories from Sujala III project. A Compendium of Abstract of Papers, Conference on Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019), (eds: Adhikaryet al.) held during, February 6-8, 2019 at Koraput, Odisha Organized by Indian Association of Soil and Water Conservationists, Dehradun.p.124.
- Barla, G.W. 2019.Adoption of off-season vegetables cultivation by tribal farmers of Koraput,Odisha Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, p164.
- Beer, Karma., Adhikary, P.P., Sahoo, D.C., Madhu, M.,Dash, Ch. J. and Naik,GB. 2019.Jhola kundi based vegetable farming for increasing profitability farmers in Eastern Ghats high land region Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, 89p.
- Beer, Karma., Adhikary, P.P., Sahoo, D.C., Madhu, M.,Dash, Ch. J., Jakhar, P. and Naik,GB. 2019.Performance of banana and drumstick plant treated with Azotobacter under diverse soil moisture condition Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, p126.
- Bhatnagar PR, Kakade V, and VC Pande (2019). Rainwater Harvesting Techniques for Horticultural Development in Ravine Lands. Presented in 53rd Annual Convention of ISAE and International Symposium on "Engineering Technologies for Precision and Climate Smart Agriculture" at BHU, Varanasi on January 28-30, 2019. Technical Compendium Abstract no. ISAE-019/SWC/WMES-11: 257.
- Bhatt V.K., Pankaj Panwar, Ram Prasad and Sharmistha Pal. 2019. Estimation of Soil loss and Run off and production potential of recommended land use systems.In: Farmer'sFirst for Conserving Soil and Water Resources in Eastern Region. February 6-8, Koraput, Odisha. Page -62.

- Biswas H., Raizada A. and Patil, S.L. (2019). Soil test-based micronutrient application for augmenting maize yield on farmers' fields. In the Proceedings of National Conference on "Farmer's First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019)" A Compendium of Abstract of Papers. (Ed. Adhikary, P.P., Sahoo, D.C., Jakhar, P., Dash, Ch. J., Karma Beer, Hombegowda, H.C., Kumar, G., Mandal, D. and Madhu, M) organized by Indian Association of Soil and Water Conservationists (IASWC), DehraDun, Uttarakhand, India, from 6-8th February, 2019, pp.125.
- Biswas H., S.L. Patil, Suresh Kumar, A. Raizada, B.S. Naik, A.S. Morade, M. Prabhavathi, Ravi Dupdal and P.R. Ojasvi (2019). Linking land resource inventory data with soil security - why and how? A Compendium of Abstract of Papers, Conference on Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019), (eds: Adhikaryet al.) held during, February 6-8, 2019 at Koraput, Odisha Organized by Indian Association of Soil and Water Conservationists, Dehradun.p.19.
- D.Dinesh, K.Kannan, V.Selvi, D.V.Singh, K.Rajan, O.P.S.Khola, V.D.Kakade (2019). Nutrients loss through sediments in the cultivation of vegetables under different slope condition of Acid soil presented in the Conference on FFCSWR-2019 organized by IAS&WC during 6-8 Feb., 2019 at ICAR- IISWC, RC, Koraput
- Dash, Ch. J., Madhu, M., Adhikary, P.P., Maurya,U.K.and Barla, G.W. 2019.Characterization of Jhola land(terraced low land)soils in Koraput,Odisha and its implication in policy issues Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, p157.
- Dash, Ch. J., Madhu, M., Adhikary, P.P., Sahoo, D.C. and Das,N.K. 2019. Monthly variation of erosivity density in Eastern Ghats high land region of Odisha. Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, Uttarakhand, p33.
- Dash, Ch. Jyotiprava, Adhikary, P.P., Madhu, M., Maurya, U.K., Barla, G.W. (2019). Characterization of Jhola Land (terraced low land) soils in Koraput district of Odisha and its implication in policy issues. Abst. T.5.7, 157p, In: Adhikary, et al. (Ed.) Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019): A Compendium of Abstract of Papers. Indian Association of Soil and Water Conservationist (IASWC), Dehradun, Uttarakhand, 172p.
- Dinesh, D, Velu, V, Rajan, K, Kakade, Vijay S, Bhatnagar, P. R. (2018). Effect of treated distillery effluent, biocompost and FYM and yield attributes of maize and soil properties. .Presented in the National Seminar on Developments in Soil Science organized by ISSS during 27-29 November., 2018 at AAU, Anand
- Dinesh, D., Kannan, K., Selvi, V., Singh, D.V., Rajan, K., Khola, O.P.S. and Kakade, V.D. (2019). Nutrients loss through sediments in the cultivation of vegetables under different slope condition of acid soil. Presented in National conference on "Farmers first for conserving soil and water resources in Eastern India" organized by IASWC at ICAR-IISWC, RC, Koraput, Odissa during 6-8, Feb, 2019.
- Dubey S.K., Dubey R.K. and Pal Rama (2019) "Sustainable management of land degradation in ravines" presented in 28th National conference on Farmer's Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact organized by Soil Conservation Society of India held at IISWC RC Udhagamandalam T.N. during 31 January to 02 February,2019 pp121:128
- Hombegowda, H.C., Madhu, M.,Beer, Karma. and Jakhar, P. 2019.Soil organic carbon recovery potential of shifting cultivated abandoned sites in Central Eastern Ghats,India. Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, DehraDun, Uttarakhand, p36.
- Jakhar, P., Hombegowda, H.C., Beer, Karma., Adhikary, P.P., Sahoo, D.C., Madhu, M., Dash, Ch. J. and Naik, GB. 2019.Potential of organic farming in tribal regions of Odisha Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, DehraDun, p87.
- Jakhar, P., Madhu, M., Hombegowda, H.C., Beer, Karma., Adhikary, P.P., Sahoo, D.C., Dash, Ch. J., Kindal, S., Naik, GB. and Das, N.K.2019. Conservation based efficient farming systems for hilly tribal

regions Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, p67.

- K. Rajan, Sanjeev Kumar, B.P. Bhatt, Deo Karan, P. Raja and D. Dinesh (2019). Assessing soil potential for organic carbon storage in old alluvium under sub-humid dry agro-eco region of Indo-genetic plains, Eastern India Presented in the Conference on FFCSWR-2019 organized by IAS&WC during 6-8 Feb., 2019 at ICAR- IISWC, RC, Koraput
- Kala, S., Parandiyal, A.K., Meena, H.R., Rashmi, I. and Singh, R.K. (2018): Productive Utilization of Degraded Lands Using Silvipasture System for Strengthening Sustainable Agro-ecosystem, 32nd National Convention of Agricultural Engineers at Kota (Rajasthan) during 18-19 th August, 2018.
- Khola, O.P.S., Selvi, V., Singh, D.V., Kannan, K. and Sundarambal, P. (2019). Participatory Water Resource Development and their impact on farm productivity in tribal areas of Nilgiris. Presented in the National Conference on Farmers First for conserving soil and water resources in Eastern India" organized by IASWC at ICAR-IISWC, RC, Koraput, Odissa during 6-8, Feb, 2019.
- Khola, O.P.S., Sundarambal, P., Kannan, K., Sahoo, D.C., Selvi, V., Singh, D.V., Manivannan, S. Dinesh, D., Thilagam, V. Kasthuri, Rajan, K. and Raja, P. (2019). Performance of Resource Conservation Technologies on the Farmer's Fields in The Nilgiris, Tamil Nadu in the 28th National Conference on Farmers' friendly soil and water conservation technologies for mitigating climate change impact" organised by Soil conservation society of India and ICAR- IISWC, RC, Udhagamandalam at Ooty during 31st January 02nd February, 2019.
- Kumar, Ambrish., Kaushal, Rajesh., Tomar, J.M.S., Singh, D.V., Durai, Jaram, Selini Reza and Ojasvi, P.R. (2019). Bamboo based bio-engineering measures for stabilizing eroded land slopes in Indian Himalayan Foothills. Abstract submitted to the ASEAN Bamboo Congress 2019 to be held during August 12-16, 2019 at Iloilo City, Philippines.
- Kumar, Ashok, Meena, H.R., Rashmi, I., Singh, R.K. and Kumar, K. (2019). Farmers' perception, attitude and adaptation strategies for climate change risk in agriculture-a case study in baran district of south eastern Rajasthan. In a compendium of abstract of papers, national conference, Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019) by Indian Association of Soil and Water Conservationists, Dehradun during February 6-8, 2019 at Koraput(Odisha). 116-117p.
- Kumar, G., Verma, Shilpi, Singh, D., Sharma, N.K., Singh, Gambhir and Gupta, Sarita (2019). Soil organic carbon estimation under different land uses using three different approaches (Theme I). Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019): Indian Association of Soil and Water Conservationists, Dehradun, Uttarakhand, 34 pp.
- Madhu M., P.P. Adhikary, D.C Sahoo, Ch. Jyotiprava Dash, H.C. Hombegowda, Praveen Jakhar, B.S. Naik, M.K. Meena, Karma Beer, G.B. Naik, G.W. Barla, S. Kindal and N.K. Das (2019). Conservation technologies for resource conservation in Eastern Ghats Region. A Compendium of Abstract of Papers, Conference on Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019), (eds: Adhikaryet al.) held during, February 6-8, 2019 at Koraput, Odisha Organized by Indian Association of Soil and Water Conservationists, Dehradun.p.49.
- Madhu, M.,Hombegowda, H.C., Beer, Karma., Adhikary, P.P., Jakhar, P., Sahoo, D.C., Barla, G.W., Kindal,S., Naik,GB., Naik, B.S., Choudhary, P.R., Dash,B.K. and Das,N.K. 2019. Effect of soil moisture conservation practices on soil properties, resource conservation and growth performance of forest plantation in Eastern Ghats Region of Odisha Presented in "Farmers First for Conserving Soil and Water Conservation Resources in Eastern Region (FFCSWR-2019)". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, p127.
- Maurya, U.K. (2018). Assessment of zeolites and associated minerals in soil degradation and development-a case study from Baramati, Pune. In Abstract, Conference on "Doubling Farmers Income for Sustainable & Harmonious Agriculture (DISHA-2018)" by S&T SIRI, Warangal, Telangana.
- Maurya, U.K. (2018). Characterization of zeolites of semi arid regions of India for its cation exchange. In Abstract, 21st Annual Convention and National Conference on "Advances in Clay Science towards Agriculture, Environment and industry" CMSI-2018, New Delhi.
- Maurya, U.K., Kumar, Ambrish, Gupta, A.K., Arya, R.K. and Gambhir Singh (2018). Groundwater management for enhancing adaptive capacity to climate change in sugarcane based farming system in Muzaffarnagar district, Uttar Pradesh. Abst. T.2.21, 74-75p, In: Adhikary, et al. (2019). Farmers First

for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019): A Compendium of Abstract of Papers. Indian Association of Soil and Water Conservationist (IASWC), DehraDun, Uttarakhand, 172p.

- Meena, G.L., Singh, R.K., Meena, H.R. and Sethy, B.K. (2018). Effect of land use systems on runoff and soil loss in vertisols of India. 27th National Conference on "Sustainable Management of Soil and Water Resources for Doubling Farmers' Income" held at Assam Agricultural University Jorhat (Assam) during 25- 27 October, 2018.
- Meena, G.L., Singh, R.K., Meena, H.R. and Sethy, B.K. (2018). Quantification of soil loss and runoff reduction efficacy of prominent land use systems in semi-arid region of western India. 32nd National Convention of Agricultural Engineers at Kota (Rajasthan) during 18-19August, 2018.
- Meena, H. R., Kala, S., Meena, G. L., Kumar, A. and Mina, B.L. (2018). Development of horti-pastoral systems using underutilized fruits species for productive utilization of chambal ravines. 32nd National Convention of Agricultural Engineers at Kota (Rajasthan) during 18-19 August, 2018.
- Meena, H.R., Kaushik, R.A., Meena, G.L. and Singh, R K. (2018) Effect of Integrated Nutrient Management on Growth and Yield of Sapota and Soil Properties. 27th National Conference on "Sustainable Management of Soil and Water Resources for Doubling Farmers' Income" held at Assam Agricultural University Jorhat (Assam) during 25- 27 October, 2018.
- Mukesh. Meena, P.P. Adhikary, M. Madhu, D.C. Sahoo, (2019). Socio –economic analysis of tribal farming system in different topo-sequences in Koraput district, Odisha, In Compendium of Abst. of Papers of the Conference on "Farmers First for Conserving Soil and Water Resources in Eestern Region , 6-8 February, 2019. Adhikary, et. al. (Eds.) P 115.
- Naik B.S., J.C. Paul, B. Panigrahi, B.C. Sahu and A.P. Sahu (2019). Quantification of runoff potential of Koraput district in Eastern Ghats region of Odisha. A Compendium of Abstract of Papers, Conference on Farmers First for Conserving Soil and Water Resources in Eastern Region, (eds: Adhikaryet al.) held during, February 6-8, 2019 at Koraput, Odisha.p.21.
- Naik B.S., S.L.Patil, A. Raizada, H.Biswas, S. Kumar, K.K.Reddy and W.Muralidhar (2019). Assessment of farmer's preferences for soil and water conservation treatment measures in watershed: a case study of Karnataka state. A Book of Abstracts, 28th National Conference on "Farmers' Friendly Soil and Water Conservation Technologies For Mitigating Climate Change Impact, (eds: Manivannanet al.) held during 31st January to 2nd February, 2019 at Ooty, Tamil Nadu organized by Soil Conservation Society of India, New Delhi.p.173.
- Narayan, D., Ranjan, R., Adhikary, P. P. and Dogra, P. (2019). Effect of improved package of practices on productivity at farmer's field in Bundelkhand region in Central India. In "Farmers First for Conserving Soil and Water Resources in Eastern Region : A compendium of abstract of papers", Adhikary, et. al. (Eds.), Indian Association of Soil and Water Conservationists, Dehradun, Uttarakhand, 152-153.
- Pal, S., Ram Prasad., Swarn Lata Arya. and Sathiya, K. (2019). Soil Fertility under Peach based land use systems in degraded soil of lower Shivaliks. In: Farmers First for Conserving Soil and Water Resources in Eastern Region, 6-8February 2019, Koraput, Odisha. P - 78.
- Parandiyal, A.K.; Meena, H.R., Meena, D.C.; Dubey, S.K. and Singh, R.K. (2019) "Agroforestry Landuses for Restoration of Degraded Ravine lands". Paper presented in National conference on Farmers First for Conserving Soil and Water Resources in Eastern Region , held during 06-08 February, 2019 at Koraput, Odisha.
- Patil, S.L. (2019). Improved conservation and production technologies on sustained crop yields and income under rainfed situations in red and black soils of South India. In the Proceedings of National Conference on "Farmer's First for Conserving Soil and Water Resources in Eastern Region" A Compendium of Abstract of Papers. (Ed. Adhikary, P.P., Sahoo, D.C., Jakhar, P., Dash, Ch. J., Karma Beer, Hombegowda, H.C., Kumar, G., Mandal, D. and Madhu, M) organized by Indian Association of Soil and Water Conservationists (IASWC), Dehradun, Uttarakhand, India, from 6-8th February, 2019, pp.154.
- Patil, S.L., Biswas, H., Ramesha, M.N. and Ojasvi, P.R. 2019. Lead paper on "Water Harvesting and Management in Semi-Arid Regions of south India". In the Proceedings of 28th National Conference on "Farmer's Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact" organised by Soil Conservation Society of India, New Delhi from 31 January to 2February, 2019 (ed. S. Manivannan, V. Kasthuri Thilagam, O.P.S. Khola, K. Kannan, P. Sunderarambal, H.C. Hombegowda, G. Thiyagarajan , Balaji Kannan) pp. 61-75.

- Prasad Ram,S.L Arya, Sharmistha Pal, K.Sathiya and V.K Bhatt. 2019. Peach-A suitable plant for resource conservation and sustainable development of degraded Shivaliks.In: Farmers First for conserving soil and water resources in Eastern Region,February 6-82019, Koraput, Odisha. Page 54-55.
- Rajan, K, Ragupathy, R, Raja, P, Dinesh, D, Khola, OPS (2018). Effect of forest vegetation's on soil organic carbon in the high altitude of western ghats mountain, India. presented in the National Seminar on Developments in Soil Science organized by ISSS during 27-29 November., 2018 at AAU, Anand
- S.L. Patil, H. Biswas, M.N. Ramesha and P.R. Ojasvi. (2018). In Augmentation of Groundwater Recharge and Water Quality Improvement by Water Harvesting Structures in the Semi-Arid Deccan – Review 2018. In International Consultation on Water: Augmentation of Supply and Management of Demand, pp-17.
- Sahoo, D.C., Hombegowda, H.C., Adhikary, P.P., Jakhar, P. and Naik, B.S. (2019). Bio-engineering measures for increasing rain water use efficiency under sloping land of red soil in Eastern Ghats Regions of Odisha Presented in "FFCSWR-2019". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, p70.
- Sahoo, D.C., Madhu, M., Beer, Karma., Adhikary, P.P., Jakhar, P., Dash,Ch J., Kindal,S., Naik,GB. and Das,N.K. 2019. Assessment of indefinable benefit of soil conservation measures in the perspective of doubling farmer's income in Eastern Ghats Region of Odisha Presented in "FFCSWR-2019". A compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, p158.
- Sankar, M., Sena, D.R., Lekh Chand, Suresh Kumar, Singh, Avindra, Islam, S. and Sharma, N.K. (2019). Effect of soil redistribution on CO2 flux uder different tillage practices and slope shapes in agricultural fields from Indian lesser Himalaya (Theme I)). Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019): Indian Association of Soil and Water Conservationists, Dehra Dun, Uttarakhand, 60 pp.
- Singh, A.K., Ali, Shakir, Rao, Rama Mohan and Reddy, K.K. (2018). Impact of watershed development programme on inflow of traditional tanks in semi arid region of north Karnataka-A case study. Paper presented in 32nd National convocation of Agricultural Engineers on Agricultural Engineering for sustainable Agricultural and Rural Development in India. Held from Aug. 18-19, 2018 at Kota (Rajasthan) organized by The Institute of Engineers (India), Kota Local Centre. Kota (Rajasthan).
- Singh, D.V., Patra, S., Mishra, P.K., Sharma, N.K. and Kadam, D.M. (2018). Participatory Water Resource Development in Hilly Areas of Uttarakhand – A Success Story from Jounsar Tribal Area. Presented in the Summit on "Climate Resilient Mountain Agriculture" organized by Directorate of Watershed Management at FRI, Dehra Dun, Uttarakhand during May 2-4, 2018.
- Singh, R.K., Meena, H. R., Kala, S. and Rashmi, I. (2018). Resource conservation approaches for eco-restoration and profitability in arid and semi-arid region. National Conference on "Arid Horticulture for Enhancing Productivity and Economic Empowerment" held at ICAR- CIAH, Bikaner (Rajasthan) during October 27-29, 2018.
- Suresh Kumar, H. Biwas, Alka Singh, Ankhila R.H., Prabhakar Kumar. (2019). Presented research poster on "Soil Security Index: A Tool for Prioritizing Sustainable Soil Health Planning in India" in XIV Agricultural Science Congress on the theme "Innovations for Agricultural Transformation"at New Delhi from February 20-23, 2019.
- Vijayakumar, S., Kumar, D., Singh, N., Jinger, D., Raghavendra, G.B., Poornima, S. and Khanam, R. (2018). Potassium uptake and apparent potassium balance of dry direct seeded rice- wheat cropping system. XXI Biennial National Symposium of Indian Society of Agronomy, 24–26 October, 2018 at MPUAT, Udaipur, Rajasthan, Pp. 104–105.

Popular article

- Bankey Bihari, Lakhan Singh, Rajesh Bisnoi and Suresh Kumar (2018). Innovative Market Mechanism. Published in LEISA India Vol. 20 No. 4 Dec. 2018 page 18-21.
- Beer, Karma., Jakhar, Praveen., HC, Hombegowda., Meena,MK. and Madhu, M. 2018, Horticulture Based Integrated Farming System in Tribal Region of Odisha. Marumegh: Volume 3(4): 64-71.
- D. Dinesh, K. Kannan and K. Rajan (2018). Buckwheat (*Fagopyrum esculentum*)- A multipurpose cover crop for hilly regions. Rashtriya Krishi. 13(2): 99-101

- Dupdal, R, Patil, S.L., Biswas, H., Morade, A., Naik, B.S. and Prabhavathi, M (2018) Pradhan Mantri Jan DhanYojana: Strategy towards Financia Inclusion in India. Popular Kheti, 6(3): 151-155
- HC, Hombegowda., Jakhar, Praveen., Beer, Karma. And Madhu, M. 2018 Aadivasi kisano ke liye Krishi vaniki pranali. 71(4): 21-23.
- Hombegowda, H.C., Jakhar, P., Karma Beer and Madhu, M., 2018.Income generative suitable agroforestry systems, Kethi (Hindi mazine), August 2018, 21-23pp.
- Indu Rawat, Trisha Roy, Madan Singh, Suresh Kumar (2018) Hindi Calendar. HRD&SS Division.
- रावत इन्दु, तृशाल धर्सेन्द्र एवं नन्दा एस0 के0 (2017) मशीन कम्पन्नः एक यांत्रिक विश्लेशण, प्रसंस्करण प्रगति, प्रकाशन सिफेट लुधियाना, अंक–2, जुलाई–दिसम्बर पेज 11–15.
- Kadam, D. M., Singh, R. J., Kumar, P., Kumar, V. Singh, L., and Burman, R. Roy. (2018). Plug Tray Production of Cucurbit Seedlings for Better Economic Returns in Riverbed Lands of Haridwar District. Soil Water Conservation Bulletin. Vol. 3: Page 75-79.
- Kala, S., Meena, H.R., Rashmi,I., Ali, Shakir and Singh, R.K.(2019): Promising Agroforestry Trees species for Dryland Farming Systems in Semi-Arid Regions of South Eastern Rajasthan, Agriculture & Food: e - Newsletter, 1(3): 12-16.
- Karma Beer, Praveen Jakhar, Home Gowda HC, Mukesh Kumar Meena and M. Madhu (2018). Horticulture based Integrated Farming System in Tribal region of Odisha, Marumegh, 3(4): 64-71.
- Kumar, Ashok, Singh, R. K, Meena, H. R., Kumar, Kuldeep and Kumar. Kamlesh (2018). Adhik Utpadan hetu Jal avam Mrida Samrakshan Taknik: Contour Furrow. Kheti (April): 16-18.
- Kumar, Kuldeep, Kumar, Ashok, Singh, R.K, Mina, B.L.(2018). Adhik aay aur paryaavaran sanrakshan ke liye khetee aise Karen. Krishi Jagran.com, 14 August 2018.
- Maharana, J., Panda, CM., Tripathy, P., Sahoo, GS. and Jakhar, P. 2018. Kharif potato cultivation prospects in Odisha. Marumegh Kisan e-Patrika, p35-39.
- Meena H, Parandiyal A.K. and Meena G.L. "Aam ka Mulya Sanvardhan" published in Krishi gyan ganga edition (II &III) Jan- Jun & Jul-Dec, 2017 pp-86:88
- Meena H., kala S., Parandiyal A.K. and Rashim I "Fal ayum sabjiyon ka mulya sanvardhan" published in Krishi Amrit Patrika 1 February , 2019 pp4:5
- Meena, H. R., Kala, S., Parandiyal, A.K. and Rashmi, I. (2019). Phal avam Sabjiyon ka Mulya Sanvardhan. Krishi Amrit, 12: 4-5.
- Monalisha Pramanik, Rajeev Ranjan, Mukesh Meena and Pramod Kumar (2019) Irrigation scheduling technique for efficient water use productivity. Marumegh, 4(1): 56-66.
- Naik, B.S. (2018). Effect of climate change on agriculture and its mitigation. In: Technical bulletin:The Institution of Engineers (India), 51st Engineers' Day,Sunabeda Local Center, Sunabeda, Koraput (Odisha): p. 6-9.
- Pal Rama (2019) Climate change impact on Indian Agriculture. Indian Farmers' Digest. (popular article)
- Pal Rama, Dubey R.K. and Gupta A.K. " Wastewater generation and its scope in Indian Agriculture" in Indian Farmers Digest ISSN 0537-1589 April 2018 pp 25:29
- Rathore, AC, Mehta, H and Sharma NK (2018) Performance of peach based land use system in gravelly riverbed lands. Field Forester 3(1):197-201.
- Roy, Trisha, Sharma, N.K. , Singh, Deepak, Sarkar, Abhijit, Das, Madhumanti (2018). Alternate uses of paddy straw: effective ways to curb menace of residue burning. NESA, E-version Vol. 21 Issue –10, October, 2018 : 13-14.
- Sharma, N.K. (2017). हिमालयी पारिस्थितिक तंत्र के सतत् रूप हेतु राष्ट्रीय नियोग. मृदा एवं जल संरक्षिका, भा.कृ. अनु.प.–भारतीय मृदा एवं जल संरक्षण संस्थान. : 118–120.
- Singh, R.J., Sharma, N.K., Kumar, G. and Deshwal, J.S. (2018). Doubling Farmer's Income in Rainfed Areas in the Context of Climate Change. Soil Water Conservation Bulletin. Vol. 3: Page 7-12.
- Trisha Roy, I Rashmi, Rama Pal, Uday Mandal and Deepak Singh (2017) Jaiveek Kheti ke Labh. Mrida ebam Jal Sanrakshika: Rajbhasha Patrika. Vol 2: 92-93.
- Trisha Roy, N. K. Sharma, Deepak Singh, Abhijit Sarkar and Madhumanti Das (2018) Alternate Uses Of Paddy Straw: Effective Ways To Curb Menace Of Residue Burning. National Environmental Science Academy (NESA- News Letter) October 2018, 13-14.
- U.K. Maurya, Ashok Kumar, Gambhir Singh and Sarita Gupta (2017). Mrida Parikchan kee Mahatta. Rajbhasha patrika: Mrida avam Jal Sanrakshika (2), IIWSC Publication, 15-17pp.

- U.K. Maurya, Ashok Kumar, Gambhir Singh and Sarita Gupta (2017). Lakshhano se phasalon me poshak tatyo ki kami ki pahchan, Mrida avam Jal Sanrakshika (2), IIWSC Publication, 86-90pp.
- U.K. Maurya, Ashok Kumar, Gambhir Singh and Sarita Gupta (2017). Poshak tatyo ke prakar aur shroat, Mrida avam Jal Sanrakshika (2), IIWSC Publication, 121-122pp.
- रावत इंदु (2017) कृषि आधारित उद्योगों में परचलित व्यवसायिक स्वास्थ्य समस्याए व उनका निदान मरदिा एवं जल संरशिका 10–109

Books Published/Edited

- Adhikary, P.P., Sahoo, D.C., Jakhar, P., Dash, Ch. J., Karma Beer, Hombegowda, H.C., Kumar, G., Mandal, D. and Madhu, M. 2019. Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019): A Compendium of Abstract of Papers. Indian Association of Soil and Water Conservationists, Dehradun, Uttarakhand, 176 pp.
- Beer, Karma., Jakhar, P., Dash, Ch. J., Adhikary, P.P., Sahoo, D.C., Hombegowda, H.C., Kumar, G., Mandal, D. and Madhu, M. 2019. Resource Conservation in Eastern Region of India: Lead Papers of FFCSWR- 2019. Indian Association of Soil and Water Conservationists, Dehradun, Uttarakhand, 237 pp.
- पी0के0 मिश्रा, ए0सी0 राठौर एवं हर्ष मेहता (2018) बागवानी फसलों हेतु मृदा और जल प्रबंधन की नवीनतम विधियांए स्मारिका बदलती जलवायु में उच्च तकनीकी पर्वतीय बागवानी के उभरते रूझान पेज नं0 1.14 भा0कृ0अनु0प0 – भारतीय मृदा एवं जल संरक्षण संस्थान देहरादून उत्तराखण्ड 248195।
- Karma Beer., Jakhar, P., Dash, C. J., Adhikari, P., Sahoo, D. C. Hombegowda, H. C., Kumar, G., Mandal, D. and Madhu, M. (2019). Resource conservation in eastern region of India: Lead papers of FFCSWR-2019, published by IASWC, pp-243, ISBN:978-93-5351-052-7.
- Kaushal R, Kumar Ambrish, Durai J, Mandal D , Rao IVR, Dogra P, Alam NM, Gupta AK, Tomar JMS, Singh DV, Mehta H, Mishra PK. 2018. Research methodologies for field monitoring analysis and evaluation of Resource conservation aspects of bamboos. International Bamboo and Rattan Organization (INBAR) 117p. ISBN:978-92-990082-9-4
- Kurothe, R.S., Singh, H.B., Tiwari, S.P., Pande, V.C., Bagdi, G.L., Sena, D.R., Vishwakarma, A.K., Kumar, G., Rao, B.K. (2018). *60 Years of Research on Soil and Water Conservation in Gujarat*. ICAR-Indian Institute of Soil & Water Conservation, Research Centre, Vasad 388306. 190 p.
- Madhu M., Adhikary P.P., Sahoo, D.C., Jakhar, Praveen, Hombe Gowda, H.C., Dash Ch. Jyotiprava, Beer, Karma, Meena, M.K., Naik, B.S. and Barla, G.W. (Eds) (2018). 25 Years of Research on soil and water conservation in Eastern region of India. 149pp ISBN: 97881924624-5-5
- Manivannan. S, Kasthuri.V Thilagam, Kannan.K, Sundarambal.P, Hombegowda H.C, KholaO.P.S, Senthilkumar.T, Thiyagarajan.G, Balaji Kannan and Valliammai.A (2019). Book of Abstracts, 28th National Conference on Farmers' Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact. Tamil Nadu State Chapter of SCSI, ICAR-IISWC, Regional Centre, Udhagamandalam, Tamil Nadu, India. P316.
- Manivannan.S, V. Kasthuri Thilagam, Balaji Kannan and G.Thiyagarajan (2018). Integrated Watershed Management (Tamil), Thannambikai Publication, Coimbatore (ISBN 978-93-87314-60-3). Pp. 262.
- Mishra, P.K., Sharma, N.K., Mandal, D., Kumar, G., Kaushal, R., Das, A., Singh, R.J. (2018). Sustainable land management Issues, Problems and Prospects, Satish serial Publishing House, ISBN: 978-93-873880204-6-6.
- Sharma, N. K. Awasthe, R. K., Kumar, A., Mandal, D. Kaushal, R., Singh, L, Das, A. Kumar, G. Singh, R. , Mishra, P. K. (2018). Farmers Innovation, Initiative and Expectation in Natural Resource Conservation in North Eastern Region, published by IASWC, Dehra Dun, pp-128.

Book Chapters

- शर्मा के. के., सिंह ए. के. एवम् दुबे एस. के., 2017 यमुना बीहड़ो के विस्तार को रोकने तथा उन्हें उपजाउ बनाने हेतु उचित तकनिकियां मृदा एवं जल संरक्षिका राजभाषा पत्रिका अंक – 2 , 2017 । भारतीय मृदा एवं जल संरक्षण संस्थान, देहरादून (उत्तराखण्ड) द्वारा प्रकाशित । पृष्ठ संख्या 56 से 58 ।

- Bairwa S L, Rahaman S.M. and Meena D.C. (2019) Public Private Partnership (PPP) in agricultural marketing. Published in Book – Marketing of agricultural commodities in India (ISBN 978-93-88317-09-2), pp 38-47
- Bankey Bihari (2018). "Agro-ecosystem Analysis for Planning of Resource Conservation Projects" Training Manual on "Collaborative Training Programme on Climate Change and Doubling Farmers Income", Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun, pp.77-88.
- Bankey Bihari (2018). "PRA/PLA for Watershed Planning" Training Manual on "Collaborative Training Programme on Watershed Concept, Planning and Management", Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehra Dun, pp.84-94.
- Bankey Bihari (2018). "PRA/PLA techniques for Participatory Project Planning" Training Manual on "Collaborative Training Programme on Advanced Engineering Measures for Drainage line Treatment", Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun, pp.27-39.
- Bankey Bihari (2018). "PRA/PLA techniques for Participatory Watershed Planning" Training Manual on "Collaborative Training Programme on Integrated Watershed Management", Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun, pp.39-50.
- Bankey Bihari (2019). "Briefing on PRA and Mappings" Training Manual on "Collaborative Training Programme on PRA and Micro Watershed Planning", Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun, pp.16-27.
- Biomass and carbon stock under high density spacings of different tree species. In Agroforestry for Climate Resilience and Rural Livelihood (Eds. Inder Dev/Asha Ram/Naresh Kumar, Ramesh Singh, Dhiraj Kumar,A.R. Uthappa, A.K. Handa, O.P. Chaturvedi). Scientific Publisher. 185-197
- Biswas, H., Prabhavathi, M. Patil, S.L., Kumar, S. andMorade, A.S.(2018) Application of Biochar as Soil Amendment: Theory and Practice. Integrated natural resource management in India through participatory integrated watershed management. *In*: Rakshit,*et al*. (Eds.) Soil Amendments for Sustainability. Boca Raton: CRC Press, https://doi.org/10.1201/9781351027021. 16 pp.
- सिंह अशोक कुंमार एवं शर्मा कमल किशोर, 2017 जल ग्रहण तथा अन्य विकास कार्यक्रमों के कारण सूखते पारम्परिक तालाब । मृदा एवं जल संरक्षिका राजभाशा पत्रिका अंक – 2 , 2017 । भारतीय मृदा एवं जल संरक्षण संस्थान, देहरादून (उत्तराखण्ड) द्वारा प्रकाशित । पृश्ठ संख्या 25 से 28 ।
- Jakhar, P., M, Madhu., Naik, BS., Hombegowda, HC., Adhikary, PP. and Naik, GB. 2019. Experience of Watershed Management in Rainfed Areas of Eastern Regions: Case studies from tribal region of Odisha. In: Resource conservation in Eastern region of India: Lead Papers of FFCSWR-2019, Ed. Karma etc.al., Indian Association of Soil and Water Conservationists, Dehradun, p134-145.
- Joshi Pratibha and Karki Indu (2019) Women participation in Agriculture and allied sector in Hills: a contextual paradigm. Women in Agriculture (The Invisible partners in Development) Jaya Publishing House, New Delhi, 248 p. ISBN:978-93-87 590-98-4.
- Kannan, K., Sundarambal, P. and O.P.S. Khola. 2018. CN grass for soil conservation and fodder production in hilly areas. Babu, C. Ayyanar, K., Sivakumar, S.D. and Ganesamurthy, K. (editors). 2018. Forage Crops and Dairyíng. Tamil Nadu Agricultural University, Coimbatore. P:131-138. ISBN No.: 978-93-83799-91-6.
- Karki Indu and Joshi Pratibha (2019) Women participation in Agriculture and allied sector in Hills: a contextual paradigm. Women in Agriculture (The Invisible partners in Development) Jaya Publishing House, New Delhi, 248 p. ISBN: 978-93-87 590-98-4.
- Karthika K.S., Rashmi I., Parvathi M.S. (2018). Biological functions, uptake and transport of essential nutrients in relation to plant growth. In M Hasanuzzaman et al. (eds.) Plant Nutrients and Abiotic Stress Tolerance. https://doi.org/10.1007/978-981-10-9044-8_1.
- Kaushal R, H Mehta and P K Mishra .2018. Agroforestry for Sustainable Land Use P. 23-36 In: Agroforestry for Climate Resilience and Rural Livelihood. (Edts. Inder Dev, Asha Ram. Naresh Kumar, Ramesh Singh, Dhiraj Kumar, A.R. Uthappa, A.K. Handa and O.P. Chaturvedi). Scientific Publishers. ISBN: 9789387307063
- Kumari Maina, Meena D.C. and Bairwa S L. (2019) Assessment of Marketing channels of rapeseed-mustard used by the farmers for strengthening farmers' income: A case study of Rajasthan. Published in Book – Marketing of agricultural commodities in India (ISBN 978-93-88317-09-2), pp 227-234.

- Manish Kumar, Monalisha Pramanik, Rajeev Ranjan, M.N. Ramesha, Prabhat Kumar and Raj Kumar (2019). Effect of in-situMoisture Conservation on Establishment of Tree Borne Oilseeds (TBOs) Plantation in Red Soils of Bundelkhand Region. In: Sustainable Land Management: Issue, Problems & Prospects (Mishra et al., eds) Satish Serial Publishing House, Delhi. pp 350.
- Meena D.C., Kumari Maina, Kumar Dileep and Meena R.B. (2019). An analysis of seasonality and volatility in arrivals and prices and constraints faced by the farmers in marketing of rapeseed-mustard in Rajasthan. Published in Book – Marketing of agricultural commodities in India (ISBN 978-93-88317-09-2), pp 235-243
- Meena, Mukesh (2019). Economic analysis of zero tillage in wheat under Rice-Wheat production system of Haryana, Sustainable land management: Issue, Problems and Prospects (Mishra et al., eds) Satish Serial Publishing House, Delhi. pp 350.
- Mishra, P.K., Singh, M. and Kumar, G. (2017). Water Management and Conservation Innovations for Doubling Farmers income, Bulletin of the Indian Society of Soil Science, No. 32. pp 23-47 (2018).
- Muruganandam, M. (2018). Integrated Farming Systems (IFSs) for sustenance of environment and rural livelihoods. Collaborative Training Programme on Climate Change and Doubling Farmers Income. Compiled by Bankey Bihari, K.C. Gummagolmath and P.R. Ojasvi. Sponsored and organized by National Institute of Agricultural Extension Management, Hyderabad, MANAGE, Hyderabad and ICAR-IISWC, Dehra Dun (November 12-21, 2018). Pp. 95-116.
- Nath, V., Kumar, G., Pande, S. D. and Pandey, S. (2018). Impact of Climate Change on Tropical Fruit Production Systems and its Mitigation Strategies (129-146) in the book "Climate change and Agriculture in India: Impact and adaption" edt. by Syed Sheraj Mehdi, Springer, ISBN: 978-3-319-90085-8, 978-3-319-90086-5 (e-book), pages 262.
- NK Jat, RS Yadav, S Kumar and M Shamim (2018). Weed Management Strategies under Conservation Agriculture Based Rice-Wheat System. In: System Based Conservation Agriculture (V.K. Singh and B. Gangwar eds). Westville Publishing House, New Delhi. pp 272.
- P.R. Bhatnagar, D. Dinesh, Gopal Kumar, V.C. Pande, Gaurav Singh and V.D. Kakade (2018). Ravine management techniques: Reduction of soil erosion and utilisation of degraded land in Gujarat. Souvenir of 83rd Annual Convention and National Seminar of Indian society of Soil Science. New Delhi at Anand Agricultural University, Anand held during November 27-30, 2018. pp. 1-269.
- Pande, V.C., Kurothe R.S., Singh H.B., Krishna Rao B., Kumar G., Bhatnagar P.R. (2018). Socio-economic and Conservation Measures in Ravine-affected Areas of Gujarat: Policy Interventions (591-600). In: Dagar J., Singh A. (eds.), Ravine Lands: Greening for Livelihood and Environmental Security. Springer, Singapore, DOIhttps://doi.org/10.1007/978-981-10-8043-2_27, ISBN: 978-981-10-8043-2.
- Panigrahi, B., Paul, JC. and Sahoo, DC. 2019. Water Saving Irrigation through Scientific Water Management - An Approach to Increase Water Productivity. In:Resource conservation in Eastern region of India: Lead Papers of FFCSWR-2019, Ed. Karma et.al., Indian Association of Soil and Water Conservationists, Dehradun, p92-102.
- Parandiyal, A.K., Kaushal, R. and Chaturvrdi, O.P. (2018) Forest and fruit tree based agroforestry systems for productive utilization of ravine lands. (in) Ravine lands greening for livelihood and environmental security. Ed Dagar et al.Pp 361-383
- Rajan, K., Dinesh, D. and Raja, P. 2018. Water regulating services of Agro-forestry. In: Multifunctional Agro-forestry. Eds.: Parthiban K.T, K. Ramesh, Sivakumar.K, Rajeshwar Rao.G and Deepak Srivastava, FC&RI, TNAU, Mettupalayam. Jaya Publishing House, New Delhi, pp. 392-405
- Rao B.K, Pande, V.C., Kurothe, R.S., Singh, A.K., Parandiyal, A.K. (2018). Bamboo-based Bioengineering Interventions for Rehabilitation of Ravines. In: Dagar J., Singh A. (eds.) Ravine Lands: Greening for Livelihood and Environmental Security. Springer, Singapore. Pp 397-412.
- Rawat Indu (2018). Occupational Health Hazards in Agro Processing Units: a Consequence of Adverse Micro-Climate. Chapter published in the Compendium of ICAR Summer School on Machinery for Conservation Agriculture for Mitigation and Adaptation of climate change during Sep 5-25, 2017 at ICAR-IIFSR, Modipuram, Meerut pp 135-153.
- Sarvade, S; Mishra, H.S., Chaturvedi, S., Singh, R., Negi, C., Attri, V., Kaushal, R. 2019. Carbon sequestration potential of fast growing short rotation tree species based agroforestry systems in terai region of central Himalaya. In Agroforestry for Climate Resilience and Rural Livelihood (Eds. Inder Dev/Asha Ram/Naresh Kumar, Ramesh Singh, Dhiraj Kumar,A.R. Uthappa, A.K. Handa, O.P. Chaturvedi). Scientific Publisher. 153-165.

- Satyawali, K., Chaturvedi S., Bisht, N., Maikhuri S., Tewari, S.,and Kaushal R.2019.
- Sharma K. K., Singh A. K. and Dubey, S. K. (2017) Yamuna ravines ke vistaar ko rokane tatha unhen upjau banana hetu uchit taknikiyan. Mrida evam jan sanrakshik (Rajbhasha Patrika), 2017 ICAR-Indian Institute of soil and water conservation, Dehradun page: 56-58
- Singh A. K. and Sharma K. K., (2017) Jalgrhan tatha vikas karyakramon ke karan sukhate paramparik taalab. Mrida evam jan sanrakshik (Rajbhasha Patrika), 2017 ICAR-Indian Institute of soil and water conservation, Dehradun page: 25-28
- Sinha, N.K., Priyabrata Santra and Raja. P, Brajendra and Nathawat, N.S. (2018). Conserving Soil Seed Bank of Sewan Grass in Under Grazing in Indian Arid Rangelands for Doubling Farmers' Income. p. 94-97. In (Ed. B.P. Bhatt et al.,) Doubling Farmers Income through Sustainable and Harmonious Agriculture, Jaya Publishing House, New Delhi. ISBN.978-93-87590-66-3.
- Somasundaram, J., Parandiyal, A.K., Jha, P., Lakaria, B.L., Singh, R.K., Mina, B.L., Kala,S. and Ali,S. (2018) Ravines: Prospective zones for carbon sequestration. (in) Ravine lands greening for livelihood and environmental security. Ed Dagar et al. Pp 433-443
- Somasundaram, J., Parandiyal, A.K., Jha, P., Lakaria, B.L., Singh, R.K., Mina, B.L., Kala, S. and Ali, Shakir (2018): Ravines: Prospective Zone for Carbon Sequestration. Chapter-19. J. C. Dagar, A. K. Singh (eds.), Ravine Lands: Greening for Livelihood and Environmental Security Springer, Singapore, Pp-433-443. https://doi.org/10.1007/978-981-10-8043-2_19.
- Sundarambal, P., Raja, P, Kannan, K and Ragupathy, R. 2018. Indigenous Technical Knowledge Practiced for Natural Resource Management by Tribal Farmers of Nilgiris District in Tamil Nadu, India pp:247-254.In Integrated Resource management: The Way Forward. Editors:Vinod Kumar Tripathi, Amithava Rakshit, Chandola V.K, Singh R.M, Nema A.K and Saswat Kumar Kar 2018. New Delhi Publishers, New Delhi. ISBN-978-93-86453-08-2.
- Uthappa, A.R., Chavan, S.B., Ramesha, M.N., Kala, S., Kumar, V., Handa A.K. and Chaturvedi, O.P. (2018): Plant Biodiversity of Ravine Ecosystem: Opening New Vistas for Enhancing Productivity. In: Dagar J., Singh A. (eds) Ravine Lands: Greening for Livelihood and Environmental Security, Springer, Singapore, Pp-119-141: https://doi.org/10.1007/978-981-10-8043-2-4.

Training Manual/Chapter /Report

- Bankey Bihari and P.K. Mishra (2018) Training Manual "Collaborative Training Programme on Watershed Concept, Planning and Management". Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun for training organized at IISWC, Dehradun in collaboration with MANAGE, Hyderabad from June 18-27, 2018, pp 1-226.
- Bankey Bihari, B. Renuka Rani and P.R. Ojasvi (2018) Training Manual "Collaborative Training Programme on Advanced Engineering Measures for Drainage line Treatment". Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun for training organized at IISWC, Dehradun in collaboration with MANAGE, Hyderabad from Oct. 3-12, 2018, pp 1-150.
- Bankey Bihari, B. Renuka Rani and P.R. Ojasvi (2018) Training Manual "Collaborative Training Programme on Integrated Watershed Management". Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun for training organized at IISWC, Dehradun in collaboration with MANAGE, Hyderabad from Sept. 10-19, 2018, pp 1-210.
- Bankey Bihari, B. Renuka Rani and P.R. Ojasvi (2019) Training Manual "Collaborative Training Programme on PRA and Micro Watershed Planning". Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun for training organized at IISWC, Dehradun in collaboration with MANAGE, Hyderabad from Feb. 12-21, 2019, pp 1-94.
- Bankey Bihari, K.C. Gumagolmath and P.R. Ojasvi (2018) Training Manual "Collaborative Training Programme on Climate Change and Doubling Farmers Income". Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun for training organized at IISWC, Dehradun in collaboration with MANAGE, Hyderabad from Nov. 12-21, 2018, pp 1-200.
- Dinesh, D., Kakade, V.D., Singh, G. and Jinger, D. (2019). Soil Health Management for Sustainable Farm Productivity. Training manual on Soil and water conservation measures for sustainable farm productivity for ATMA Farmers beneficiary and officials of Nagapattinam district, Tamil Nadu From 6-8th March, 2019, Pp. 41–59.

- Dinesh. D and P.R. Bhatnagar (2018). Training programme on "Soil and Water Conservation Practices in degraded lands" for ATMA Farmers beneficiary and officials, The Nilgiris district Sponsored by Department of Horticulture and Plantation Crops, ATMA, Nilgiris District, Tamil Nadu from 13-15th September, 2018
- Dinesh. D and Vijaysinha Kakade (2019). Training programme on "Soil and Water Conservation measures for sustainable farm productivity" for ATMA Farmers and officials From Department of Agriculture, Nagapattinam District From 06-08 March, 2019
- Hombegowda, H.C., Mannivannan, S., Kasthuri Thilagam, V. and O.P.S. Khola, 2018, Soil and Water conservation in watershed, Orissa Watershed Development Mission sponsored 3 days training from 7 to 9th Nov. 2018 at ICAR-IISWC Research Centre, Udhagamandalam. pp. 102.
- Jinger, D., Dinesh, D. and V. D. Kakade (2019). Agronomic Measure for Soil and Water Conservation for Sustainable Production. Training manual on Soil and water conservation measures for sustainable farm productivity for ATMA Farmers beneficiary and officials of Nagapattinam district, Tamil Nadu From 6-8th March, 2019, Pp. 77–81.
- Kakade, V.D., Dinesh, D. Singh, G. and Jinger, D. (2019). Suitable fruit based interventions for sustainable farm Productivity. Training manual on Soil and water conservation measures for sustainable farm productivity for ATMA Farmers beneficiary and officials of Nagapattinam district, Tamil Nadu From 6-8th March, 2019, Pp. 31–40.
- Lekh Chand, Bankey Bihari and P.R. Ojasvi (2018). Training Manual "Mrida Avam Jal Sanrakshan". Published by Advanced Skill Development Centre, HRD & Social Science Division, ICAR-IISWC, Dehradun for training organized at IISWC, Dehradun, sponsored by Directorate of Agriculture, Uttarakhand on July 19 & 20, 2018, pp 1-44.
- Manivannan, S., V. Kasthuri Thilagam and O.P.S. Khola (Eds.) 2018. Training Manual on Participatory Integrated Watershed Management. ICAR-IISWC, Research Centre, Udhagamandalam, The Nilgiris, Tamil Nadu Pp: 230.
- Ojaswi, P.R., Charan Singh, Maurya, U.K., Arya, R.K., Dwivedi, V.K., Rakesh K., Ashok Kumar and Gambhir Singh (2018).Consultancy Project on "Study for Conservation, Remedial and Management Measures for Nainital Lake" by IIT & NIH Roorkee and ICAR-IISWC DehraDun 190 P. Project sponsored by Irrigation Dept. Govt. of Uttarakhand.
- Raja, P., Rajan, K, Hombegowda, H.C. and Kannan, K. (2018). Integrated Nutrient Management and Nutrient Budgeting through Advanced Models to Improve Crop Productivity. Training manual of DST Sponsored training programme from 22-26 Oct. 2018 at ICAR-IISWC Research Centre, Udhagamandalam. pp.197.
- Raja. P, Rajan.K, Kannan.K (2018). Training Manual of National level DST Sponsored training programme on "Advances in Integrated Watershed Management for Rural Livelihood" during 12-23 Nov.2018 at ICAR-IISWC, Research Centre, Udhagamandalam. on "Advances in Integrated Watershed Management for Rural Livelihood". pp.432.
- Training manual on Soil and Water Conservation Practices in Degraded Lands for ATMA farmers beneficiary and official of Nilgiris district, Tamil Nadu entitled "Land degradation challenges and potential solution under climate change for sustainable agriculture in India" from 13-15th September, 2018 sponsored by Department of Horticulture and Plantation Crops, Agricultural Technology Management Agency (ATMA), Nilgiris District, Tamil Nadu held at ICAR-Indian Institute of Soil and Water Conservation, Research Centre-Vasad, Anand, Gujarat.

Bulletins/Brochures/Policy Papers/Leaflets and others

- Adhikary, PP. and Dash, Ch J. 2018. Hydrometeorology.Module id EVS/AP-VIII/36.18p (E-Publication).
- Adhikary, PP., Hombegowda, HC. and Madhu, M. 2018 Alley Cropping for Resource Conservation in Degraded High lands of Eastern Ghats of India.TB-06/KR/E-2018. 8p.
- Arya, Swarn Lata, A.K Tiwari, P.K Mishra. 2017. Ensuring People's Participation for Successful Implementation of Watershed Development Projects in Shiwalik Foothill Region. Policy Paper. P.P.-05/C/E-2017.
- B.S.Naik, S.L.Patil, P. R. Ojasvi, H.Biswas and A. Raizada. "Use of energy efficient solar powered pump with drip irrigation system for efficient utilization of runoff for cultivation of tomato and chilli in the semi-arid tropics of south India". (2019).

- D. Dinesh and V.D. Kakade (2018). Agronomical Crop calendar for soil & water conservation in semi-arid regions of Gujarat.
- Dash, Ch. J., Adhikary, P.P., Madhu, M., Maurya, U.K. and Mishra, P.K. (2018). Characterization and development of Jhola land system 'a rice bowl' of tribal's of Koraput district, Odisha: Status and Strategies. TB-07/KR/E2018, ISBN 978-93-5346-995-5
- Division of HRD&SS published three years Hindi Calendar (2018-2020).
- Dry-land horticulture as alternative land use system for higher farm income. 101 Modern Agricultural Technologies. Published by Sugarcane Breeding Institute. P.111.
- Economic utilization of bench terrace riser. 101 Modern Agricultural Technologies. Published by Sugarcane Breeding Institute. P.108.
- Hrittick Biswas, M. Prabhavathi, S.L. Patil and Suresh Kumar. "Biochar as an amendment for sustainable crop production and soil quality in Vertisols". (2019).
- Inward Bench Terraces- An effective method of soil conservation in Nilgiris. 101 Modern Agricultural Technologies. Published by Sugarcane Breeding Institute. P.107.
- Kannan. K and Sundarambal. P 2019. Soil and Water Conservation Measures in Young Tea Plantation.
- Kumar, G., Sena, D. R., Rao, B. K., Pande, V. C., Kurothe, R. S., Bhatnagar, P. R., Mishra, P. K. (2018) Ravines of Gujarat-Delineation and Characterization. ICAR-IISWC, Technical Bulletin No. TB-04/V/E-2018, 33 p.
- Lekh Chand and Smeera Qayoom (2018).Profitability of kharif pulses with different weed management practices under rainfed conditions of Himalaya. XXI Biennial National Symposium of Indian Society of Agronomy, 24–26 October, 2018: 158(Extended summary)
- M. Prabhavathi, H. Biswas, N. Chandra Sekharan and S. L. Patil. "Increasing nutrient and water use efficiency in paddy through irrigation management" (2019).
- Madhu, M., Hombegowda, H.C., Meena, M.K and Barla, GW. 2018. Shifting Cultivation in Odisha State: Issues and Challenges.PP-02/KR/E-2016. 34p.
- Melia dubea (Mali Vembu) for Industrial Farm Forestry in Tamil. 101 Modern Agricultural Technologies. Published by Sugarcane Breeding Institute. P.110.
- Narayan, D. (2018). Bundelkhand Mein Prakirtik Sansadhan Sanrakchan Evum Tikau Utpadan Hetu Chana + Sarson Ki Antaphasi Kheti (in Hindi). ICAR-IISWC, Research Centre, Datia, pp 1-8.
- Narayan, D. (2018). Bundelkhand Mein Rain-gun Duara Sinchai Se Jal Ki Bachat Evum Jal Upyog Chhamta Mein Viradhdi (in Hindi). ICAR-IISWC, Research Centre, Datia, pp 1-8.
- Narayan, D. 2018. Ardh Susk Chetra Ki Lal Mittion Mein Varsha Jal Sanghran Evum UpyogTakniki (in Hindi). ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Narayan, D. 2018. Barani Dasaon Mein Bundelkhand ki Lai lMittion Mein Sansadhan Sanrakchan Evum Utpadan Hetu Arand + Moong Ki Anta Phasli Kheti (in Hindi). ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Narayan, D. 2018. Bundelkhand ki Lal Mittion Mein Sansadhan Sanrakchan Evum Tikau Utpadan Hetu Samochya Mend Bandi (in Hindi). ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Narayan, D. 2018. Castor + green gram intercropping for resource conservation and production under rainfed conditions in red soils of Bundelkhand. ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Narayan, D. 2018. Contour bunds for resource conservation and sustainable production in red soils. ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Narayan, D. 2018. Green manuring for resource conservation and productivity enhancement in red soils of Bundelkhand region. ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Narayan, D. 2018. Hari Khad Duwara Bundelkhand ki Lal Mittion Mein Sansadhan Sanrakchan EvumUtpadaktaVridhi (in Hindi). ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Narayan, D. 2018. Improved tillage and mulch practice for resource conservation and higher yield of sorghum in red soils. ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Narayan, D. 2018. LalMittion Mein Sansadhan Sanrakchan Evum Jowar Ki Upaj Badhane HetuUnnat Bhupariskaran Ttha PalwarVidhion (in Hindi). ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Narayan, D. 2018. Rainwater harvesting and utilization techniques for red soils of semi-arid region. ICAR-IISWC, Research Centre, Datia, pp 1-2.
- Pande, V. C. Bhatnagar, P. R., Kumar, R., Dinesh, D., Kumar, G. (2018). Mahi ravine ecosystem-farmers' perception, services & incentives for management. ICAR-IISWC, Vasad 388306 (Anand), Gujarat. Bulletin No TB-03/V/E-2018, 28 p.

- Panwar, Pankaj, V.K. Bhatt and A.K. Tiwari. 2019. Farm Pond: Design and utilization of stored water in Shivalik Himalayas. Technical Bulletin No. TB-09/C/E-2018. ICAR-IISWC, Research Center-Chandigarh.
- Patil, S.L., Biswas, H., Ramesha, M.N. and Ojasvi, P.R. 2019. Lead paper on "Water Harvesting and Management in Semi-Arid Regions of south India". In the Proceedings of 28th National Conference on "Farmer's Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact" organised by Soil Conservation Society of India, New Delhi from 31st January to 2nd February, 2019 pp. 61-75.
- Rajeev Ranjan, N.K. Sharma, Ambrish Kumar Tiwari and Harsh Mehta (2018)

07 APPROVED ON-GOING RESEARCH PROJECTS

P-1 WATER EROSION APPRAISAL IN DIFFERENT AGRO-ECOLOGICAL REGIONS

1.1 INVENTORY AND DATABASE OF EROSION STATUS USING MODERN TOOLS AND PROCEDURES

1. Assessment of soil erosion fluxes of Uttarakhand.
2. An evaluation of the potential to use the Fallout Radionuclide (FRN) Caesium – 137 ($^{137}C_S$) in national scale soil erosion assessment in India.
3. Impact of land use land cover changes on soil erosion susceptibility in Bundelkhand region using Remote Sensing and GIS technique.
4. Regionalization of erosivity density and identification of hot-spot of erosion risk under different agro-ecological regions of India.

1.2 SOIL EROSION PROCESS MODELING AND CLIMATE CHANGE STUDIES

5. National Mission on Sustaining Himalayan Eco-system (NMSHE) - Task force on Himalayan agriculture for lower and middle Himalayan region.
6. Comprehensive assessment of climate change implication on watershed development component of PMKSY (WDC-PMKSY).
7. Assessment of potential soil erosion of India using spatial science tools.
8. Study of atmospheric and soil carbon dioxide fluxes in temperate mountainous ecosystem of western ghats with reference to climate change impact assessment.

1.3 SOIL CARBON DYNAMICS AND EROSION PRODUCTIVITY STUDIES

9. Erosion productivity relationships for evaluating vulnerability and resiliency of soils under different agro-climatic regions of India.
10. Assessment of soil organic carbon in transit under erosion processes: A source or sink for atmospheric CO_2.
11. Environmental tracer based study on erosion induced loss of soil organic carbon and its impact on agronomic productivity and environmental quality.
12. Development and validation of a spatially explicit simulation framework to quantify runoff-erosion-carbon flux at watershed scale.
13. Assessing the vegetation and SOC recovery potentials of abandoned / fallowed shifting cultivated sites in Central Eastern Ghats.
14. Land use effect on soil carbon stock and soil quality in Mahi ravine ecosystem of semi-arid tropics.

P-2 CONSERVATION MEASURES FOR SUSTAINABLE PRODUCTION SYSTEM

2.1 RESOURCE CONSERVATION MEASURES FOR ARABLE LANDS

15. Development of conservation agriculture practices for rainfed production systems in North-western Himalayan region.
16. Evaluation of conservation tillage based *Arundo donax* mats for resource conservation and enhancing cropping intensity on sloping crop lands.

17. Determining resource conservation potential of bio-degradable waste and their on-farm utilization to increase crop productivity and profitability.
18. Utilization of different industrially derived waste along with *Arbuscular Mycorrhizal Fungi* (AMF) for sustainable soil management.
19. Effect of varying water regimes on Zn and N dynamics and rice productivity in saline vertisols.
20. Efficient utilization of fruit / vegetable waste (FVW) for improving soil health and productivity of organic agri-oleri system.
21. *In situ* moisture conservation practices under aonla based agro-forestry system for sustainable production in red soils of Bundelkhand.
22. Restoration of shifting cultivated lands for resource conservation and sustainable production in Eastern Ghats.
23. *Jhola kundi* based vegetable farming with soil moisture conservation practices for increasing profitability of tribal farmers of Eastern Ghats High Land region.
24. Evaluation of catchment-storage-command area relationship for improving rainwater productivity under integrated production systems.
25. Conservation tillage systems for enhancing productivity and resource use efficiency under rainfed area of South-eastern Rajasthan.
26. Resource conservation and productivity enhancement through organic and inorganic amendments in soyabean- mustard cropping systems.
27. Cover crops and reduced tillage for enhancing productivity and soil health in rainfed farming system in the hilly areas.

2.2 RESOURCE CONSERVATION MEASURES FOR NON-ARABLE LANDS

28. Improvisation of soil working techniques for enhancing tree establishment under rainfed conditions of North-Western Himalayas.
29. Evaluation of traditional minor millet based agro-forestry systems under recommended agri-silvi-cultural practices of North-Western Himalayas.
30. Development and characterization of quality planting material of important MPT's for degraded lands of North-West Himalayas.
31. Evaluation of *Bael* and Olive based agro-forestry system with soil amendments in Doon Valley.
32. Soil fertility restoration and carbon sequestration potential of multipurpose trees for agro-forestry system in Himalayan foothills.
33. Evaluation of rooting media and rootstocks of major sub-tropical fruits spp. for raising quality planting materials on degraded lands.
34. Promotion and expansion of Lemon grass (*Cymbopogon flexuosus*) cultivation as an alternative crop for livelihood security in SC and ST communities in Dehradun district.
35. Upscaling research assessment of productivity, hydrological behaviour, resource conservation and intangible benefits of selected commercial bamboo species in Uttarakhand.
36. Assessment and improvement of nutritional quality of horticultural crops on sloping lands in North-west Himalayas.
37. Improving out-planting success of various multipurpose tree species in Yamuna ravines using improved planting stock and bio-fertilizers.
38. Phyto-rehabilitation of saline - sodic vertisols through *Prosopis juliflora* based silvipastoral system.
39. Regulated deficit irrigation and canopy architecture management for fig (*Ficus carica L.*) in semi-arid vertisols.
40. Evaluation of promising fruit species with different moisture conservation practices in red soils of Bundelkhand region.
41. Evaluation of cover crops under cashew and mango plantation for improving soil health and productivity in Eastern Ghats High Land Region of Odisha.
42. Evaluation, characterization and development of elite genotypes of *Cassia auriculata* for cultivation *in* semi- arid regions.
43. Resource utilization and productivity of Dragon fruit based horti-silviculture system under rainfed agro eco- systems of Central Gujarat.

P-3 WATERSHED HYDROLOGY FOR CONSERVATION PLANNING

3.1 HYDROLOGICAL BEHAVIOUR OF LANDUSES AND MANAGEMENT PRACTICES

44. Hydrologic systems analysis across multiple spatial scales and its implications on hydro-logic processes in sub-humid catchment of Eastern Ghat High Land Region of Odisha.

3.2 WATER HARVESTING, GROUNDWATER RECHARGE AND MANAGEMENT

45. Development and rejuvenation of natural springs through soil and water conservation measures.
46. Consortia Research Platform-Water Theme 1 Water Resources Augmentation/ Conservation.
47. Quantitative and qualitative assessment and management strategy for the sustainable development of the groundwater resources in Haridwar district.
48. Employing system approach on zero energy drip irrigation system in bench terrace farming for hill region.
49. Efficient groundwater management for enhancing adaptive capacity to climate change in sugarcane based farming systems in Muzaffarnagar district, U.P.
50. Water quality assessment and its impact on adjacent soil and vegetation in riparian areas of Hindon and Kali rivers.
51. Study on pollution status of Yamuna river and its impact on soil and crop health in Western U.P.
52. Evaluation of direct recharge filter for revival of defunt and low yielding borewell vis-a-vis augmentation of ground water table in semi-arid region of Karnataka.
53. Estimation of water budget components for predominant land uses of south-eastern Rajasthan for conservation planning.
54. Strategies for rainwater harvesting and its multiple uses in rainfed agriculture in Central Gujarat.
55. Field evaluation of ground water recharge filters developed by ICAR-IISWC, Vasad.
56. Design and evaluation of HDPE sheet embedded gabion check dams for water harvesting in North West Himalayas.

P-4 REHABILITATION OF AREAS AFFECTED BY MASS EROSION

4.1 DEVELOPMENT AND REFINEMENT OF TECHNOLOGIES FOR REHABILITATION OF RAVINES, LANDSLIDES, MINE SPOILS, RIVERBED MINING, STREAM BANKS, TORRENTS ETC.

57. Ecological restoration of stone mine spoil area in south-eastern Rajasthan.
58. Field evaluation of refinement of ravine reclamation technology in a model ravine area development project at Lohli-Bagli village in district Bundi (Rajasthan).
59. Field evaluation of design of trenches under different agro-climatic regions.
60. Enhancing productivity of ravine lands by plantation of *A. sapota* with intercropping systems.

P-5 INTEGRATED WATERSHED MANAGEMENT FOR SOCIO-ECONOMIC GROWTH AND POLICY ADVOCACY

5.1 PARTICIPATORY WATERSHED MANAGEMENT AND INTEGRATED FARMING SYSTEM (IFS)

61. Evaluation of criteria and techniques for classification of fisheries - sensitive watersheds for conservation and production management.
62. Socio-economic analysis of farming/livelihood systems of farmers across different land categories in Yamuna ravine area.
63. Refining methodologies for data validation, planning, monitoring and evaluation of watersheds.
64. Economic impact assessment of water harvesting structure-Farm Pond in the semi-arid regions of Karnataka.
65. Valuation of ecosystem services from natural resource conservation and management interventions in different agro-ecological regions in India.

P-6 HUMAN RESOURCE DEVELOPMENT AND TECHNOLOGY TRANSFER

6.1 CAPACITY DEVELOPMENT APPROACHES AND INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

66. Developing ICT based e- learning tools for conservation measures and watershed management.
67. Exploring the potential of mKRISHI to disseminate the knowledge about soil and water conservation technologies to the stakeholders: An innovative approach to reach the unreached.

6.2 PARTICIPATORY TECHNOLOGY DISSEMINATION AND ADOPTION

68. Assessing farmers knowledge, vulnerability and adapting capacity of soil and water conservation technologies under changing climatic scenario.
69. Assessment of sustainability factors for soil and water conservation projects.
70. Farmer participatory technology application for sustainable resource management and livelihood security in North-west Himalayas.
71. Role of women in conservation and management of natural water resources for domestic and irrigation uses.
72. Determination of heterogeneity in agro-forestry practices and acceptability alongwith altitude gradient in Western Himalayas.
73. Documentation and validation of ITKs in soil and water conservation practiced by tribal farmers of Tamil Nadu.

08 CONSULTANCY

The consultancy projects under taken at Institute Head Quarters and its Regional Centers, during the period under report are as under.

Title of the Consultancy Project	Name of the Client Department	Date of Start	Date of Completion	Category of Consultancy	Total Amount (Rs.)
Head Quarters, DehraDun					
Assessment of extractable river bed material from the river Nandhaur and Kailash for the year 2018-19.	Divisional Logging Manager (Khanan), UKFDC, DehraDun, Uttarakhand	15 July, 2018	30 June, 2019	Institutional	5,94,374/-
Assessment of extractable river bed material from the river Malan for the year 2018-19.	Divisional Sales Manager, UKFDC, Kotdwara, Uttarakhand	16 Aug., 2018	30 June, 2019	Institutional	3,97,318/-
Assessment of extractable river bed material from the river Dabka for the year 2018-19.	Regional Manager & Divisional Logging Manager (Khanan), UKFDC, Ramnagar, Uttarakhand	01 Oct., 2018	30 June, 2019	Institutional	4,12,114/-
Assessment of extractable river bed material from the river Kosi for the year 2018-19.	Regional Manager & Divisional Logging Manager (Khanan), UKFDC, Ramnagar, Uttarakhand	01 Oct., 2018	30 June, 2019	Institutional	4,73,693/-
Assessment of extractable river bed material from the river Sharda for the year 2018-19.	Divisional Logging Manager (Khanan), UKFDC, Tanakpur, Uttarakhand	01 Oct., 2018	30 June, 2019	Institutional	4,55,174/-
Assessment of extractable river bed material from the river Song I, II & III and Jakhan I & II at Dehradun for the year 2018-19.	Divisional Logging Manager (Khanan), UKFDC, Dehradun, Uttarakhand	17 Oct., 2018	30 June, 2019	Institutional	8,28,250/-
Planning of bio-engineers measures to check the erosion in Paniyali and Bahera Stream at Kotdwar range of Lansdown Van Prabhag, Kotdwar.	DFO, Lansdown Van Prabhag, Kotdwar	15 Jan., 2019	15 July, 2019	Institutional	3,06,484/-
Assessment of extractable river bed material from the river Gaula for the year 2018-19.	Regional Manager, UKFDC, Haldwani, Uttarakhand	15 Mar., 2019	30 June, 2019	Institutional	4,93,715/-
Research Centre Agra					
Providing technical guidance for bio-engineering measures to Girraaj Ji Parvat at District Mathura, Agra, U.P.	Conservator of Forest, Agra, U.P.	15 March, 2019	15 Dec., 2019	Institutional	21,15,145/-
Research Centre Koraput					
Evaluation of spring water based diversion irrigation systems under ISARA water and food security project.	Mennonite Central Committee (MCC), India, 22, Girish Chandra Bose Road, Kolkota	12 Nov., 2018	17 Nov., 2018	Institutional	3,50,000

09 RAC, IMC, IRC Meetings

Research Advisory Committee:

RAC Members [06-12-2017 to 05-12-2020]

The members of Research Advisory Committee are as under.

Dr. V. N. Sharda Former member, Agricultural Scientist Recruitment Board (ASRB) Flat No. - 202, Tower No. - 3 A, Suncity Parikarama Housing Complex, Sector - 20, Panchkula - 134 116, (Haryana) Email id: vnsharda2@gmail.com, Mobile No.-9810505328	Chairman
Dr. M. N. Jha, Former Head, Soil Science Division, FRI House No.-11,Vasant Vihar, Phase -II Dehradun-248006, Uttarakhand Email: m.yogimn2003@gmail.com, Mob No. - 91-9412055048	member
Dr. R. K. Panda Professor & Head of the School of Infrastructure (Civil Engineering) and Dean (Research & Development) IIT, Bhubneshwar, Toshali Bhawan, Bhubneshwar -751007, Email.id:rkpanda@iitbbs.ac.in: rkpanda56@gmail.com Mob: +91-7894435400	member
Dr. D. S. Rana Emeritus Scientist, Agronomy, IARI, New Delhi-110012 Email.id:dsrana5554@yahoo.com, dsrana5554@gmail.com, Mob: +91-9868200898	member
Dr. M. C. Nautiyal, Former Dean CF&HA Lane - 4, Doon Enclave, Nakraunda Road, Harrawala, Dehradun-248001, Uttarakhand Email: mcnautiyal@rediffmail.com, Mob: +91-9412076770	member
Dr. R. L. Shiyani Professor and Head **(Agril Economics)** Block No: B-109,Radha Krishna Nagar, Vanthali Road, Junagarh -362001, Gujarat Email: rlshiyani@yahoo.com , Mob: +91-9427228486	member
Sh. Matbar Singh Kandari 33/1, Shastri Nagar, Lane No. 3 DehraDun-248009, Uttarakhand, Mob:-8433084175	member
Sh. Ram Sharan Nautiyal 183-Rajpur Road, Dehradun-248009, Uttarakhand	member
Dr. S. K. Chaudhary ADG (SWM), ICAR KAB-II, Pusa, New Delhi-110012, Email: adgswm@gmail.com,	member
Dr. P. R. Ojasvi Director, I/C ICAR-Indian Institute of Soil and water Conservation, 218-Kaulagarh road, DehraDun, Uttarakhand-248195 Email id: directorsoilcons@gmail.com,	member
Dr. Gopal Kumar Senior Scientist ICAR-Indian Institute of Soil and water Conservation, 218-Kaulagarh road, DehraDun, Uttarakhand-248195 Email id: gkcswcrti@gmail.com, 9409545159, 7033401808	member secretary

Management Committee:

50th meeting of Institute Management Committee was held on29/01/2019 at the Institute Head Quarters, Dehra Dun. The following Members were present in the meeting.

Name of the Member	Status
Dr. P.R. Ojasvi, Acting Director, ICAR-IISWC, Dehra Dun	Chairman
Dr. N.K. Sharma, I/c Head, Division of Soil Science & Agronomy, ICAR-IISWC, Dehra Dun	Member
Dr. Harsh Mehta, I/c Head, Division of Plant Science, ICAR-IISWC, Dehra Dun	Member
Dr. K.S. Reddy, Pr. Scientist, ICAR -CRIDA, Hyderabad	Member
Dr. V.K. Bhatt, Acting Head, ICAR-IISWC, Research Centre, Chandigarh.	Member
Director, Agricultural & Soil Conservation, Nanda –Ki-Chowki, Prem Nagar, Dehra Dun, Uttarakhand	Member
Director, Soil Conservation, Shimla-5, Himachal Pradesh	Member
Dean, Uttarakhand University of Horticulture and Forestry, Tihari Garhwal, Uttarakhand	Member
Sh. Anuj Guleria, Vill. Ten Pur, PO. Ambadai, Vikashnagar, Dehra Dun	Member
Sh. Surya Vir Malik, Vill. Uddalhedi, PO. Mangalore, Hardwar	Member
Sh. K. K. Sharma, Sr. Finance& Accounts Officer, ICAR-NBPGR, Krishi Bhawan, New Delhi	Member
Sh. S.K. Gajmoti, Chief Administrative Officer, ICAR-IISWC, Dehra Dun	Member Secretary

The meeting was chaired by Dr. P.R. Ojasvi, Acting Director of the Institute. The Chairman apprised the committee members of the establishment, mandate, research achievements and other related activities, initiatives undertaken by the institute viz. Tribal Sub Plan, Transfer of Technology, Consultancy Projects, Training Programmes.

Institute Research Committee (IRC):

Institute Research Committee meeting was held at Institute Head Quarters DehraDun during 23-28 April 2018, wherein all the scientists, from Head Quarters as well as Research Centres, participated for reviewing the progress of research projects and finalising the research programme for the year 2018-19.

Quinqueenial Review Team (QRT):

Quinqueenial Review Team constituted for the period 2012-to- 2017 submitted the final report. The details of members of QRT and salient recommendations made are as under.

Name	Address	
Dr. Pratap Narain	Ex-Vice-Chancellor, RAU, Bikaner 13, Raj Vihar, P.O. New Forest, DehraDun-248006, Uttarakhand pratapn45@gmail.com	Chairman
Dr. M.V. Ranghaswami	Dean Agril, Engg. Bannar Amnan Institute of Technology, Sathmagalan-638401,Tamilnadu mvrswami@gmail.com	Member
Dr. Basudev Behera	Head, Agronomy Division, OUAT, Bhubaneswar, College of Agriculture, Odisha University of Agriculture & Technology, Bhubaneswar-751003, Odisha bdbehera1@rediffmail.com	Member
Dr. S.P.S. Kushwaha	S.P.S. Kushwaha Humboldt House, 62- Hari Vihar. Vijay Park, Chakrata Road, DehraDun-248001, Uttarakhand spskushwaha@gmail.com	Member
Dr. G.R. Maruthi Sankar	A-410 CJN Sai Golden Land Mark, ECC Road, Whitefield, Bangalore, 560059, Karnataka gmsankar2009@gmail.com	Member
Dr. H. Mehta	I/c Head, Division of Plant Sciences, IISWC, DehraDun 248195, Uttarakhand harshmehta41ddn@gmail.com	Member Secretary

Recommendations:

- The IISWC and its 8 Centres have 1198 ha area, of which only 350 ha happens to be under cultivation, which is very small by any standard, particularly when on-farm research studies are required to be conducted in field size gauged plots or in micro-watersheds. Besides, the Institute is compelled to pay high lease rates or surrender some of the areas to State Forest Department which are currently under long-term watershed hydrological studies. There is a great need of long-term hydrological data to develop the models for conservation agriculture. This issue needs to be resolved at the ICAR level for making sufficient area available for research purposes.
- Soil and Water conservation activities are expensive. Small and marginal farmers can hardly afford to undertake land management required to protect their land from degradation due to water and undercutting, if the land is situated near the ephemeral streams. The QRT, therefore, recommends that high priority should be given to develop cost-effective soil and water conservation measures or else, partially subsidize such measures *in-lieu* of environmental protection.
- The QRT also feels that the Institute needs to take up climate change resilient soil and water conservation and cropping practices research. Hence, it could gear-up to develop agronomic practices, bio-engineering/engineering measures for cost-effective *in-situ* rain water conservation, run-off harvesting and its management.
- Centres expressed their desire to use Remote Sensing, Geographic Information System and Global Positioning System for their day-to-day project work. There could be a state-of-art laboratory at Headquarters and a working facility at each Centre. This would facilitate creation of local to national level seamless natural resources spatial database as well as integration/ modelling. The QRT therefore, recommends that this facility should be created on priority basis with matching budgetary provisions.
- The Institute can introduce medicinal and aromatic plants, tree borne oil seeds, nutritive fodder crops and grasses along with existing crop plans on marginal and degraded lands for maximizing and sustaining the monetary returns and improving the livelihood of farmers.
- There is need for developing efficient utilization of land use systems by exploring alternative land uses with trees, bushes, Agro-forestry, Horticulture and other enterprises for maximizing the returns of small and marginal farmers over a period of time. The QRT recommends that there is potential for traditional minor millets in hilly areas/ tribal area of Koraput. However, value addition and market chains need to be taken care of the IISWC.
- The QRT emphasised that efforts of ravine Centres at Agra, Kota and Vasad should be coordinated with Kota as the Lead Centre to tackle the management problems of ravines by utilizing small-ruminant animal-based farming systems. Accordingly, collaborative research in these three Centres (Vasad, Kota and Agra) along with Datia should be taken up on priority. The QRT also recommends that there is a need to integrate livestock component with the existing farming systems for maximizing farm income. Hence, profitable Integrated Farming Systems in the Institute/ Research Centres may be developed.
- Of late, there is lot of emphasis on Watershed Management in the Country. There is a need to create/ identify benchmark watersheds in different regions for documentation of long-term data collection, research and management of watersheds, which could be made available in the public domain.
- The impact of watershed management on improvement of ground water level and its quality should be monitored even after completion of the watershed project. The QRT suggested that an efficient groundwater recharge simulation model should be developed by utilizing the long-term spatio-temporal data.
- The QRT recommends creating a dedicated cell for Transfer of Technologies with budgetary and manpower provisions for expediting the technology transfer to farmers/ stakeholders.

- The position of the scientists, technical and administrative staff is a major impediment for the smooth functioning of the institute. About 25 to 30 % of positions were vacant during the review period. In an Institute, where training of manpower takes a lion's share, the research and development projects are likely to suffer adversely. Poor manpower at Datia, Koraput and Udhagamandalam Centres is a matter of concern that needs to be addressed urgently. The ratio of scientists and technical staff has reduced from 1.7 (2012-13) to 1.1 (2016-17). The QRT strongly recommends that vacant positions should be filled up on priority or else the Institute is allowed to keep the manpower on contractual basis.

- The quality of research is not judged by the number of studies conducted by a scientist or even the number of review publications made in low impact factor journal. Soil and water conservation is a field oriented work and perhaps it is difficult to bring out of large number of papers from development kind of research. The QRT feels that the assessment of scientists/technical staff should take into consideration value of the field research for which some norms are required to be developed.

- The IISWC, Dehradun has multi-location regional Centres situated at far flung areas, *viz.*, Udhagamandalam (Tamil Nadu), Koraput (Odisha), Ballari (Karnataka) and remote locations like Vasad (Gujarat) and Datia (MP). Due to this the pre-audit clearances and sanctions from Dehradun get delayed, hampering timely execution of works at Centres particularly in respect to Tribal sub-plan and Development Projects operative in remote areas. In view of this, the QRT recommends that more financial powers should be delegated to the Heads of the Centres.

- In all Centres, scientists expressed difficulties in executing the development works in watersheds for want of government-registered contractors. Further, no registered contractors come forward to execute works in the remote areas of watersheds. The QRT feels that the rules may be relaxed and the Institute permitted to execute the works through the beneficiaries of the watersheds and paid under the supervision of the Institute staff.

- The IISWC is a premium institute in the country involved in basic, strategic and applied research on soil and water conservation. There are several research institutes dealing with water resource research in the country, *viz*., CWC, CGWB, NIH, Hydrology Departments of IITs, WTC, IIWM and All India Coordinated Research Project on Water Management. The basic research on soil erosion due to water, a major cause of land degradation and desertification, is somewhat overshadowed**.**

10 PARTICIPATION

Participation (in Workshop/Coordination/Training/Meetings/Symposia etc.)

Dehra Dun:

- Attended review meeting with Chief Engineer, Irrigation Development, Govt. of Uttarakhand for Rejuvenation of Nainital Lake at ITI, Roorkee in on 21.4.2018.
- Attended meeting with Kumaun Commissioner and other Institute NIH, IIT, Roorkee and State Govt officers regarding Nainital Lake consultancy on 14.06.2018.
- Attended review meeting of Sujala project at NBSSLUP, Bangalore, organised by WDD, Govt. of Karnataka on 25.6.2018.
- Attended ICAR-IWMI meeting at NASC, New Delhi on 27.6.2018 organised by ICAR, New Delhi.
- Attended 90th Foundation Day of ICAR and Directors Conference during 15-18th July, 2018 in NASC Complex, Pusa, New Delhi.
- Attended meeting of the Assessment Committee for Workshop Staff Group of Technical Category-III nominated by ASRB, New Delhi to act as a Chairman of the Assessment Committee Meeting at ICAR-CSSRI, Karnal on 12.7.2018.
- Attended Brainstorming Workshop on Development of Pro-forma for Ranking of ICAR I**nstitutes** at NAAS, New Delhi on 28.7.2018.
- Attended meeting with Commissioner, Kumaon on the project rejuvenation of Nainital lake on 23.8.2018.
- Attended National Workshop on "Sustainability of Indian Agriculture Natural Resource Perspective with Special reference to Soil on 8th September, 2018 at NASC Complex, New Delhi.
- Attended assessment committee meeting of scientists under CAS of Department of Agriculture Engineering of ND University of Agriculture and Technology, Faizabad (U.P.) as an expert nominated by the Hon'ble Governor of Uttar Pradesh on 13.9.2018 .
- Attended Inter-Ministerial Committee meeting on Water Conservation under the chairmanship of Secretary, Ministry of Water Resources, River Development and Ganga Rejuvenation on 24.09.2018.
- Attended meeting with the Adviser (Agriculture), NITI Aayog, Government of India, Sansad Marg, New Delhi on 26.9.2018.
- Attended ICAR-IISWC, IJSC meeting on 27.9.2018 at Research Centre, Chandigarh, official works and visit to Research Farm, Chandigarh on 28.9.2018.
- Attended International Conference on Global Water Security being organized by American Society of Agricultural and Biological Engineers (ASABE), USA and the Indian Society of Agricultural Engineering (ISAE), India during 3-6 October, 2018 at Hyderabad.
- Attended National Workshop on "Sustainability of Indian Agriculture: Natural Resource perspective with special reference to water" on 11th October, 2018 at ICAR-IIWM, Bhubaneswar.
- Attended Scientific Cadre Review meeting under the Chairmanship of DG, ICAR on 29th October 2018 at New Delhi.
- Attended meeting of the Assessment Committee of CAS at ASRB, Pusa, New Delhi on 30.10.2018.
- Attended meeting of consultancy project work at Haldwani (Nandhore and Kailash) on 3110.2018.
- Attended GPDP meeting at Shimla during 11-12th November, 2018 organized by Ministry of Panchayati Raj.
- Attended meeting with DDG (NRM) regarding proposals of RE 2018-19 and BE 2019-20 in KAB-II, Pusa, New Delhi on 20.11.2018.
- Attended meeting with Addl. Chief Secretary (Krishi) Govt. of Uttarakhand on landslide and water conservation works in Dosapani/Nainital.
- Attended review meeting of NMSHE- Task Force on Himalayan Agriculture Lower and Middle Himalayas on 6th December 2018 at New Delhi.

- Attended review meeting of Agri-CRP on Water project on 7th December, 2018 at IIWM Bhubaneswar.
- Attended preparatory meeting for 5th ASP meeting with DDG (NRM), ICAR, New Delhi on 14.12.2018.
- The Director's Conference on 31st January and 1st February, 2019 at NASC Complex, Pusa, New Delhi.
- Attended National Conference organised by Soil Conservation Society of India (SCSI), New Delhi at IISWC, Research Centre, Udhagamandalam on 2.2.2019 and reviewed Centre's activities on 3.2.2019.
- Attended IWMI-ICAR Mini Symposium and International Conference at CAZRI, Jodhpur on 12-13 February, 2019.
- Attended 5th meeting Asian Soil Partnership (ASP) of Food and Agricultural Organisation (FAO)) during 26th Feb, 2019 to 1st March, 2019 at NASC Complex, Pusa, New Delhi
- Attended 90th AGM of ICAR Society on 28.2.2019.
- Delivered the lecture in training program at Central Board of Irrigation and Power, New Delhi on 12.3.2019.
- Attended meeting with DG, ICAR regarding QRT report presentation on 8.4.2019
- Attended one-day policy forum on Social Transfers and Rural Revitalization in India organised by ICAR, NAAS and IFPRI on April 26, 2019 at NASC Complex, Pusa, New Delhi.

Dr. P.R.Ojasvi

- Acted as chairman & coordinator, organizing committee for celebrating Institute Annual Day and Farmer's Interaction at IISWC, Dehra Dun on 7th April, 2018.
- Nodal Officer for conducting Yoga rehearsal for Yoga with Hon'ble Prime Minister Sh. Narender Modiji on 21.6.2016, the International Yoga Day.
- Acted as Coordinator for celebrating "Parthenium Awareness Week" from 16th – 22nd August, 2018 at IISWC, Dehra Dun and Research Farm, Selaqui.
- Attended the meeting under the NMSHE Project to discuss the status of research work done as planned on 28th August, 2018 at IISWC, Dehra Dun.
- Attended National Workshop on "Sustainability of Indian Agriculture: Natural Resource Perspective with Special reference to Soil" on 8.9.2018 at New Delhi.
- As Director in charge chaired the inauguration function on fgUnh fnol lekjksg on 14.9.2018 at IISWC, Dehradun.
- Attended the चयन समिति एक्सपर्ट/मेम्बर, एन.एम.एच.एस. प्रोजेक्ट 'कन्जर्वेशन ऑफ थ्रेटेन्ड प्लान्टस इन इंडियन हिमालयन रीजन : रिकवरी एण्ड कपैसिटी बिल्डंग' के अर्न्तगत अस्थायी आधार पर शोध सहयोगी (आर.ए.), कनिष्ठ परियोजना अध्यता (जे.पी.एफ.), क्षेत्रीय सहायक/परियोजना सहायक (फील्ड असिस्टेंट.) के चयन हेतु साक्षात्कार at Botanical Survey of India, DehraDun on 25.09.2018.
- Attended the meeting of the Institute Joint Staff Council (IJSC) and interacted with the staff of Chandigarh Centre on 27.09.2018.
- Attended XXI Biennial National Symposium on "Doubling Farmers' Income through Agronomic Interventions under Changing Scenario" on 24-26 October, 2018 at Rajastha College of Agriculture, MPUAT, Udaipur, Rajasthan.
- As In charge Director Inaugurated the training programme on "Climate Change and Doubling Farmers Income" (during November, 12-21, 2018) on 12th November, 2018 at IISWC, Dehra Dun.
- Participated and co-chaired the technical session in the seminar on "Opportunity and Challenges in Agroforestry" on 16th November, 2018 at FRI, DehraDun.
- Inaugurated as in charge Director, Stakeholders' Workshop on "Water Census and hotspot Analysis of Upper Ganga Basin (UGB) under National Mission for Sustaining the Himalayan Ecosystem (NMSHE) at IISWC, Dehra Dun on 30th November, 2018.
- Acted as Chairman and delivered lecture on the topic "Mitigation of climate change impact through conservation agriculture" during Stakeholder Workshop on Climate Change Impact and Mitigation Measures (CCIMM-2019) on 27th November, 2018 at ICAR-IISWC, Sunabeda, Koraput, Odisha.
- Visited Research Centre, Koraput and evaluated the research project under P2.1 on 28.11.2019.
- Attended the valedictory function as Chief Guest on 10th January, 2019, addressed and distributed the certificate to the participants in the training for administrative staff at ICAR-IISWC, Research Centre, Vasad.
- Participated as a member in IMC meeting of the Institute on 29.01.2019 at IISWC, Dehradun.
- Organised Farmers Meeting at Damta village of Kalsi Block of DehraDun Dist. under MGMG programme on 4th January, 2019.

- Acted as Co-President and Co-Chairman organized the National Conference on Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019) w.e.f. 6-8 February, 2019 at Bhanja Mandap, HAL, Sunabeda, Odisha.
- As In charge Director inaugurated the Collaborative Training Programme on "PRA and Micro Watershed Planning' organized by MANAGE, Hyderabad and ICAR-IISWC Dehrdun on 12th February, 2019.
- Attended inaugural session of 13 Uttarakhand State Science and Technology Congress 2018-19 on 26.2.2019 at Vigyan Dham, Jhajra, Dehra Dun.
- Attended the valedictory function of Green Skill Development Programme (Parataxonomy-PBR) as Guest on 29th March, 2019 at Botanical Survey of India, Northern Regional Centre, Dehra Dun.

Dr. N.K. Sharma

- Coordinated, organised and participated "The World Soil Day" at IISWC, Dehra Dun on 5th December, 2018.

Dr(s).N.K.Sharma, D.V.Singh, Gopal Kumar, U.K. Maurya, M.Shankar and Raman Jeet Singh,

- Coordinated, organised, participated and delivered lectures in different training programme (Farmers Meetings and Kishan Goshtis etc.) under Mera Gaon Mera Gaurav (MGMG).

Dr(s).N.K.Sharma, D.V.Singh, Gopal Kumar, U.K. Maurya, M.Shankar and Raman Jeet Singh,

- Coordinated, Organised and Participated in various activities under the programme Swachchta Mission during the period under report.

Dr(s).N.K.Sharma, D.V.Singh, Gopal Kumar, U.K. Maurya, M.Shankar and Raman Jeet Singh,

- Coordinated and Participated in the programme on "Parthenium Awareness Week" organised at IISWC, DehraDun during August 16-22, 2018.

Dr(s).N.K.Sharma, D.V.Singh, Gopal Kumar, U.K. Maurya, M.Shankar and Raman Jeet Singh,

- Participated and presented paper in the Summit on "Climate Resilient Mountain Agriculture" organized by Directorate of Watershed Management at FRI, Dehra Dun, Uttarakhand during May 2-3, 2018.
- Participated in Uttarakhand State level Farmers' Conference and Farm Machinery Fare organized by Directorate of Agriculture, Dehradun on 04-05-2018.
- Participated in the programme on Digital Transformation-GeM Portal Explaination of all Products organized by Dell EMC at Four Points by Sheraton, Dehradun on June 8, 2018.
- Coordinated "Soil and Water Conservation Training-cum-Exposure visit" programme for farmers from Kaljikhal and Yamkeshwar blocks in Pauri Garhwal, Gairsain block in Chamoli and Ukhimath block in Rudraprayag districts of Uttarakhand during 11-15th June, 2018 organized at IISWC, DehraDun.
- Represented Director in Hindi Inspection of the Udhagamandalam Centre by the Parliamentary Committee on 30-06-2018.
- Coordinated the meeting of the officials from Irrigation Department, Srinagar Division and Netaji Subhash Chandra Bose Educational Society (NSCBES), DehraDun for developing the Water Resources in Bunga-Dharoli-Bilkhet area of Kaljikhal block in Pauri District, Uttarakhand on 02-02-2019.
- Served as an Expert in Brain Storming Session on *Uttarakhand main Kheti Kisani: Dasha, Disha Nirdharan main Vigyan evam Prodhogiki kee Bhumika* and presented invited paper in the Second-State Science and Technology Conference organized by Uttarakhand Science Education and Research Centre and Guru Ram Rai University at DehraDun, Uttarakhand during February 23-24, 2019.
- Participated in 13th Uttarakhand State Science and Technology Congress organiszed by UCOST, Dehradun during February 26-28, 2019.

Dr. D.V. Singh

- Attended ISER International Conference held in New Delhi, India 2018 and made oral presentation of the paper entitled "Climate Resilience in Perennial Crops Through Soil Manipulations, A Case Study of Litchi (*Lychee Chinensis*)" 15th-16th July 2018.
- Attended the meeting under the NMSHE Project to discuss the status of research work done as planned on 28th August, 2018 at IISWC, Dehra Dun.
- Attended annual national workshop of NICRA project in NASC complex and made presentation of the progress of the project at Institute on 6-7th August, 2018.

- Acted as Convenor and delivered a lecture on the topic of "Comprehensive assessment of climate change implication on watershed development" during Stakeholder Workshop on Climate Change Impact and Mitigation Measures (CCIMM-2019) on November 27, 2018 at ICAR-IISWC, Sunabeda, Koraput, Odisha.
- Acted as Chief-de-Mission in the ICAR North Zone Sports Meet held at ICAR-CIRB, Hissar from 14 to 16th November, 2018.
- Attended International seminar on Recent Trends and Experimental Approaches in Science, Technology, Nature & Management and made oral presentation on the paper entitled "Ravine formation- new hypothesis, status, and management approach" at FDDI, Jodhpur :23- 24 December, 2018.
- Attended the National Conference on Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019) during 6-8 February, 2019 at Bhanja Mandap, HAL, Sunabeda, Odisha.
- *Attended* International Conference on Agriculture and Allied Science: The Productivity, Food Security and Ecology" and made oral presentation *of the paper entitles* "Bamboo based intervention for averting land degradation and income generation in Mahi ravine" held at BCKV, West Bengal,-2018.
- Attended FFCSWR-2019 for Eastern region held at Koraput from 1-3rd Feb 2019.

Dr. Gopal Kumar

- Attended the National Conference on Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019) during 6-8 February, 2019 at Bhanja Mandap, HAL, Sunabeda, Odisha and chaired Technical Session 3: Panel Discussion on "Biodiversity and Rural Livelihood".
- Technical coordinator for the M.Sc. Tech., Applied Geology, Final year students of RTM University, Nagpur, for arranging their lectures, visit to museum as well as Selaqui Farm during their educational tour to IISWC, Dehradun on 19th Jan. 2019.
- Delivered lecture on "Role of geological formations in SWC measures" to M.Sc. Tech., Applied Geology, Final year students of RTM University, Nagpur on 19th Jan. 2019 at IISWC, DehraDun.
- Attended IRDP International Symposium on "Education Excellence" organized by IRDP Group of Journal at Hotel Atchaya, Chennai, on 28th October, 2018.
- Participated in 5 days DST Sponsored Training programme on "Integrated Nutrient Management and Nutrient Budgeting through Advanced Models to improve Crop Productivity" organized by ICAR-Indian Institute of Soil & Water Conservation, Udhagamandalam Research Centre, during 22-26th Oct, 2018.
- Delivered lecture on "Geology and soil formation, GIS & Remote Sensing" to M.Sc. I & III Semester Geology students of Dolphin Institute on 6th October, 2018 at IISWC, Dehradun.
- Attended "International Conference on "Environmental Nano Technology for Socio Economic Development of India (ENTSED-2018)" organized by Department of Chemistry and Civil Engineering, DIT University during 28th - 29th September, 2018 at DIT University, Dehradun, Uttarakhand and delivered Invited lecture on "Zeolites engineered nano-material in environmental protection".
- Attended Seminar on "Nanotechnology" organized by ICAR-Indian Institute of Soil & Water Conservation (IISWC), Dehra Dun on 20th Sep., 2018.
- Organised and attended "21st Annual Convention and National Conference on "Advances in Clay Science towards Agriculture, Environment and industry" organized by CMSI, New Delhi at ICAR-NBSS & LUP, Regional Centre, Kolkata, West Bengal, during September 14-15, 2018.
- Participated in workshop as an expert member in panel discussion on "Participatory Spring Revival in Uttarakhand" organized by Central Himalayan Rural Action (CHIRAG) and Spring Initiative Partners with support of Arghyam at Hotel Aketa, DehraDun on 17August 2018.
- Chaired the session during workshop "Rejuvenation of springs and spring-streams in Mid-Himalayan Basins" organised by G.B. Pant National Institute of Himalayan Environment and Sustainable Development (GBPNIHESD), Almora at IISWC , Dehra Dun on 14 August, 2018.
- Attended Conference on "Doubling Farmers Income for Sustainable & Harmonious Agriculture (DISHA-2018)" organized by Science & Tech Society for Integrated Rural Improvement (S&T SIRI), Warangal, Telangana in association with ICAR Institutes at Ranchi held at ICAR- IINRG, Ranchi during 11-12 August 2018.
- Chaired the Technical Session 3 during Conference on "Doubling Farmers Income for Sustainable & Harmonious Agriculture (DISHA-2018)" organized by Science & Tech Society for Integrated Rural Improvement (S&T SIRI), Warangal, Telangana held at ICAR- IINRG, Ranchi on 11th Aug. 2018.

- Delivered invited talk under Resource Development Programme of Oak Tasar Development Project, organized by Central Silk Board (CSB), Sahaspur in collaboration with Department of Sericulture, Uttarakhand, at Hotel Calista, Saharanpur Road, Dehradun on 14th July, 2018.
- Coordinated meeting on "Global Water Security Situation" by M/S Virentiatech Pvt. Ltd., Southern Park, Saket District Centre, New Delhi, on 6th July, 2018 at IISWC, DehraDun.
- Organised National Project Management Committee Meeting under Farmer FIRST programme at ICAR-IISWC, Dehra Dun during 28-29 May, 2019.

Dr. U.K. Maurya

- Participated and presented poster in Farmers first conference during February 2019 at Koraput, Odisha.

Dr. M. Sankar

- Attended 21st International Soil Tillage Research Organisation (ISTRO) conference in Paris, France during 24-27 September, 2018.

Dr. Raman Jeet Singh

- Attended national conference on managing natural resources for sustainable agriculture organized by G.K.V. Society at Agra, Uttar Pradesh, during 8-9 December, 2018.
- Attended Brain Storming Session as a subject expert in Second State Science and Technology Conclave during 23-24 February, 2019, organised by Uttarakhand Science Education and Research Centre in association with SGRR University and Vigyan Bharti at SGRR University, Dehra Dun.
- Completed short course on "Physiological approaches to phytoremediation: advances, impacts and prospects" organised by ICAR- IISS, Bhopal, M.P. during 10- 19 December 2018.

Dr. Devideen Yadav

- Demonstrated and explained laboratory activities to MANAGE trainees on 19.11.2018.

Sh. J.S. Deshwal

- Participated in "The World Soil Day" celebrations at IISWC, Dehra Dun on 5th December, 2018.

Sh. J.S. Deshwal , Sh. M.K. Kaul and Smt. Mamta Negi

- Participated in different programmes under Mera Gaon Mera Gaurav (MGMG) conducted during the period under report.

Sh. J.S. Deshwal , Sh. M.K. Kaul and Smt. Mamta Negi

- Participated in various activities under the programme Swachchta Mission during the period under report.

Sh. J.S. Deshwal, Sh. M.K. Kaul and Smt. Mamta Negi

- Attended 38th CJSC annual meeting at New Delhi on 27 April 2018.
- Attende Administrative cadre review meeting on 05 September 2018 at New Delhi.
- Attended FAC meeting on 18 December 2018 at New Delhi.
- Attended AGM on 28 February 2018 at New Delhi.
- Attended Technical Cadre review meeting on 18 and 27 March 2019 at New Delhi.

Sh. Deepak Kaul

- Attended the Skill Development Training Programme under "Training Programme for Administrative Staff" w.e.f. 7-10th January, 2019 at ICAR-IISWC, Research Centre, Vasad.

Smt. Mamta Negi

- Deliberated on Impact Assessment of Land Use/ Land Cover (LULC) on Wetland Ecosystems and Fisheries Production Potential at the ICAR-IIT, Delhi interaction workshop on NASF for project planning and possible collaboration at IIT, New Delhi on 22nd Nov. 2018.
- Attended and presented an invited paper in the International Conference on Advances in Biological and Environmental Research for Human Welfare, Department of Zoology, DeenDayal Upadhya Gorakhpur University, Gorakhpur, UP during 16th-18th Nov. 2018.
- Attended and presented a paper in the International Biodiversity Congress (IBC 2018) at Forest Research Institute, DehraDun (4-6 Oct. 2018).
- Participated and presented an invited seminar on Nano-Technological Potential in Fisheries and Water Resource Management at the International Conference on Environmental Nanotechnology held during 28th-29th Sep. 2018 at DIT University, DehraDun.
- Deliberated in Workshop on Applications of Satellite Altimetry for Inland Water bodies held at 30th May 2018 at Indian Institute of Remote Sensing (IIRS), Dehra Dun.

- Attended the National Programme Management Committee Meeting under Farmers First Program at ICAR-IISWC, Dehra Dun during 28-29 May 2018.

Dr. M.Muruganandam

- Completed a short term research project entitled "Integration of Survey Data for Small Domain Inference", in the three month (April 16, 2018 to July 16, 2018) Professional Attachment Training Program (PAT) in ICAR-IASRI, New Delhi.
- Participated in "'J-Gate@CeRA Regional Ambassador Training Program held on August 27, 2018 at Mohinder Singh Randhawa Library, Punjab Agricultural University (PAU), Ludhiana.
- Completed four month (October 08, 2018 to February 07, 2019) training program entitled "Certificate course on soil and water conservation and watershed management" (119th batch) organized by HRD & Social Science Division, ICAR-IISWC, DehraDun.
- Attended the 72nd national conference of Indian Society of Agricultural Statistics (ISAS) on "Statistics, Informatics and Engineering Interventions-A road map to transform Indian Agriculture towards prosperity" organised at ICAR-CIAE, Bhopal, Madhya Pradesh,(13-15December, 2018).
- Attended Conference on Farmers First for conserving soil and water resources in Eastern Region-2019, Koraput, Odisha.
- Participated in Stata Science and Technology Conclave during 23-24 February, 2019, at SGRR University, DehraDun.

Dr. Sadikul Islam

- Completed Professional Attachment Training at IIRS (ISRO), DehraDun from 16th November, 2018 to 15th February, 2019.

Mr. Saswat Kumar Kar

- Attended Zonal Project Management Committee meeting under Farmers FIRST project at ICAR-ATARI, Ludhiana on 20th April, 2018 and presented Action Plan of Farmer FIRST project for the year 2019-20.
- Organized and attended National Project Management Committee Meeting on Farmers FIRST Programme on 28-29 May, 2018. It was attended by all the 52 FFP centres across the country. The meeting was presided by Hon'ble DDG (Agril. Extn) & ADG (Agil. Extn.) along with other NPMC members.
- Attended ITMC/ITMU meeting at ICAR-IISWC, DehraDun on 9th October, 2018.
- Attended Annual General Body meeting of CGEWCC/RSB at Surveyor General's Office, Hathibarkala, Dehradun on 23.10.2018.
- Attended Training Programme on "Strategic R&D Management" at ASCI, Hyderabad from December 10-12, 2018.
- Attended Annual Zonal Review Workshop of Farmer FIRST Project organised by ICAR-ATARI, Ludhiana on February 9, 2019.
- Attended National Group Meeting on Impact Assessment of technological Modules under Farm FIRST Project organized by ICAR-NIAP, New Delhi at CSSRI, Karnal on February 13-14th, 2019.
- Attended Scientific Advisory Committee meeting at KVK, Dhakrani, DehraDun on 27.02.2019.
- Attended Scientific Advisory Committee meeting at KVK Dhanauri, Haridwar on 28.02.2019.
- Attended Workshop on "National Training Policy" at ISTM, New Delhi during March 25-26, 2019.
- Attended "MDP for HRD Nodal Officers of ICAR for Effective Implementation of Training Functions" at NAARM, Hyderabad from March 14-16, 2019.
- Attended Stakeholders' Workshop on "Water Census and Hotspot Analysis of Upper Ganga Basin (UGB) under National Mission for Sustaining the Himalayan Ecosystem (NMSHE) at ICAR-IISWC, Dehra Dun on Nov.30, 2018.
- Attended World Soil Day Celebrations at ICAR-IISWC, Dehra Dun on Dec.5, 2018.
- Organised four months regular "Certificate course on Soil and water conservation and watershed management" (118th batch) at IISWC, Dehradun during April 22-Aug.21, 2018.
- Organised four months regular "Certificate course on Soil and water conservation and watershed management" (119th batch) at IISWC, Dehradun during Oct.08, 2018-Feb. 2019.
- Coordinated 10 days Collaborative Training Programme on "Watershed Concept, Planning and Management" sponsored by MANAGE, Hyderabad, organized at ICAR-IISWC, Dehradun from June 18-27, 2018.

- Co-ordinated live telecast by Hon´ble Prime Minister Sh. Narendra Modi interacting with farmers on June 20, 2018 at ICAR-IISWC, DehraDun regarding doubling the income of farmers by 2022.
- Coordinated one month orientation training for Shri Ravi K.N., Scientist (Agril. Extn.) from 26th July to 25th August, 2018.
- Coordinated 10 days Collaborative Training Programme on "Integrated Watershed Management" sponsored by MANAGE, Hyderabad, organized at ICAR-IISWC, DehraDun from Sept.10-19, 2018.
- Coordinated 10 days Collaborative Training Programme on "Advanced Engineering Measures for Drainage Line Treatment" sponsored by MANAGE, Hyderabad, organized at ICAR-IISWC, DehraDun from Oct. 3-12, 2018.
- Organized and coordinated Vigilance Awareness Week from Oct. 29- Nov.3, 2018.
- Coordinated 10 days Collaborative Training Programme on "Climate Change and Doubling Farmers Income" sponsored by MANAGE, Hyderabad, organized at ICAR-IISWC, DehraDun from Nov.12-21, 2018.
- Coordinated 10 days Collaborative Training Programme on "PRA and Micro-watershed planning" sponsored by MANAGE, Hyderabad, organized at ICAR-IISWC, DehraDun from Feb.12-21, 2019.
- Coordinated 21 days FET of the ARS Probationers from ICAR-NAARM, Hyderabad from February19-March 11, 2019.
- Organized 5 days Short Training Course sponsored by ICAR, New Delhi under "Pandit Deen Dayal Upadhyay Unnat Krishi Shiksha Yojana" at ICAR-IISWC, DehraDun, May 28 to June 1, 2018.
- Organised 02 days short training course on Mrida Avam Jal Sanrakshan for Farmers, sponsored by Agriculture Department, Uttarakhand from July19-20, 2018.
- Organised 03 days short training course on Mrida Avam Jal Sanrakshan Hetu Upyogi Padhhatian for farmers sponsored by Forest Department, Jaunpur Range, Mussorrie from July 23-25, 2018.
- Coordinated Soil Water and Land Management (SWLM) sessions for IFS probationers at IGNFA, DehraDun from Jan 07-14, 2019.
- Coordinated one day "Watershed Module" for IFS officers from IGNFA, Dehradun on Dec. 04, 2018.
- Coordinated three months Professional Attachment Training for Mrs. Shruti, Scientist (108thFOCARS) from ICAR– Directorate of Mushroom Research, *Solan* from Nov.12-Feb.11, 2019.
- Organised two days training programme on "Man Animal Conflict" for farmers in collaboration with Wild Life Institute of India, under Farmer FIRST Project" from March 26-27, 2019.

Dr. Bankey Bihari

- Participated in National Group Meeting on Impact Assessment of technological Modules under Farm FIRST Project organized by ICAR-NIAP, New Delhi at CSSRI, Karnal on February 13-14th, 2019.

Dr (s). Bankey Bihari and Madan Singh

- Attended Management Development Programme on Leadership Development (a pre-RMP programme) organized at ICAR-NAARM, Hyderabad during18 – 29 December 2018.
- Participated in the Global Bamboo and Rattan Congress held at Beijing, China during 25-27 June 2018
- Attended National workshop on sustainability of Indian agriculture: Natural resource perspective with special reference to water at IIWM Bhubaneswar on 11 October 2018.
- Presented research proposals on bioengineering in the IITD-ICAR joint workshop held at Delhi on 22 November 2018
- Attended a meeting chaired by Jt. Secretary, Uttarakhand for organizing International Yoga Day at FRI ground on 21 June 2018.
- Attended Review meeting of NMSHE-task force on Himalayan Agriculture held at conference room, 2nd floor, NASC complex, Delhi6 December 2018.
- Attended Meeting of State level sanctioning committee of Uttrakhand on PMKSY held at Committee room of Chief Secretary, Uttarakahnd at Dehradun19 July 2018.
- Coordinated parliamenrry 2nd hindi sub-committee held at Madhuvan Hotel Dehradun on 8/6/18. Chaired by Dr Prasan Kumar Patsani, alongwith other members-Sunil Baliram Gayakwad, Lakshmi Narayan Yadav and Sh. Pratap rao Gapatrao Jadhav.
- Presented progress on monitoring theme of the NMSHE project in review meeting of NMSHE-task force on Himalayan Agriculture held at conference room, 2nd floor, NASC complex on 6/12/2018; chaired by Secretary, DARE & DG, ICAR.

Dr. Ambrish Kumar

- Coordinated 15 days in-plant summer training program for 8 M.Sc. Soil and Water Conservation students from BHU, Varanasi from 14th-28th June, 2018.
- Attended the "International Conference on Agriculture and Allied Sciences: The Productivity, Food Security and Ecology" held at BCKV, Kalyani, West Bengal during 13-14th August, 2018.
- Attended the National Children Science Congress-2018 at IMA, Kendriya Vidyalaya, DehraDun on 25-26th September, 2018 and acted as a judge for evaluation of Research Projects of young researchers from school.
- As a visiting scientist undertook tour to village clusters under National Food Security Mission of Govt. Of India in Hardwar District, Uttarakhand on 14th and 22nd September, 2018.
- Coordinated the 119th Batch Certificate Course on Soil and Water Conservation and Watershed Management from 8th October, 2018 to 7th February, 2019.
- Coordinated the celebration of "Mahila Kisan Diwas" on 15th October, 2018 at Ghaisen Village, Raipur, Dehra Dun.

Dr. Trisha Roy

- Attended training program on "New Media for Agricultural Extension" scheduled at MANAGE, Hyderabad during July 9-13, 2018.
- Attended the training program on "Role of Technology in Community Level Disaster Mitigation" for Scientists & Technologists at Lal Bahadur Shastri National Academy of Administration (LBSNAA) , Mussoorie during August 20th-24th, 2018.
- Attended the training Programme on "Innovative Practices in Extension Research and Evaluation" at ICAR-NAARM, Hydewrabad during September 24-29, 2018.

Dr. Madan Singh

- Participated in XIV Agricultural Science Congress organized by NASS and ICAR-IARI, New Delhi during 20-23 February, 2019 and Co-ordinated Institute exhibition stall.
- Participated in Krishi Kumbh 2018 organised Department Of Agriculture and Allied Departments and Uttar Pradesh State Agriculture Produce Marketing Board from 26th to 28th October, 2018 at Indian Institute Of Sugarcane Research(IISR), Telibagh Raebareli Road, Lucknow, India and Co-ordinated Institute exhibition stall.

Dr. Madan Singh, Sh. Suresh Kumar and Sh.R.P. Yadav

- Attended the Collaborative Training programme on "Watershed concept , Planning and Management" organised by MANAGE, Hyderabad and ICAR-IISWC, DehraDun dated 18.06.2018 to 27.06.2018
- Attended the Inaugural function for a farmer Training-cum-Exposure and Share their valuable experiences with the farmers on Soil and Water Conservation on 11.06.2018.
- Attended the Collaborative Training programme on "Watershed concept, Planning and Management" organized by MANAGE, Hyderabad and ICAR-IISWC, DehraDun during 18-27June 2018.
- Delivered lectures during the training programme for 118th Batch Regular Training Course from 22.04.2018 to 21.08.2018.
- Attended the training programme on "Watershed concept, planning and Management" organized by MANAGE, Hyderabad and ICAR-IISWC, DehraDun on 10.09.2018 to 19.09.2018 and delivered lecture on 17.09.2018.
- Attended the training programme on "Climate Change and Doubling Farmer Income" organised by MANAGE, Hyderabad and ICAR-IISWC, DehraDun during 12-21 November 2018 and delivered lecture "Role of millets in Changing climate and doubling farmer income".
- Attended the Field Experience Training FET (109th Focars, NAARM, Hyderabad Interaction in Plant Science Division dated February 22, 2019.

Dr. Harsh Mehta

- Attended the one-day seminar Seminar on "Opportunities and Challenges in agroforestry" at FRI, Dehradun and made oral presentation on "Minor Millets based agroforestry systems in Western Himalaya.
- Attended the viva Voice examination of Ms. Himshikha Conference Hall of FRI Deemed University, Dehradun.
- Attended the Seminar Genetic variability and stability analyses of Azadirachta Indica Germplasm for economically important traits by Rimpee Garg and Genetic modeling for growth and wood parameters in Melia composite Willd pre-thesis by Priyanka Shrivastava at Deemed University Dehradun on 28-06-2018

- Attended the Brainstorming Workshop on Development of Pro-Forma for Ranking of ICAR Institutes at NAAS, New Delhi Vide letter No. 2869/1(1)/93-Cdn./2017 Dated 26.07.2018 on 28.07.2018
- Attended the one-day seminar Seminar on "Opportunities and Challenges in Agroforestry" at FRI, Dehradun vide letter No II17/DE/Seminar/2018/509 dated November 05, 2018 on 16-11-2018

Dr. R.Kaushal

- Participated in 1st National Genetics Congress held at IARI, New Delhi during 14-16 December, 2018.

Dr. Pawan Kumar

Agra:

- Participated and delivered a lecture in a workshop on "Converting crop residue and animal extracts in valuable manure" at Surerhra Etmadpur on 22 Dec. 2018.
- Participated and delivered a lecture in Kisan Diwas was organized at village Brahmpur block Etmadpur Agra on 23 Dec. 2018.
- Delivered a lecture to participants of Out state women education inspirational tour of female farmers from Surendranagar Gujrat on 29 Dec. 2018.
- Visited the Goverdhan hillock in the Goverdhan range of the forest in Mathura on 19.1.2019 on request of Conservator of forests (Agra) for suggesting soil and water conservation measure to facilitate greening of the hillock.
- Participated and presented a paper in "National conference on Farmers Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2018)" organised at ICAR- IISWC, Sunabeda Koraput, from February 06-08, 2019.
- Coordinated the visit of 35 farmers from Surendranagar, Gujarat under Farmers training scheme through Deputy Director of Agriculture, Surendranagar, Gujarat on December 17, 2018
- Attended 28th National conference on Farmer's Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact organized by Soil Conservation Society of India held at IISWC RC Udhagamandalam T.N. during 31 January to February,2019 pp121:128
- Conducted training programme for District Development Officers, NABARD visited IISWC, RC, Agra on February 21, 2019.

Dr. S.K.Dubey

- Coordinated, organised, participated and delivered lectures in different training programme (Farmers Meetings and Kishan Goshtis etc.) under Mera Gaon Mera Gaurav (MGMG).

Dr(s).S.K.Dubey,A.K.Parandiyal, K.K.Sharma,R.K.Dubey, D.C. Meena

- Coordinated, organised and participated in various activities under the programme Swachchta Mission during the period under report.

Dr(s).S.K.Dubey,A.K.Parandiyal, K.K.Shama, R.K.Dubey, D.C. Meena

- Conducted Ph. D. Viva at Division of Agroforestry, Navsari Agriculture University, Navsari Gujrat as external expert on 18.8.2018
- Conducted farmers contact programme under TOT on 24 October, 2018 at Bilpura village Fatehabad, Agra.
- Participated and delivered a lecture in a workshop on "Converting crop residue and animal extracts in valuable manure" at Surerhra Etmadpur on 22 Dec. 2018.
- Delivered a lecture to participants of out state women education inspirational tour of female farmers from Surendranagar Gujrat on 29 Dec. 2018.
- Visited the Goverdhan hillock in the Goverdhan range of the forest in Mathura on 19.1.2019 on request of Conservator of forests (Agra) for suggesting soil and water conservation measure to facilitate greening of the hillock.
- Participated and presented a paper in "National conference on Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2018)" organised at ICAR- IISWC, Sunabeda Koraput, during February 06-08, 2019.

Dr. A.K. Parandiyal

- Coordinated one month student trainings for 04 students in the month of June, 2018 for B. Tech. (Agril. Engg.) Students from college of Agril. Engg. and Post harvest Technology, Ranipool, Gangtok from 1-30th June 2018.

- Coordinated one month student trainings for 04 students in the month of July, 2018 for B. Tech. College of Agril. Engg. & Technology, OUAT, Bhubaneswar from 1-31st July 2018.
- Delivered one lectures on planning and designing SWC structures in a watershed for 50 District development Managers, NABARD, Regional Office, Lucknow Uttar Pradesh on 21.02.2019 at ICAR-IISWC Research centre, Chhalesar Agra-282006.
- Delivered special lectures on planning and designing SWC structures in a watershed for 50 District development Managers, NABARD, Regional Office, Lucknow Uttar Pradesh on 21.02.2019 at ICAR-IISWC Research centre, Chhalesar Agra-282006.
- Participated in quarterly Hindi workshops and Hindi month programme on 14 September, 2018 held at the centre.

Dr.K.K. Sharma

- Delivered a lecture on bird conservation to school students in Bird Festival organized by Regional Forest Officer Baipur Range Agra at Kakretha on 2 February, 2019.

Dr. R.K.Dubey

- Delivered lectures on "Socio-economic analysis of soil and water conservation measures and related issues" in one month (01-30th June, 2018) summer practical training in soil & water conservation conducted by IISWC, RC, Agra for B.Tech. (Agril. Engg) students.
- Participated in Farmers Fair for exhibition of Centre's developed technologies on July 12, 2018 at CIRG, Makhdoom, Farah, Mathura.
- Delivered lectures on "Socio-economic analysis of soil and water conservation measures and related issues" in one month (01-31th July, 2018) summer practical training in soil & water conservation conducted by IISWC, RC, Agra for B.Tech. (Agril. Engg) students.
- Participated in farmers fair to demonstrate the Centre's developed technologies on October 07, 2018 at Deen dayal Dham, Farah, Mathura.
- Coordinated the visit of 14 Krishi Udyami trainees from RUDSET, Agra at ICAR- IISWC, Research Centre Agra on October 11, 2018.
- Coordinated and participated in Krishi kumbh 2018 to demonstrate the centre's developed technologies on October 26, 2018 at ICAR-IISR, Lucknow.
- Attended the workshop on "Valuation of Ecosystem services from natural resource conservation and management interventions in different agro-ecological regions in India" during 12-13 December, 2018 at IISWC, RC Vasad, Gujrat.
- Coordinated the visit of 35 farmers from Surendranagar, Gujarat under *Farmers training scheme through Deputy Director of Agriculture,* Surendranagar, Gujarat on December 17, 2018.
- Coordinated and participated in Krishi kumbh 2019 to demonstrate the centre's developed technologies during February 09- 11, 2018 at Motihari, Bihar.

Dr.D.C. Meena

- Attended and gave oral presentation in an international conference on "Emerging issues in Agriculture, Environmental and Applied Sciences for Sustainable Development" from 27-29 November, 2018 at Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P.

Dr. Rama Pal

Ballary

- Participated in 19th Scientific Advisory Committee Meeting of ICAR-KVK, Hagari on 28th Aug, 2018 in ICAR-KVK, Hagari as a member of the SAC, ICAR-KVK, Hagari.
- Participated in the State level stake holder's workshop on the use of LRI data in Sujala-III watersheds held on 22-09-2018 at office of the Commissioner, Sujala, Bengaluru.
- Participated in the meeting with the Institutes and Regional Centre of ICAR located in Karnataka under the Chairmanship of Honourable Minister for Agriculture Shri. Shivashankara Reddy on 25-09-2018.
- Participated in Bi-annual meeting of AICRPDA at Bengaluru on 17-18 January, 2019 and also attended to the finalisation of MoU of M&E of Sujala.

Dr. S.L. Patil

- Participated in interaction workshop on 'Developing framework to evaluate LRI based watershed development programs' on 12-06-2018 at Bengaluru.

Dr(s). S.L. Patil, H. Biswas, B.S. Naik, Ravi Dupdal , Sh. A.S. Morade and Sh. P. M. Kumar

- Attended a 3-day "International Consultation on Water: Augmentation of Supply and Management of Demand" organised by M S Swaminathan Research Foundation, Chennai, during 7-9August, 2018.

Dr(s). S.L. Patil and H. Biswas

- Participated in the State level stake holders meeting on the Frame work for comparison of LRI vs Non LRI based watershed planning in Sujala-III watersheds on 26 Oct 2018 at office of the Commissioner, Sujala, Bengaluru.

Dr(s). S.L. Patil, H. Biswas, B.S. Naik, Ravi Dupdal and Sh. A.S. Morade

- Attended workshops, progress/ review meetings and other related activities on different occasions with regards to the implementation of SUJALA-3 project Protocol.

Dr(s). S.L. Patil, H. Biswas, B.S. Naik, Ravi Dupdal and Sh. A.S. Morade

- Attended to workshop on core project of Ecosystem held at RC, Vasad from 12-13, Dec 2019

Dr. Ravi Dupdal

Chandigarh

- Participated in one day workshop on "Application of hydrological models for soil erosion management at Regional Research Station (Punjab Agricultural University) Ballowal Saunkhri on October 16, 2018.
- Attended regional committee meeting at CSSRI Karnal on 2-3,2018
- Participated in write shop on " Project formulation: climate change adaptation and mitigation" in Chandigarh from December 17 to 19 2018
- Attended IMC meeting in Dehradun on 29.01.2019
- Invited for delivering lectures on watershed management and soil and water conservation aspects to teachers of Engineering colleges at NITTR Chandigarh
- Participated in conference on Farmers' first for conserving soil and water resources in Eastern region at Koraput, Odisha during February 6-8, 2019
- Participated in three Hindi workshops.
- Participated at CII Agrotech Exhibition during 1st to 4th December, 2018

Dr(s). V.K. Bhatt, Ram Prasad, S. Pal and Sathiya, K.

- Coordinated, organised and participated in various activities under the programme Swachchta Mission during the period under report.

Dr(s).V.K. Bhatt, S.L.Arya, Ram Prasad, P.Panwar,S. Pal and Sathiya, K.

- Attended workshop on Network Project entitled,"Valuation of Ecosystem Services from natural resource conservation and management interventions in different agro-ecological regions in India" from December 12-13, 2018 at Vasad Research Centre.

Dr. S. L. Arya

- Attended Scientific Advisory Committee meeting of KVK, Ropar at Haveli Kalan on 31st January2019.
- Attended one day exhibition/festival on Organic products at Chandigarh on 14January2019, organised by Ministry of Women and Child Development,Govt of India.
- Attended Guava Show-cum-Seminar, organized by PAU, Regional Fruit Research Station, Bahadurgarh, Patiala on December 5,2018.
- Attended Press Information Bureau meeting at Sec 9, Kendriya Sadan,Chandigarh on May 24, 2018.

Dr. Ram Prasad

- Participated in one day workshop on applicability of EROSION – 3D model at Regional Research Station, PAU-Ballowal Saunkhari, Punjab on 16th October, 2018
- Participated in review meeting on National Mission for Sustaining the Himalayan Ecosystem funded by Department of Science and Technology, Government of India, organized at New Delhi by Department of Science and Technology, Government of India on 6th December, 2018.

Dr. Pankaj Panwar

- Participated in International Conference on food security, held at Thapar University Patiala (Pb.) during7-8 December, 2018.
- Participated at world soil day celebration, organised by Department of Agriculture, Haryana at Kalka, on 5th December 2018.

Dr. Sharmistha Pal

Datia

- Participated in Foundation Day of ICAR – CAFRI, Jhansi on May 08, 2018 and also workshop on "Opportunities of Bamboo Production in Bundelkhand Region".
- Participated in progammme on 'Research Excellence in Organizations' at ASCI, Hyderabad organized by ASCI, Hyderabad during Aug. 08-10, 2018.
- Participated in 'Scientific Advisory Committee' meeting of KVK, Datia on Oct. 10, 2018.
- Participated in Foundation Day of ICAR – IGFRI, Jhansi on Nov. 01, 2018.
- Participated in World Soil Day organized by ICAR – CAFRI, Jhansi on Dec. 05, 2018.

Dr. R. S. Yadav

- Participated in Conference on "Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019)" during Feb. 06-08, 2019 at Koraput organized by ICAR-IISWC RC, Koraput.

Dr. R. S. Yadav and Mr. M.K.Meena

- Participated and presented developed technologies of ICAR-IISWC, Research Centre, Datia for extending technological support to KVKs operational in M.P. and Chhattisgarh in 'Action Plan Workshop 2018 for KVKs', organised during April 23-25,2018 at ICAR-CIAE, Bhopal by ICAR-ATARI, Jabalpur.
- Participated in "District Level Farmers Workshop" organized under "*Mukhyamantri Krishak Samridhi Yojana*" on June 10, 2018 organized by State Agriculture Department, Datia.
- Participated in "*Mukhyamantri Krishak Samridhi Sammelan Sah Krishi Vigyan Mela*" on June 15, 2018 as organized by State Agriculture Department, Datia.
- Participated as Member, Selection Committee for the post of Scientist (Agronomy), Rani Laxmi Bai Central Agricultural University, Jhansi on Feb. 23, 2019.
- Participated and displayed the soil and water conservation technologies of the Centre during "Kisan Mela cum Exhibition" organised by the KVK Bharari, Jhansi of Banda University of Agriculture and Technology, on Feb. 28, 2019.

Dr. Dev Narayan

- Attended ATMA, Datia governing body meeting at District Collectorate Datia on 11/07/2018.
- Participated in 57th Foundation Day of ICAR-IGFRI, Jhansi and displayed the different SWC technologies in Agricultural Technologies Exhibition on Nov. 01, 2018.

Dr. Rajeev Ranjan

- Participated in "District Level Farmers Workshop" organized under "*Mukhyamantri Krishak Samridhi Yojana*" on June 10, 2018 organized by State Agriculture Department, Datia.

Mrs. M. Pramanik

- Coordinated One month summer practical training of 11 B. Tech students from CAET, JNKVV, Jabalpur, MP and NAU, Gujrat during June 01-30, 2018.

Mrs. M. Pramanik and Mr.M.K.Meena

- Attended workshop on "Possibility of cultivation of bamboo in Bundelkhand region" at ICAR-CAFRI, Jhansi on May 08, 2018.
- Participated in exhibiting institute technology to the farmers at foundation day celebration at ICAR-CAFRI, Jhansi on May 08, 2018.
- Attended International Conference on "Rural Livelihood Improvement by Enhancing farmer's income through sustainable Innovative Agri and Allied Enterprises (RLISSAe)", during October, 30-31 and Nov. 01, 2018 at BIT Patna, Bihar.
- Organised and attended a *Kisan Goshthi* at village Maheba, Datia on Dec. 01, 2018
- Attended *Kisan Goshthi* at village Hastinapur, District-Jhansi (UP) on Dec. 23. 2018
- Participated in exhibiting institute technology to the farmers on "Technology and demonstration meet "at ICAR-IGFRI, Jhansi on February 25, 2019.
- Participated in "Kisan Mela and Krishi Exhibition "at KVK, Bharari, Jhansi on February 28, 2019.

Mr. M. K. Meena

- Participated in the training on "Motivation, Positive Thinking and Communication Skills' for Technical officers of ICAR institutes at ICAR-IISWC, Dehradun during March 13-19, 2019.

Mr. Pramod Kumar

- Participated in the training on 'Automobile Maintenance, Road Safety and Behavioural Skills' for regular drivers in technical grade of ICAR institutes at ICAR-CIAE, Bhopal during Jan 16-22, 2019.

Mr. C.S. Samele

- Participated in the training on 'ERP, pension, e-procurement/GeM, vigilance matter, works, RTI related matters and taxation' for administrative staff at ICAR-IISWC RC, Vasad during Jan. 07-10, 2019.

Mr. A.K. Ahirwar and Mr. Rakesh Kumar

Koraput

- Attended "Zonal Research and Extension Advisory Council Meeting of Eastern Ghat Highland Zone and South Eastern Ghat Zone at KVK, Semiliguda on 17th April, 2018.
- Delivered a lecture on "Bio-diversity Conservation in relation to soil erosion "at Central University, Koraput, and Odisha 22nd May 2018.
- Attended meeting with NALCO foundation to take-up development activities in selected villages in Koraput district under corporate social responsibility programme.
- Attended the KVK SAC meeting at Bhawanipatna on 4- 5, September, 2018.
- Participated in the national workshop on sustainability of Indian agriculture: natural resource perspective with social reference to water at ICAR- IIWM- Bhubaneswar on 11th October, 2018
- Participated in the stakeholder's consultation workshop on "Prioritization of climate smart agriculture interventions for scaling up climate village approach in Odisha and on 23rd October, 2018 at IMAGE-Bhubaneswar.
- Visited Kundura, Koraput District on 15th February, 2019 to celebrate "Radio Kisan Diwas Mela".
- Participated in National Consultancy on Climate Change Impact and Sustainable at Bhubaneswar from 18th -19th February, 2019.
- attended a District Level Seminar on Recent Advances in Production and Processing of Spices on 1st March, 2019 at High Altitude Research Station, OUAT, Pottangi, Dist. Koraput (Odisha).
- Attended International Women's Day on 8th March, 2019 at Sunabeda Women's Degree College, Dist. Koraput (Odisha).
- Participated in two days workshop on "Valuation of Ecosystem Services from Natural Resource Conservation and Management interventions in different agro-ecological regions in India" from 12th-13th December, 2018 at ICAR – IISWC, RC, Vasad, Gujarat.

Dr. M. Madhu

- Attended the KKA meeting cum training programmes organised on different dates and locations during the period under report.

Dr(s). M. Madhu, Karma Beer and Sh. G. B. Naik

- Attended the NARAKAS meeting at officers club HAL on 28-09-2018.

Dr(s). M. Madhu and Karma Beer

- Attended the 2nd review meeting of KVK on 1st October 2018.

Dr(s). M. Madhu and D. C. Sahoo

- Participated and delivered lecture for field level functionaries of Government of West Bengal in the training programme "Watershed management and land use planning" at IIWM on 27-07-2018 and 10-08-2018.
- Participated in the meeting under the Chairmanship of Hon'ble DG, ICAR and Secretary, DARE, Govt. of India on August 11, 2018 at ICAR-NRRI, Cuttack on the progress of activities for Doubling Farmers' Income in Odisha by 2022, Kisan Kalyan Abhiyan in Aspirational Districts, KSHAMTA, VATICA, NARI and other flagship programmes of Govt. of India.

Dr. D.C. Sahoo

- Attended training in NAARM Hyderabad from 06-11, September, 2018.

Dr. P. Jakhar

- Attended Two day Stakeholders' workshop on "Climate Change Impact and Mitigation Measures (CCIMM-2018)" form 27-28 November 2018.

Dr(s). P. Jakhar, J. Dash and Karma Beer

- Organised the 22 training programmes from 1 June to 20 July 2018 in 22 villages of Sarsopadar and khudi panchayat.

Dr. Karma Beer and Sh. G. B. Naik

- Attended one day training programme on Awareness training programmes to the adopted village by NALCO foundation under corporate social responsibility (CSR) organized by ICAR- IISWC, RC, Koraput on 21-08-2018.

Dr(s). Karma Beer, P. Jakhar and P. P. Adhikary

- Attended training on Hindi typing training programme held at HAL, Sunabeda, on 4th May 2018.

Mrs. H. N. Lakra and Sh. R. Sivaprasad

- Participated in exhibition at NRRI, Cuttack on 23 rd April, 2018.

Sh. G.B.Naik

- Participated in Krishi Mela cum exhibition at NRRI, Cuttack On 26-02-2019.
- Participated in Exhibition and displayed the exhibits of centre's technologies to the farmer at Dayanidhiguda, Koraput during 21th & 22th December, 2018.

Sh.G.B. Naik and Sh. S.Kindal

Kota

- Attended project meeting cum workshop on "Carbon Sequestration" at IISWC, DehraDun during June 5-6, 2018.
- Attended 2nd Research Council Meeting of Kota Agriculture University, Kota on August 7, 2018.
- Presented State of the Art Lecture titled "*Rehabilitation of Chambal Ravine for sustainable Rural Development" in* 32nd National Convention of Agricultural Engineers on "Agricultural Engineering for the Sustainable Rural and Agriculture Development in India" organized by Institution of Engineers Kota centre at Kota on 18th August, 2018.
- Attended Selection Board meeting of Technical post recruitments at the Agricultural University, Kota during 31 August to 02 September 2018 at Kota.
- Attended and presented lead lecture titled "Resource conservation approaches for eco-restoration and profitability in arid and semi-arid regions" in National Conference on arid horticulture: Enhancing Productivity and economic empowerment organized by CIAH-Bikaner during October 27-29, 2018.
- Acted as panelist of technical session–IV entitled "Organic farming, Integrated cropping/farming System and advances in biotic stress management" in National Conference on arid horticulture: Enhancing Productivity and economic empowerment on October 28, 2018 in a Conference organized by CIAH-Bikaner during 27-29 October 2018 at Bikaner
- Attended meeting as chairman of the assessment committee for technical personnel under career advancement at ICAR- CIAH Bikaner on 27th October, 2018
- Participated as Chief Guest in Republic Day flag hoisting and prize distribution ceremony of Tare Secondary School, Kota on 26th January, 2019.
- Participated as Chief Guest in inaugural session of a National Seminar entitle "Post harvest management of potato, onion and garlic for doubling farmers income under changing climate scenario" at KVK, Anta of Baran district on 27th January, 2019.
- Attended ICAR regional committee meeting for Zone VI held at Anand during February 4-5, 2019
- Co-chaired the technical session VI devoted to Chhattisgarh in the conference on "Farmers First for Conserving Soil and Water Resources in Eastern Region" at Koraput, Orissa during February 6-8, 2019
- Acted as Convener for the technical session VIII entitled "*Bhoochetna*-ICRISAT Programme in the conference on "Farmers First for Conserving Soil and Water Resources in Eastern Region" at Koraput, Orissa during February 6-8, 2019.

Dr. R.K. Singh

- Attended Live telecast of interaction of Hon'ble Prime Minister with farmers organized at ICAR-IISWC, Research Centre Kota on June 20, 2018.

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, I.Rashmi, Kuldeep Kumar, S. Kala and G.L. Meena

- Attended "4th International Yoga Day" celebrated at ICAR-Indian Institute of Soil and Water Conservation, Research Centre, Kota on June 21, 2018.

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, I.Rashmi, Kuldeep Kumar , S. Kala and G.L. Meena

- Attended and participated in **"**32nd National Convention of Agricultural Engineers on "Agricultural Engineering for the Sustainable Rural and Agriculture Development in India" organized by Institution of Engineers Kota centre at Kota during August 18-19, 2018.

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, I.Rashmi, Kuldeep Kumar, S. Kala and G.L. Meena

- Participated in technology week organised at the centre during August 27-30, 2018.

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, I.Rashmi, Kuldeep Kumar and G.L. Meena

- Participated in aadranjali event organized to pay homage to our former primeminister A.B.Vajpayee after one month completion of his death on September 16, 2018 at the centre.

Dr (s) R.K. Singh, Ashok Kumar, B.L. Mina, H.R. Meena, I.Rashmi, Kuldeep Kumar, S. Kala and G.L. Meena

- Organised and participated in Hindi Divas on September 14, 2018 at the Centre.

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, S.Kala, Kuldeep Kumar and G.L.Meena

- Attended four days training programme on "stress Management" at NAARM, Rajendranagar, Hyderabad (A.P.) during September17-20, 2018.

Dr(s) A.K. Singh and Shakir Ali

- Organised and participated in Hindi Karyashala on "Unicode" at the Centre on September 28, 2018.

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, S.Kala, Kuldeep Kumar and G.L.Meena

- Organised, coordinated, and participated in various activities under Swacchh Bharat Abhiyan/Mission on different occasions.

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, S.Kala, Kuldeep Kumar and G.L.Meena

- Organised and participated in Foundation day of Research centre, Kota was celebrated on Oct. 18, 2017

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, S.Kala, Kuldeep Kumar and G.L.Meena

- Organised and participated in 64th foundation day of Research Centre, Kota on 20th October, 2018.

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, S.Kala, Kuldeep Kumar and G.L.Meena

- Organised and participated in workshop on "Role of vigilance for corruption free India" on Nov. 3, 2018 under Vigilance awareness week (30th October to 4th November)

Dr (s) R.K. Singh, Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena, Kuldeep Kumar, S. Kala, I. Rashmi and G.L.Meena

- Participated as panel Judge in the final round of Technovation, Science Exhibition and Competition - 2018 held at Career Point University, Kota on 2nd May, 2018
- **A**attended " Kota Nagar Rajbhasha Karyawayan Samitee" meeting organized by the NTPC,Anta, on May 18, 2018.
- Attended "Kota Nagar Rajbhasha Karyawayan Samitee" meeting organized by Heavy water plant, Rawatbhata, Chittorgarh on November 23, 2018.
- Attended meeting cum workshop for identifying indicators to measure ecosystem services from watershed management under project "intangible benefits of NRM interventions in different projects in different climatic regions at IISWC, Resaerch centre, Vasad during December 12-13, 2018.
- Delivered Guest lectures on" Market survey for establishing Food processing industries" in referser course for agricultural supervisors from Rajasthan state at State institute of agriculture management (SIAM) Kota on 17th December 2018.
- Attended and participated in Scientific advisory meeting of Krishi Vigyan kendra,Kota at Borkheda on 20th December,2018
- Attended and presented paper in Conference on "Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR-2019) held during February 6-8, at Sunebada-Koraput (Odisha).

Dr. Ashok Kumar

- Organised and participated in training programmes in adopted villages under MGMG scheme on various occasions.

Dr (s) Ashok Kumar, A.K. Singh, Shakir Ali, B.L. Mina, H.R. Meena ,S.Kala and Kuldeep Kumar

- Attended annual meeting of Institute of Engineers, Kota Chapter at Kota on 28th Oct. 2018.
- Attended a seminar on organic farming at Career Point University, Kota on Feb. 18th, 2019

Dr. A. K. Singh

- **A**ttended and presented a research paper on "Optimum sizing of recharge filter for artificially recharging the dug well" in a International Conference on "Global Water Security for Agriculture and Natural

Resources " organised by American Society of Agricultural and Biological Engineers (ASABE), USA during October 3-6, 2018 at Hyderabad .

- Attended workshop "Building an operational composite drought monitoring index for India" organized by Water Technology Centre, IARI New Delhi during January 22-23, 2019.
- Acted as a member of ZMC (Zonal Monitoring Committee) visit to NICRA KVKs, Bharatpur, Jhunjhunu and Kota during February 4-6, 2019.

Dr. Shakir Ali

- Attended and presented a research paper on "Soil properties and growth and yield of sapota as influenced by integrated nutrient management" in the 27th National conference of Soil Conservation Society of Soil Science, New Delhi on "Sustainable Management of Soil and Water Resources for Doubling Farmer's Income" held at Assam Agricultural University, Jorhat during October 25th -27th , 2018.
- Acted as paper setter and examiner by Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur to the course of HORTI- 111 (Fundamentals of Horticulture) for B.Sc. (Ag.) Hons. Semester examination conducted during academic session, 2018-19.

Dr.H.R. Meena

- Attended meeting on Rabi crop called by Commissioner Kota at CAD, Kota on 16th October2018.

Dr. Kuldeep kumar

- Attended and presented a research paper on "Karanj (Pongamia pinnata) based silvipastoral system: Ideal technology for effective rehabilitation and utilization of Chambal ravines" in the 13th ICDD: Converting Dryland Area from Grey into Green at Jodhpur.

Dr. S. Kala

- Attended and presented a research paper on "Effect of land use systems on runoff and soil loss in vertisols of India" in the 27th National Conference on "Sustainable Management of Soil and Water Resources for Doubling Farmers' Income" held at Assam Agricultural University Jorhat (Assam) during 25th- 27th October, 2018.

Dr. G.L. Meena

Udhagamandalam

- Attended the meeting at ICAR-SBI, Coimbatore on 12 July 2018 for organizing State Level Kisan Mela for the state of Tamil Nadu during 24-26 Aug. 2018.
- The Chief Guest of the Hindi Debate Competition on the occasion of Hindi Day on 14.08.2018 at The Lawrence School, Ooty and distributed prizes and trophies to the students from the different schools in the Nilgiris.
- Attended the Training Programme on 'Managing Technology Value Chains for Directors & Division Heads' during 03.09.2018 to 07.09.2018, Sponsored by Department of Science & Technology, Government of India, New Delhi Contact at Administrative Staff College of India, Hyderabad.
- Chief Guest during Inaugural Function of Agricultural Students' Association, School of Agriculture and Biosciences, Karunya Institute of Technology & Sciences (Deemed University), Coimbatore – 641114 on 10.09.2018.
- Chairman, Organising Committee for the 28th National Conference on Farmers' friendly soil and water conservation technologies for mitigating climate change impact" organised by Soil conservation society of India and ICAR- IISWC, RC, Udhagamandalam at Ooty during 31st January 02nd February, 2019.
- Guest of Honour during the Inaugural Function of the National Seminar on Medicinal Plants used in Homeopathy - Cultivation, Standardization and Quality Control in India, 23 March 2019 at Hotel Kluney Manor, Ooty.

Dr. O.P.S. Khola

- Attended National conference on "Farmers first for conserving soil and water resources in Eastern India" from 6-8, February, 2019 held at ICAR-IISWC, RC. Koraput, Odisha.

Dr(s). O.P.S. Khola and K.Rajan

- Participated in the"28th National Conference on Farmers' friendly soil and water conservation technologies for mitigating climate change impact" organised by Soil conservation society of India and ICAR- IISWC, RC, Udhagamandalam at Ooty during 31st January 02nd February, 2019.

Dr(s).O.P.S. Khola, K.Kannan, S.Manivannan, P. Raja, H. Hombegowda and V. K.Thilagam

- Participated in National Seminar on "Climate Resilient Technologies for Sustainable Agriculture-CRTSA-2019" on 25 January, 2019 at Department of Agronomy, Annamalai University, Chidambaram.

Dr(s). K. Kannan and P. Raja

- Attended Farmers-Scientists –Extension workers Interaction meet-cum-technical training Kolikarai village on 12.02.2019 or the farmers of selected MGMG and TSP villages.
- Participated **in** Kisan Kalyan Karyashala organised by State Horticultural Department at Kotagiri on 02May2018.

Dr(s). K. Kannan and P. Sundarambal

- Participated in The Nilgiri 200 and exhibited the centres contribution on 02May2018.

Dr. V.Selvi

- Attended World Soil Day Celebration on 05-12-2018 at Kunjapanai village.

Dr(s). K. Kannan, P. Sundarambal, K.Rajan and P.Raja

- Attended and delivered lecture on "Opportunities of resource conservation for profitability of custom hiring centers" in Model training course on establishment of farm machinery custom hiring centre for entrepreneurship development organised by Central Institute of Agricultural Engineering, Regional Centre, Coimbatore on 04August 2018.
- Attended training Programme on "Landslide Mitigation & Detailed Project Report Preparation" during 06-07 September 2018 at CRRI, New Delhi.
- Attended and delivered key note address on "Recent trends in soil and water conservation technologies" during the inaugural function of the Agricultural students association on 10September 2018 at Karunya Institute of Technology and Sciences, Coimbatore.
- Attended training Program on "Landslide Mitigation & Detailed Project Report Preparation" from September 06-07, 2018 at CRRI, New Delhi.

Dr S. Manivannan

- Participated as committee member in the interviews conducted from 24.09.2018 to 30.09.2018 for selection of technical Trainees at Radio Astronomy Centre, TIFR, Ooty.

Dr. P. Sundarambal

- Attended training programme on "Science Administration and Research Management" at Administrative Staff College of India, Hyderabad from 11-22, February, 2019.

Dr K. Rajan

- Attended International Conference on Impact of Climate Change on Water Resources organized by the Centre for Geoinformatics and Planetary Studies, School of Physical Sciences, Periyar University, Salem during 12-13, July 2018.
- Participated in National Seminar on "Developments in Soil Science: 2018, and the 83rd Annual Convention held at Anand Agricultural University, Anand, Gujarat from 27th – 29th Oct.2018.
- Participated in 106th Indian Science Congress held at Lovely Professional University, Jalandhar, Punjab during 3-7 January, 2019.
- Attended International Symposium on "Advances in Agrometeorology for Managing Climate Risks of Farmers-INAGMET 2019 held at Jawaharlal Nehru University, New Delhi on 11th -13th February, 2019.
- Attended National Conference on "Flood and Drought Management Practices and Future Challenges" organised by the Department of Geology, Periyar University, Salem during February 21-22, 2019.

Dr. P. Raja

- Attended Scientific Expert Committee Meeting organised by Tamil Nadu Pollution Control Board at Madurai on 17 .05.2018.
- Participated workshop on Carbon sequestration potential of different land use and conservation measures during 05-06 June 2018 at IISWC, DehraDun.
- Attended Disaster Management Committee Meeting on 07.09.2018 at Additional Collectors Office, Ooty.
- Attended farmers interaction meeting during training on natural agricultural farming organised by Department of Horticulture, Ooty held on 13.12.2018.
- Participated in the "National Science day" Exhibition organized at Radio Astronomy Centre, Tata Institute of Fundamental Research, Ooty on 28.02.2019.

Dr. V. Kashturi Thilagam

Vasad

- Attended one day workshop on "Aquaculture in Village ponds" is going to be organised at Rajpipla, Narmada under Tribal Sub-Plan Schemes at Rajpipla, Narmada on 24th May, 2018
- Delivered lecture to Extension Education Institute, AAU Anand students on 19th June, 2018
- Attended 38th meeting of Academic Council at NAU, Navsari (Gujarat) on 3rd July, 2018
- Participated as Guest of Honour in valedictory function of "workshop-cum-training programme on Freshwater Ornamental Fish Breeding and Culture" on 26 July 2018, organised by CIFA, Regional Centre, Anand at Anand Agricultural University campus.
- Attended one-day consultation meeting for Centre and Western Region at ICAR-Central Institute of Agricultural Engineering, Nabibagh, Bhopal on 1st Sept. 2018
- Acted as a Chairman in the Assessment committee for assessment of Technical staff at ICAR-DMAPR, Boriavi on 24th Oct. 2018
- Participated in Ekta Rath for Sardar Patel Pratima at Vasad village on 17th Nov. 2018
- Attended 45th meeting of the Academic Council at JAU, Junagadh on 19th Nov. 2018
- Attended 83rd Annual Convention of ISSS & National Seminar on "Development in Soil Science-2018" at AAU, Anand during 27-30th Nov. 2018
- Participated and presented a paper in 53rd ISAE Convention at BHU, Varanasi during 28-30 Jan. 2019
- Co-chaired with Dr. S.N. Panda as chairman, session on "Groundwater and Drainage" in 53rd ISAE Convention at BHU, Varanasi on 29 Jan 2019.
- Participated in Regional Committee Meeting of Region VI on 04-05 Feb 2019 at Anand Agricultural University, Anand.
- Participated Agricultural Research Council Meeting of Anand Agricultural University on 06 February 2019 at AAU, Anand.
- Attended 17th Scientific advisory committee meeting of KVK, Chhotaudepur, Vadodara on 26th Feb. 2019
- Participated on 25th March 209 in Departmental Screening Committee for MACPs of staff of KVKs (Gandhinagar, Valsad, and Kheda) under Gujarat Vidhyapeeth, Ahmedabad.
- Participated on 27th March 209 in Departmental Screening Committee for MACPs of staff of KVK, Mangal Bharti, Chhota Udepur, Gujarat.

Dr. P.R. Bhatanagar

- Attended workshop on "Agriculture and Eco-system Services" at ICAR-NAIP, New Delhi from 28-29th May, 2018
- Attended 83rd Annual Convention of ISSS & National Seminar on "Development in Soil Science-2018" at AAU, Anand during 27-30th November, 2018
- Attended the special National Symposium "Challenges and Opportunities in Rainfed Agriculture under changing climate scenario" and presented a paper "Economic Analysis of Climate Resilient Rainfed Agriculture Technologies" at Anand, Gujarat during 83rd Annual Convention of Indian Society of Soil Science on 28th November, 2018
- Coordinated a workshop on network project partners on "Valuation of ecosystem services from natural resource conservation and management interventions in different agro-ecological regions in India at Research Centre, Vasad during 12-13th Dec. 2018
- Attended 13th International Conference on "Development of Dryland: Converting dry land areas from grey into green at CAZRI, Jodhpur during 11-14th Feb. 2019
- Attended one-week national programme on "Enhancing accountability and responsiveness in scientific organizations" sponsored by DST during 11-15th March, 2019

Dr. V.C. Pande

- Attended the conference on "Farmers first for conserving soil and water resource in Eastern region (FFCSWR-2019) at ICAR-IISWC, RC, Koraput during 6-8th Feb. 2019

Dr(s). V.C. Pande and D.Dinesh

- Coordinated the field visit of farmers of Dept. of Agri., Thiruthuraipoondi Block, Thiruvarur Dist. Tamilnadu from 11-12th June, 2018
- Coordinated the field visit cum delivered lecture to Extension Education Institute, AAU Anand students on 19th June, 2019

- Coordinated the exposure visit of certificate course in Development Management (CCDM) students of Aga Khan Rural Support Programme, Netrang (Gujarat)
- Coordinated the field visit of 7th semester of B.Sc. (Hons.) Agri. students from College of Agri. Vaso Campus of AAU, Anand
- Attended 83rd Annual Convention of ISSS & National Seminar on "Development in Soil Science-2018" at AAU, Anand during 27-30 November, 2018
- Attended the special National Symposium "Challenges and Opportunities in Rainfed Agriculture under changing climate scenario" and presented a paper "Economic Analysis of Climate Resilient Rainfed Agriculture Technologies" at Anand, Gujarat during 83rd Annual Convention of Indian Society of Soil Science on 28th November, 2018
- Attended the training programme on Analysis of experimental data using R" at ICAR-NAARM, Hyderabad during 21-26th Feb. 2019
- Coordinated 3 days short course training programme of ATMA farmers of Tamil Nadu (Karnataka) on "Soil and water conservation measures for sustainable farm productivity" at this Centre during 6-8 March, 2019
- Attended 28th Scientific Advisory Committee meeting at KVK, Devataj on 11th March, 2019

Dr. D. Dinesh

- Attended 8th Indian Horticulture Congress (IHC) 2018 at Raipur (Chhattisgadh)
- Participated in ICAR North Zone Sports Meet held at ICAR-CIRB, Hissar (Haryana)
- Coordinated the field visit of students of 7th semester of B.Sc. (Agri.), BA College of Agriculture, AAU, Anand during 4-5th Jan. 2019
- Attended 8th Indian Horticulture Congress (IHC) at Raipur (Chhattisgarh) during 17-19th Jan. 2019
- Coordinated the field visit of students of College of Horticulture, JAU, Junagadh on 16th March, 2019

Dr. V.D. Kakade

- Attended 27th National Conference on Sustainable management of soil and water resources for doubling farmers income at Assam Agricultural university, Jorhat during 25-27.10.2018
- Participated in Workshop of network project partners on "Valuation of ecosystem services from natural resource conservation and management interventions in different agro-ecological regions of India" at ICAR-Indian Institute of Soil and Water Conservation, Research Centre-Vasad, Anand, Gujarat from 12-13 December 2018.
- Participated in the trade show exhibition held under the Vibrant Gujarat Global Trade Show at Gandhinagar, Gujarat during 18-22nd Jan. 2019

Dr. Gaurav Singh

- Attended three months Foundation Course for Agricultural Research Services (FOCARS) at National Academy of Agricultural Research Management (NAARM), Hyderabad from 2nd July to 29 September, 2018.
- Attended one month orientation programme at ICAR- Indian Institute of Soil and Water Conservation, Dehradun from 9th October to 8th November, 2018.
- Attended three months Professional attachment training (PAT) at ICAR- Indian Agricultural Statistics Research Institute, New Delhi from 12th November, 2018 to 11th February, 2019.

Dr. Dinesh Jinger

11 INFRASTRUCTURAL DEVELOPMENT

Dehra Dun:

Following infrastructural development works were initiated at Institute Head Quarter Dehradun during 2018-19

- G.I. sheet over the roof terrace of new and old hostel, IGH and middle open portion between the hostels.
- Passenger lift in office building.

Ballary

Procured under Sujala-3 M&E Project:

- Sony DSC-WX 350 Digital Still Camera (01 nos) at the cost of Rs.20,990/-
- HP Laser Jet Printer M1136 MFP printer (03 nos) at the cost of Rs.36,000/-
- APC Back UPS 1.1 KVA Bx-1100C-in (03 nos) at the cost of Rs.18,600/-
- Lenovo CPU 15-7500/4 (03 nos) at the cost of Rs.1,24,500/-
- LED Lenovo 21.5" Monitor (03 nos) at the cost of Rs.77,998/-
- Key board + Mouse (03 nos) at the cost of Rs.27,090/-
- OG Heavy duty 2 TON 3 star split OG-243 SA (02 nos) at the cost of Rs.3,15,000/-
- PH /EC meter with multi parameter sensor (01 nos) at the cost of Rs.22,000/-
- UV Visible Spectrophotometer (01 nos) at the cost of Rs.24,600/-
- Executive table 5 × 2.5(01 nos) at the cost of Rs.22,800/-
- Leoma revolving chair(01 nos) at the cost of Rs.58,200/-
- Stylo computer table(02 nos) at the cost of Rs.44,700/-
- Star chair(02 nos) at the cost of Rs.1,60,306/-
- Bravo mid back revolving chair (06 nos) at the cost of Rs.44,700/-

Procured under Institute Budget

- Drip Irrigation (01nos) at the cost of Rs.1,60,306/-

Chandigarh

- Computer with printer and scanner (1 nos) at the cost of Rs. 48020/-

Vasad

- Procured HB Chair (1 no.) and MB office Chair (6 nos.) at the cost of Rs. 49990/-
- Procured D link Rank 6 II at a cost of Rs. 5998/-
- Procured Digital hand held pocket refractometer at a cost of Rs. 32499/-
- Procured systronics conductivity & TDS 308 at a cost of Rs. 26000/-
- Procured Spectrophotometer at a cost of Rs. 119800/-
- Procured Iron box at a cost of Rs. 2500/-
- Procured Rectangular water bath thermostatic double wall M.S. outer digi at a cost of Rs. 20479/-
- Procured Single bed (8 nos.) and one double bed for hostel at a cost of Rs. 42800/-
- Procured Wireless microphone at a cost of Rs. 4809/-

12 WORKSHOP/SUMMER SCHOOL/ FARMER'S DAY ETC.

Dehra Dun:

- Four Month's Certificate Course on Soil &Water Conservation and Watershed Management (118th Batch) was successfully conducted at during April 22, to August 21, 2018.
- Hindi workshop was organised on 18 July, 2018.
- Hindi week was observed during 14-19 September, 2018.
- Parthenium Awareness Week was observed during 16 -22 August, 2018.
- Observed Himalayan Day on September 08, 2018 under 'Save Himalaya' campaign.
- Celebrated "4th International Yoga Day" on June 21, 2018.
- World Soil Day was observed on December 5, 2018.
- A Wide range of events; Training-cum demonstration; exposure visits etc were organised under Mera Gaon Mera Gaurav(MGMG).
- National Agricultural Education Day was celebrated on December 03, 2018.
- Vigilance Awareness Week was observed during 30 October to 04 November 2018.
- Wide range of activities were planned and accomplished under Swacch Bharat Abhiyan.
- Four Month's Certificate Course on Soil and Water Conservation and Watershed Management (119th Batch) was successfully conducted during 08 October, 2018 to 07 February, 2019).
- Five day training progamme for administrative staff members (up to AAO Level) from institute Head Quarters and its regional Research Centres was organised during 18-22 December 2018.
- Participated in plantation drive to rejuvenate the river Rispana under Mission Rispana on May 19, 2018.
- Conducted National Project Management Committee Meeting on Farmers FIRST Programme on 28-29 May, 2018.
- Conducted training programme under *Pandit Deendayal Upadhyaya Unnat Krishi Shiksha Yojana* from 28May to 01June, 2018.
- Organised Summer Training Programme for M.Sc. Soil Science (Soil and Water Conservation) students from BHU, Varanasi during 15-28 June, 2018.
- Organised training programme on 'Watershed Concept, Planning and Management' in collaboration with MANAGE, Hyderabad during 18-27 June, 2018.
- Conducted short training course during sponsored by Agriculture Department, Uttarakhand during 19-20July, 2018.
- Organised training on '*Mrida Evam Jal Sanrakshan Hetu Upyogi Padatiyaan*' sponsored by Forest Department, Jaunpur Range, Mussoorie during 23-25July, 2018.

- Organised Training programme on 'Integrated Watershed Management' in collaboration with MANAGE, Hyderabad during 10-19September, 2018.
- Conducted seminar on nanotechnology on 20September, 2018.

Agra:

- Conducted one month student trainings for 04 students in the month of June, 2018 for B. Tech. (Agril. Engg.) Students from college of Agril. Engg. and Post harvest Technology, Ranipool, Gangtok during 1-30 June 2018
- Hindi karysala was organised on 30June, 2018 . Smt Ruchi chaturvedi Lecturer Agra College Agra and Sanjay Pachori DRDO Agra chaired the meeting.
- Conducted one month student trainings for 04 students in the month of July, 2018 for B. Tech. College of Agril. Engg. & Technology, OUAT, Bhubaneswar during 1-31July 2018
- Organised a Kharif Kishan Gosthi at at Bilpura village, Fatehabad, Agra selected under "Mera Gaon Mera Gaurav" Scheme on 02July , 2018.
- Organised a Kharif Kisan Gosthi at Garapur village, Etmadpur selected under MGMG Scheme on 03July, 2018.
- Centre exhibited its stall in Farmers Fair on 12 July, 2018 at CIRG, Makhdoom, Farah, Mathura.
- Hindi Diwas was organised on 13 September, 2018 in the conference hall.
- Hindi karysala was organized on 29 September, 2018 in the conference hall Sh Sailendra Vashith Ex-Rajbhasha Adhikari PNB and Sanjay Pachori DRDO Agra explained importance of using Hindi in offices.
- Centre exhibited its stall in farmers fair on 07October, 2018 at Deen dayal Dham, Farah, Mathura.
- Hindi kavya path was organised on 10th October 2018 in conference hall of the centre. Sh Sailendra Vashith, Smt Rekha Sharma, Sh Raj Bahadur Singh Raj, Dr. Shesh Pal Singh, Smt Yasodhra Yadav, Sh Kshetra Pal Singh and Dr.R.S.Tiwari gave their presentations.
- Hindi karysala was organized on 22 November, 2018 in the conference hall Dr.R.S.Tiwari Secretery NARKAS Agra and Sanjay Pachori DRDO Chaired the meeting.
- Kisan Diwas was organised at village Brahmpur block Etmadpur Agra on 23 Dec. 2018.
- Centre exhibited its stall in Krishi kumbh 2019 to demonstrate the centre's developed technologies during February 09- 11, 2018 at Motihari, Bihar.
- Organised training on planning and designing SWC structures in a watershed for 50 District development Managers, NABARD, Regional Office, Lucknow Uttar Pradesh on 21.February,2019.

Ballary:

- Interactive workshop on "Developing framework to evaluate LRI based watershed development programmes" was organised on 12 June, 2018.
- Celebrated "4th International Yoga Day" on 21June, 2018.
- Hindi Divas celebrated at Research Centre, Ballari on 14 September 2018
- Organised Vigilance Awareness Week" celebrated at Research Centre Ballari during 29October, 2018 to 03November, 2018.
- "Rashtriya Ekta Diwas" was celebrated on 31 Otober,2018

- Organised "World Soil Day" at Hanumapura village of Chitradurga district on 05December, 2018.

Chandigarh:

- Participated in Agro- Tech 2018, with the theme of "Technology in Agriculture: Increasing Farmers Income" organised by Confederation of Indian Industries (CII) during 01-04December, 2018 at Chandigarh.
- Imparted practical training in Soil and Water Conservation has been to twenty B.Tech students of Agricultural Engineering from four different colleges/Universities during 01-30June ,2018.
- Celebrated International Yoga day on 21June, 2018.
- Communal Harmony week was organized during 19 – 25 November, 2018.
- Conducted scientist- farmer's interaction meet on 15 February, 2019, under NIMSHE Project.

Datia:

- Celebrated International Yoga day 21June, 2018.
- Celebrated World Soil Day on 05December 2018.
- Organised summer practical training for B. Tech (Agril. Engg) students during 01-30June 2018 .

Koraput:

- In collaboration with Indian Association of Soil and Water Conservationists, DehraDun, organised National Conference of Farmers First for Conserving Soil and Water Resources in Eastern Region (FFCSWR – 2019) during 6-8 February, 2019.
- Conducted Two day Stakeholders' workshop on "Climate Change Impact and Mitigation Measures" during 27-28 November 2018.
- Conducted "Vigilance Awareness Week" on 30 October, 2018.
- Observed Vigilance Awareness Week on 02November, 2018.
- Conducted Interface Meeting with Tribal Farmers for Transfer of Technology
- Conducted One day training programme on "Hot water treatment of mango to improve the post harvest quality and shelf-life" in collaboration with Deputy Director Horticulture, Koraput on 15June, 2018.
- Organised a number of one day training programmes under Aspirational District Programme on "techniques of nursery raising of papaya/good agricultural practices/ managing kitchen garden etc.

Kota

- Celebrated International Yoga day 21June2018
- Observed Farmers Day on 30 August,2018.
- Observed Hindi Day on14September,2018
- Agricultural education day on 03December2018
- Conducted In plant training of four month duration, from 06June to 06October, 2018, to five students of

Acharya N.G. Ranga Agricultural University, College of Agricultural Engineering Baptala, Guntur district of A.P.

- Conducted summer practical training for B.E. (Agril.) students in two batches during 01-30June 2018 and 01 -30 July, 2018.

Udhagamandalam:

- 28th National Conference of SCSI on Farmers' Friendly Soil and Water Conservation Technologies for Mitigating Climate Change Impact was organised in association with Tamil Nadu State Chapter of SCSI from 31January to 02 February 2019
- Celebrated World Environment Day on 05 June 2018
- International yoga day was celebrated on 21June, 2018.
- Conduted Capacity building programme on Participatory Integrated Watershed Management for Nadi Veeras of Rally for Rivers -Isha Foundation during 09-20 July,2018 .
- Conducted model training course on "Advanced engineering training for management of natural resources in watershed" during 27November to 04 December 2018.
- World Soil Day on 5 December,2018.
- Hindi Quarterly meeting of TOLIC was conducted on 26June,2018.
- Hindi workshop on *Sansadhya Samithi Prashnavali* was organised on 27June, 2018.
- Hindi workshop on *Rajbhasha Sambandhith* was organised on 30August, 2018.
- Conducted Hindi Quarterly meeting of TOLIC on 24 September 2018.
- Hindi Chetna Mas was celebrated during 14 September to 13 October2018.
- Quarterly meeting of Official Language Implementation Committee was conducted on 24September, 2018.

Vasad:

- The 64th Foundation Day was celebrated on 11May, 2018.
- International Yoga Day Celebrated on 21 June, 2018
- Conducted exposure visit for–DAESI programme on August 31, 2018
- Hindi Pakhwada celebration during 14-28 September 2018
- Vigilance Awareness Week Celebration during 29 October to 02 November, 2018
- Agricultural Education Day on 03December, 2018
- Organised World Soil Day on 05December, 2018
- Conducted Farmers' Training programme on "Soil and Water Conservation Practices in Degraded Lands" during 13-15 September,2018.
- Conducted Training programme for administrative staff during 07-10January 2019

13 DISTINGUISHED VISITORS

Dehra Dun:

Bikram Mahendra, Tribhuvan University, Institute of Forestry, Nepal; Pratik Ojha, IOF Heataudy, Tribhuvan University, Nepal; Dr. N.L. Panwar & Dr. S.S. Vyas, Maharana Pratap University of Agri. & Tech. Udaipur (Rajasthan); Er. S.B. Verma (Principal), Muradabad Polytechnic Institute, Muradabad (U.P.); Suresh Chandel, G.B. Member ICAR, Ex. M.P.; Dr. Shikha Thakur, Rani Lakshmi Bai Central Agricultural University, Jhansi (U.P.); Dr. Chandra Shekhar Kumar, HOD, C.H.S. Mahavidyalaya, Bhuta, Brelley (U.P.); Chander Shekhar (HPFS), Deputy Director, FTI&RC, Mandi (H.P. ; Dr. R.P. Manjhi, Associate Prof. cum Jr. Scientist, BAU, Ranchi, Jharkhand ; Mrs. Rajni Kiran Labra, Jr. Scientist Cum Asstt. Prof. BAU, Ranchi, Jharkhand; B.C. Runya, Asstt. Prof. JKK Munirajah College of Agri. Science, Erode, Tamil Nadu; S. Rajesh, Block Technical Manager, Deptt. of Agriculture, Virudhurayao, Tamil Nadu; Dr. B. Renuka Rani, MANAGE, Hyderabad;Malik Fasil M. HOD, Deptt. of Forestry, Sir Syed College, Kannur University, Kerala; Dr. Aananali Laljat, CAFT (Agro) GBPUAT Pantnagar;Ambrish Sharma, Dy. Director FTI&RC, Sunder Nagar, H.P.; Dr. Jayashree G.C., GKVK, UAS-Bengalure; Dr. A. Kamaraj, AC&RI, TNAU, Thanjavur; Dr. R.D. Saklani, Asstt. Prof. Deptt. of Geology, BFIT Group of Institute, Suddhowala, Premnagar, D.Dun, Uttarakhand; Gopal Singh Chauhan SMS (Hort.) O/o Dy. Director Horticulture, Una Distt. Una (H.P.); Dr. Jayaprakash SBACXRI, TNAU, Kaiaikudi, Tamil Nadu;Project Officer/Joint Director of Agriculture, Distt. Watershed Development Agency, Tiruchirappalli, Tamil Nadu; Dr. R.C. Bali & Mr. Indra Singh & Prinyka Daprla, UUFH, College of Forestry, Hill Campus, Tehri Garhwal, Uttarakhand; Dr. Chavlesh Kumar ICAR-IARI, New Delhi; Dr. V. Vengadesan, PAJANWCOA, RIT, Karnataka; Dr. Pramanand B. Dashavant, Asstt. Prof. Deptt. of SWCE, College of Agril. Enggineering, Raichur, Karnataka; Dr. A. Krishna & Mr. D.S.Y. Gowola, College of Fenesty Sirsi, KN, UAS, DWD;Dr. V. Vijay Lakshmi, Asstt. Prof. (SS&T), Pandukkottai, TNAU; Dr. J.K. Kalappananar, Prof. UAS, Dharwad; Dr. M. Nirmala Devi, Associate Prof. (Agril. Extension) TNAU, AC&Ri, Vazhavachanur, Thiruvannamalai District; Dr. S. Radhakrishnan, Associate Prof. (Forestry) Forest College, Research Institute, TNAU, Mettupalayam; Dr. S. Ramesh Kumar, Asstt. Prof. (Horticulutre) Kumaraguru Institute of Agriculture, Tamil Nadu; Dr. R. Parimala Rangan, Asstt. Prof., ADACWRI, TGrichy, TNAU, Tamil Nadu; Dr. G.R. Garg, BFIT, D. Dun; Dr. Navneet Kumar Sood, SMS, HPCDP JICA ODA, DPMU Palampur; Dr. Prem Prakash, Asstt. Prof. COH&F, Dr. Y.S. Parmar, UFH, New Hamipur H.P.; Rabiya Basri, D/o Plant Protection, Aligarh Muslim University, Aligarh (U.P.); Dr. Rajeev Bhatia & Dr. Ramesh Janagal A.D.O. Behlapur & ADO, Agroha (Hisar) Haryana; Anil Chaudhary, HPFS, Dy. Director, FTI, Chail; Dr. Shraddha Rawat & Dr. Sameer Daniel, Allahabad; Dr. V.C. Dhyani & Dr. Sumit Chaturvedi, Assoc. Prof. GBPUA&T, Pantnagar; Dr. A.M. Varade, Geology, RTM, NV, Nagpur; M.K. Joshi, IFS, Retd. CASFOS, DehraDun; Dr. J.P. Sharma, Asstt. Prof. UFH, Nauni Solan, H.P.; Principal, Kashmir Forest Training Institute J&K (Bandipura); Dr. Rajiv Verma & Dr. Hemant Kumar, College of Forestry, Prayagraj (U.P.); Dr. Aruna Mehta, Scientist, UHF, Nauni, Solan, H.P.; Dr. Panch Ram Mirjha, Asstt. Prof. (Agronomy) DKSCARS, Bhatapara & Smt. Swati Thakur Mirjha, Subject Matter Specialist (Agronomy) Bastar, Chhattisgarh;Krishan Chand, Scientist (Agroforestry) Deptt. of SAF, College of Forestry, Dr. Y.S. Parmar, UHF, Nauni, Solan, H.P.; Dr. Reetika Sharma, HRA, Y.S. Parmar, UHF, Nauni, Solan, H.P.Prof.; D.D. Chauniyal, Garhwal University, Srinagar, Garhwal, Uttarakhand.

Agra:

Dr. S. Bhaskar, ADG (AAPCC) ,ICAR-NRM Division, New Delhi; Dr. A.S.Panwar, Director, ICAR-IIFSR, Modipuram, Meerut(U.P.); Dr. N.Ravisankar, Principal scientist,PF(CU) ICAR-IIFSR,Modipuram, Meerut(U.P.)

Ballary:

Teachers and Students from Basavarajeshwari Public School, Ballari; K Rajesh and R Dhamodharan ATMA staff Tamilnadu; students from Samsruthi School Rupangudi Road
Bellary; students from Basavarajeshwari Public School, Ballari

Chandigarh:

Sh. Suresh Chandel, Member General Body ICAR; Dr. Trilochan Mohapatra, DG, ICAR-New Delhi;

Dr. K. Alagusundram, DDG (NRM), ICAR- New Delhi;Dr.P.R.Ojaswi, Director, IISWC, DehraDun;

Dr. ManmohanJeet Singh, Director, Regional Research Station, Ballowal Saunkhari, Punjab; Dr. H. C. Verma, Head Natural Resource Division, PRSC-Ludhiana;Ms.Seema Chopra, Director, Rajbhasha, ICAR, New Delhi;Sh.Chhabilendra Roul, Secretary, ICAR, New Delhi.

Datia:

Dr. Anil Kumar,Director (A), ICAR-CAFRI, Jhansi;Dr. Pratap Narayan,Chairman, QRT ;Dr. M.V. Ranghswami,Member, QRT;Dr. Basudev Behera,Member, QRT;Dr. G. Maruthi Sankar,Member, QRT;Dr. H. Mehta,Member Secretary, QRT;Dr AK Parandiyal,Pr. Scientist, ICAR-IISWC RC, Agra;Sh Sunil Kumar Pathak,Haritima, Jhansi;Sh Arvind Kumar,Haritima, Jhansi;Dr. Sudhir Kumar, Pr. Scientist, ICAR-CAFRI, Jhansi;Dr. Veeresh Kumar,Scientist, ICAR-CAFRI, Jhansi;Shri SK Gajmoti,CAO, ICAR-IISWC, DehraDun;Dr. J.K. Babele,Asstt. Professor, BU, Jhansi;Dr. Santosh Pandey,Asstt. Professor, BU, Jhansi;Dr. Raghvendra Singh,HOD, ICAR-CSWRI, Avikanagar;Dr.AK Bharati,Asstt. Professor, BU, Jhansi;Dr. Harpal Singh,Asstt. Professor, BU, Jhansi;Dr. Shyama Praveen,Asstt. Professor, BU, Jhansi;Mr. Lal Chand,Scientist, ICAR-CAFRI, Jhansi;Dr. Dhiraj Kumar,Scientist, ICAR-CAFRI, Jhansi; Dr. Magan Singh,Sr. Scientist, ICAR-NDRI, Karnal;Dr. Sanjeev Kumar, Scientist, ICAR-NDRI, Karnal ; Dr. Ajita Gupta,Scientist, ICAR-IGFRI, Jhansi;Dr. H.M. Halli,Scientist, ICAR-IGFRI, Jhansi; Dr. S.P. Singh, Principal, Govt. High School, Nunwaha, Datia.

Koraput:

Dr Mukti Sadan Basu, Chief Executive Officer (Agri-Business), New Delhi;Sh. G. Simhachalam, Manager, INAS, Naval Armant Department;Sh. Ananta Narayan Meher, Principal, KVNAD, Sunabeda ;Sh. Pradeep Kumar Mishra, Programme Manager, Foundation for Ecological Security (FES), Koraput;Sh. Dashasana Mahanta , Programme officer, , Foundation for Ecological Security (FES), Koraput;Sh. Raghunath Satapathy, Kotpad College;G. Venkata Reddy, Soil Chemiest, Semiliguda;Sh. J.N. Padhy, Assistant Director, DAC & FW, GOI, Krishi Bhawan, New Delhi;Sh. Gunakar Nayak, At. Govindpur, Dist. Dhenkanal;Sh. Rakesh Kumar Sahu, At. NALCO Nagar, Dist. Angul (Odisha); Sh. Sambit Sourash Nayak, Koraput; Sh. Sambit Nayak, Project Manager, NALCO Foundation; Sh. Gurraj Singh Drillon, Surjit Farms Chabhal, Amritsar, Punjab, Punjab Agricultural University; Sh. M.K. Pani, Additional Secretary, Department of Agriculture & Farming Empowerment, Govt. of Odisha;Sh. Pranab R Choudhary, Ex, Scientist of the Centre;Shibani Deni, Members of F.C. I., Ministry of Consumer Affairs, Food and Public Distribution, Govt. of India;.

Kota:

Dr. Pratap Narayan, Ex-VC, SKRAU, Bikaner ; Dr. M.V. Ranghaswami, Ex-Dean, College of Agricultural Engineering, Sathmagalan ; Dr. G. Maruthi Shankar, Ex-Principal Scientist, CRIDA, Hyderabad;Dr. S.S.P. Kushwaha, Ex-Prof and Head, IIRS, DehraDun ; Dr. Basudev Behra, Prof & Head (Agronomy), OUAT, Bhubneswar;Dr. Harsh Mehta, Principal Scientist, IISWC, DehraDun; Dr. V.K. Singh, Associate Prof., J.N.K.V.V., COA, Tikamgarh (MP); Dr. Keshav Gautam, Scientist, ICAR-IIVR, Jakahinl, Varanasi;Dr. Mushtaq Ahmad, Director Extension, SKUAST- Kashmir, Shalimar, Srinagar;Prof. M. Feza Ahmad, Prof., BAU, Sabour, Bhagalpur;Dr. Raj Kumar, SMS (Hort.), ICAR-KVK-Panchmahal, Godhra, Gujarat;Sh. Keshav Kant Gautam, Scientist, ICAR-IIVR, Varanasi;Dr. Y.K. Shukla, Scientist, KVK, B.M. collage of Agri, Khandwa (MP);Dr. P. V.r Singh, Scientist (Agro), KVK, Farrukhabad, C.S.A University of Agri. & Tech., Kanpur;Dr. Mahender Singh, Prin. Sci. (Biotech.), ICAR- NBFGR, Lucknow;Dr. Vijay Singh Beniwal, Prof. (Horti), CCS, HAU, Hisar, Hariyana;Dr. Anchal Sharma, Asst. Prof., Collage of Agri. And Forestry, Jhalawar;Dr. R.P. Dwivedi, Prin. Scientist (Agri. Exte.), ICAR-CAFRI, Jhansi (UP);Dr. K.D. Singh, Rtrd., ICAR-IISWC, Kota;Prof. Raghvendar Singh, Prof. (Head), ICAR-CSWRI, Avikanagar, Tonk, (Raj);Dr. R.S. Singh, Prin. Scientist (Horti), ICAR-CIAH, Bikaner (Raj);Dr. Raghvendra Singh, Head & Pr. Sci ICAR-CSWRI, Tonk, Rajasthan; Dr. M.P.Brahmane, Pr. Scientist, ICAR-NIASM,Baramati,Pune;Dr. R.

S. Meena,Sr. Scientist, ICAR-NRCSS, Ajmer; Dr.R.P.Ghasolia, Associate Professor, SKNCOA, Jobner, Jaipur; Dr. A.D.Munshi, Pr. Scientist, ICAR-IARI, New Delhi; Dr.Mushtaq Ahmad, Director & Pr. Sci., SKUAST, Srinagar, J & K; Dr.Bhagirath Ram, Pr. Scientist, ICAR-DRMR, Bharatpur, Dr. Narendra Kr. Lohani, Dy. Director SSC, Patna, Bihar; Dr. P.R. Bhatnagar, Head & Pr. Scientist, ICAR-IISWC, RC, Vasad, Gujrat;Dr.Sunita Yadav, Scientist, ICAR-IARI, New Delhi; Dr. Uthappa A R, Scientist , ICAR- CAFRI, Jhansi, U.P;

Vasad:

Dr. Pratap Narain, Dr. M.V. Ranghaswami, Dr. SPS Kushwaha, Dr. GR Maruthi Shanker and Dr. Harsh Mehta (QRT Team); Sh. Uttam Singh Jadav, Bhopal and Sh. Reddy K., Dantiwada; Sh. M. Aral, Asstt. Technology Manager (ATMA), Tamilnadu;Dr. C.P. Desai, Dr. A.R. Macwan, Dr. R.B. Chauhan, AAU, Anand;Dr. I. Prasanth, Block Technology Manager, Udhagamandalam; Dr. G.R. Patel, Associate Professor, College of Agricutlure, AAU, Vaso; Sh. M.J. Malek, DEE, WALMI, Anand; A. Krishnamoorthy, ATMA, Dharmappuri Dist.; Dr. P.C. Sharma, Director, ICAR-CSSRI, Karnal; Sh. S.K. Chaudhari, ADG(SWM), ICAR, New Delhi; Dr. V. Thondaiman, Scientist (Hort.), ICAR, DMAPR, Anand; Dr. J.S. Samra, Ex.DDG (NRM), Chandigarh; Dr. Subhash Chandra, Ex. OIC, Florida, USA; Dr. V.K. Sood, Associate Res. Scientist, SWC, BACA, AAU, Anand; Dr. S. Roy, Director (Actg.), ICAR-DMAPR, Anand; K. Kalaikkovan, Thethakudi, Nagappattinam; Prof. H.N. Patel, JAU, Junagadh

14 PERSONNEL

(Promotion, Appointment, Transfer, Retirement etc.)

Dehra Dun

Appointments/Joining:

- Sh. S K. Gajmoti, Chief Administrative Officer joined on 21.6.2018.
- Dr. Sadiqul Islam, Scientist joined on 26.7.2018.
- Sh. E Saraswat Kar, Scientist joined on 09.10.2018.
- Sh. Pawan Kumar, Scientist joined on 09.10.2018.
- Ms. N H Pamei, Technical Assistant (T-3) joined on26.12.2018.
- Ms. Shalini Sharma, Technical Assistant (T-3) joined on28.12.2018.
- Mr. Devender Singh Bhandari, Lower Division Clerk Joined on29.12.2018.
- Sh. Shashank Kandwal, Technical Assistant (T-3) joined on31.12.2018.
- Mr. Mukul Singh, Lower Division Clerk Joined on 31.12.2018.
- Mr. Asheesh Chauhan, Lower Division Clerk Joined on 01.1.2019.
- Ms. Ekta Rawat, Lower Division Clerk Joined on 02.1.2019.
- Sh. P. K. Singh, Sr. F.A.O. Joined on transfer from CTRI, Rajahmundry on 28.1.2019.
- Dr. Devideen Yadav, Scientist joined on 14.02.2019.
- Ms. Ankita Kishore, Technical Assistant (T-3) joined on15.2.2019.
- Sh. Ravi Shankar, Technician (T-1) Joined on 18.2.2019.
- Sh. Amit Kumar, Technician (T-1) Joined on 19.2.2019.
- Sh. Sonu, Technician (T-1) Joined on 05.3.2019.
- Sh. Chandan Roy, Technical Assistant (T-3) joined on 07.3.2019.
- Sh. Dharmpal, Technician (T-1) Joined on 11.3.2019.
- Ms. Santoshi Rawat, Technician (T-1) Joined on 13.3.2019.
- Ms. Varsha Mittal, Technician (T-1) Joined on 19.3.2019.
- Ms. T. B. Chanu, Technical Assistant (T-3) joined on19.3.2019.
- Sh. Ravish Kumar, Technical Assistant (T-3) joined on 20.3.2019.

Promotion:

- Mr. R. K. Arya promoted to Asstt. Chief Tech.Officer w.e.f.01.1.2010.
- Dr. M. Murganandan promoted to Principal Scientist w.e.f.28.7.2015.
- Sh. V.K. Dwivedi (Retired), promoted to Chief Tech. Officer w.e.f. 01.1.2017.
- Dr. Gambhir Singh promoted to Chief Tech. Officer w.e.f. 03.2.2017.
- Sh. Pramod Kumar promoted to Sr.Tech.Assistant w.e.f.07.8.2017.
- Sh. Subhash Kumar promoted to Sr.Tech.Assistant w.e.f.11.8.2017.
- Sh. B.C. Bisht, promoted to Sr.Tech.Assistant w.e.f.14.8.2017.
- Sh. Hukum Singh promoted to Tech. Officer w.e.f. 02.9.2017.
- Ms. Seema Khanna promoted to Asstt. Chief Tech.Officer w.e.f.23.8.2018.

Transfer:

- Dr. N.M. Alam, Scientist, transferred to CRIJAF, Kolkata w.e.f. 05.7.2018.
- Ms. Chyna Jana, Scientist, transferred to CRISAF, Kolkata w.e.f. 05.7.2018.
- Sh. R. K. Singh, Sr. F.A.O. transferred to NDRI, Karnal w.e.f.02.2.2019.

Retirement:

- Manmohan Singh, SSS, retired on superannuation on 31.5.2018.
- Dr. P.K. Mishra, Director, retired on superannuation on 30.6.2018.
- Sh. Jahid Hasan, SSS, retired on superannuation on 30.6.2018.

- Sh. Sriram, SSS, retired on superannuation on 30.6.2018.
- Sh. Chait Singh, Sr. Technician, retired on superannuation on 31.7.2018.
- Sh. Ram Lal Sharma, SSS, retired on superannuation on 31.10.2018.
- Sh. Om Prakash, SSS, retired on superannuation on 30.11.2018.
- Sh. Amar Singh, SSS, retired on superannuation on 30.11.2018.
- Sh. V.K. Dwivedi, Chief Tech. Officer, retired on superannuation on 31.12.2018.
- Sh. U.V.S. Chauhan, Asstt. Chief Tech.Officer, retired on superannuation on 31.3.2019.
- Sh. Sunil Kumar, UDC, retired on superannuation on 31.3.2019.
- Sh. Tilak Ram, Sr.Tech.Assistant, retired on superannuation on 31.3.2019.

Agra

Promotion:
- Sh. Munna Lal got III MACP (Level-4) w.e.f. 25.2.2017.
- Sh. William got III MACP (Level-4) w.e.f. 08.5.2017

Retirement:
- Sh. Prem Pal, SSS, retired on superannuation on 30.6.2018.
- Sh. Ram Prasad, SSS, retired on superannuation on 30.6.2018.
- Smt. Premvati, SSS, retired on superannuation on 30.6.2018.

Ballary

Appointments/Joining:
- Dr. Mahantesh Shirur, Scientist joined on 9.7.2018.
- Dr. K.N.Ravi , Scientist joined on 20.2.2019.
- Sh. Rajpal, Technician (T-1) joined on 25.2.2019.
- Sh Abhishek Kumar Singh, Technician (T-1) Joined on 25.2.2019.
- Sh. Gourav Bhati, Technician (T-1) Joined on 28.3.2019.

Promotion:
- Smt. M. Prabhavathi, Scientist promoted to Level-11 w.e.f. 21.4.2014.
- Dr. B.S. Naik promoted to Senior Scientist (Level-13) w.e.f.09.4.2016.
- Sh. Suresh Kumar, Scientist promoted to Level-11 w.e.f. 15.9.2016.

Retirement:
- Smt. M. Sivajaya Lakshmi, Assistant, retired on superannuation on 31.7.18.
- Sh. W. Muralidhar, Sr.Tech. Officer, retired on superannuation on 30.11.2018.
- Smt. Shaiken Bi, SSS, retired on superannuation on 31.1.2019.

Transfer:
- Dr. Mahantesh Shirur, Scientist relieved on 21.8.2018 to join the post of Dy. Director (Agril.Extn)

Obituaries:
- Sh. G. Nagraj, SSS, expired on 24.8.2018.

Chandigarh

Appointments/Joining:
- Dr. Nyonand, Chief Technical Officer joined on transfer from R C, Vasad, on 17.10.2018.
- Sh. Mudit Mishra, Technical Assistant (T-3) joined on 01.2.2019.

Retirement:

- Sh. Tarsem Singh, SSS, retired on superannuation on 31.5.2018.
- Sh. Sona, SSS, retired on superannuation on 31.7.2018.
- Sh. Krishna Kumar, Assistant, retired on 01.9.2018 (VRS).
- Dr. Pawan Sharma, Pr. Scientist, retired on superannuation on 31.12.2018.
- Sh. Munna Lal, SSS, retired on superannuation on 31.12.2018.
- Sh. Dalbeer Singh, UDC, retired on 28.2.2019 (VRS).

Datia

Appointments/Joining:

- Sh. Gautam Singh, Technical Assistant (T-3) joined on 01.2.2019.
- Sh. Anil Kumar Dohare, Technical Assistant (T-3) Joined on 05.2.2019.
- Dr. Dinesh Kumar, Scientist Joined on 15.2.2019.

Promotion:

- Mr. Rati Ram got II MACP w.e.f. 22.4.2017.
- Mr. Ram Swaroop got II MACP w.e.f. 24.4.2017.
- Mr. Avadh Saran got III MACP w.e.f. 26.8.2017.
- Mr. Ram Nath Ahirwar got III MACP w.e.f. 27.8.2017.

Retirement:

- Sh. Sant Raj, Chief Tech.Officer, retired on superannuation on 31.8.2018.
- Dr. S.P. Tiwari, Principal Scientist, retired on superannuation on 31.10.2018.
- Sh. Harnam Singh, SSS, retired on superannuation on 31.1.2019.

Koraput

Appointments/Joining:

- Sh. Surendra Kumar, Technical Assistant (T-3) joined on 04.2.2019.
- Sh. Anjeet Kumar, Technician (T-1) Joined on 27.2.2019.
- Sh. Gaurav Kumar, Technician (T-1) Joined on 27.2.2019.
- Sh. Pradeep Kumar, Technician (T-1) Joined on 23.3.2019

.

Kota

Appointments/Joining:

- Ms. Anita Kumawat, Scientist Joined on transfer from IISWC, DehraDun on 13.2. 2019.

Promotion:

- Shri V.K. Jain promoted to Asstt. Chief Tech. Officer, w.e.f. 09.1. 2018.
- Shri Gajanand promoted to Technical Assistant (V/D) w.e.f. 01.1. 2009.

Udhagamandalam

Appointments/Joining:

- Dr. Hombe Gowda, Senior Scientist joined on transfer from RC, Koraput
- Sh. Sangili K, Technician (T-1) Joined on 16.2.2019.
- Sh. Sibin Koshy, Technician (T-1) Joined on 27.2.2019.
- Sh. Amit Kumar, Technician (T-1) Joined on 27.3.2019.

Retirement:

- Sh. J. Thangaraj, SSS, retired on superannuation on 31.1.2019.

Vasad

Appointments/Joining:

- Sh. Dinesh Jinger, Scientist Joined on 14.2.2019.
- Sh. Ankit Sukhwal, Technical Assistant (T-3) Joined on 08.3.2019.
- Sh. Ram Partap, Technical Assistant (T-3) Joined on 18.3.2019.

Promotion:

- Sh. B.D. Chauhan promoted to Technical Assistant w.e.f. 09.11.2016.
- Sh. Anand Kumar promoted to Technical Officer w.e.f. 14.2.2017.
- Sh. D.G. Damor promoted to Sr. Technical Assistant w.e.f. 08.5.2017.
- Sh. B.P. Chauhan, SSS got GP of Rs. 2400/- w.e.f. 29.10.2017.
- Sh. T.M. Sonera, SSS got GP of Rs. 2400/- w.e.f. 16.5.2018.
- Smt. D.S. Macwan, PA got GP of Rs. 4800/- w.e.f. 04.6.2018.

Transfer:

- Sh. O.P. Meena, Scientist, transferred to CAZRI, Jodhpur w.e.f. 03.7.2018.
- Dr. Nyonand, Chief Technical Officer transferred to R C, Chandigarh w.e.f 12.10.2018.

Retirement:

- Sh. Poonam bhai Parmar, SSS, retired on superannuation on 31.5.2018.
- Sh. M.K. Kurneel, Assistant, retired on superannuation on 30.6.2018.

LIST OF STAFF

[As on 31st March, 2019; not a gradation list]

Dr. P.R. Ojasvi, Acting Director

Director Cell
- Sh. Sunil Kumar, PS
- Sh. Narendra Singh, SSS

Division of Soil Science & Agronomy
Scientist
- Dr. N.K. Sharma, Pr. Scientist & Head
- Dr. D.V. Singh, Pr. Scientist
- Dr. D. Mandal, National Fellow
- Dr. U.K. Maurya, Sr. Scientist
- Dr. Gopal Kumar, Sr. Scientist & OIC (Central Lab)
- Dr. M. Shankar, Scientist
- Dr. Raman Jeet Singh, Scientist
- Dr. Devideen Yadav, Scientist

Technical
- Sh. Ashok Kumar, Chief Tech. Officer
- Dr. Gambhir Singh, Chief Tech. Officer
- Sh. J.S. Deshwal, Sr. Tech. Officer
- Mrs. Sarita Gupta, Sr. Tech. Officer
- Sh. Deepak Kaul, Tech. Officer.
- Ms. N.H. Pamei, Technical Assistant (Central Lab)
- Ms. T.B.Chanu, Technical Assistant (TSP)
- Sh. Inder Singh Chauhan, Sr.Technician
- Sh. Ravi Shankar, Technician(T-1)
- Ms. Varsha Mittal, Technician(T-1)

Administration
- Mrs. Mamta Negi, PS

Supporting (SSS)
- Sh. Sita Ram
- Sh. Ram Kishan
- Sh. Telu Ram
- Sh. Sohan Singh Bisht
- Sh. Ajeet Kumar Rana
- Sh. Satish Kumar

Division of Hydrology & Engineering
Scientist
- Dr. P. R. Ojasvi, Pr. Scientist & Head
- Dr. D.R. Sena, Pr. Scientist
- Er. S.S. Srimali, Sr. Scientist & I/c (B&M)
- Dr. M. Murganandan, Pr. Scientist
- Sh. Sridhar Patra, Scientist (on study Leave)
- Sh. Uday Mandal, Scientist
- Sh. Deepak Singh, Scientist(on study leave)
- Dr. Sadiqul Islam, Scientist
- Sh. E. Saraswat Kar, Scientist

Technical
- Sh. S.K. Sharma, Asstt. Chief Tech. Officer
- Sh. Rakesh Kumar, Asstt. Chief Tech. Officer
- Sh. R.K. Arya, Asstt. Chief. Tech. Officer
- Sh. Amit Chauhan, Sr. Tech. Officer
- Sh. H. S. Bhatia, Tech. Officer
- Sh. U.C. Tiwari, Tech. Officer
- Sh. Prakash Singh, Tech. Officer
- Sh. J.D.S. Grewal, Tech. Assistant
- Sh. Chandan Roy, Technical Assistant
- Sh. Amit Kumar, Technician(T-1)

Administration
- Mrs. Lata Bhanwar, P.S.

Supporting (SSS)
- Sh. Data Ram
- Sh. Mukesh Kumar
- Sh. Surendra Kumar

Division of Plant Science
Scientist
- Dr. Harsh Mehta, Pr. Scientist & I/c Head; OIC (PME)
- Dr. Charan Singh, Pr. Scientist
- Dr. J.M.S. Tomar, Pr. Scientist
- Dr. A.C. Rathore, Pr. Scientist
- Dr. Rajesh Kaushal, Pr. Scientist
- Dr.(Mrs.) Vibha Singhal, Sr. Scientist
- Dr J. Jayaprakash, Sr. Scientist
- Sh. A. K. Gupta, Scientist
- Sh. D. M. Rao Kadam, Scientist (on study Leave)
- Sh. Pawan Kumar, Scientist

Technical
- Sh. S. K. Yadav, Sr. Tech. Officer
- Sh. Umesh Kumar, Tech. Officer
- Ms. Shalini Sharma, Technical Assistant
- Sh. Ravish Singh, Technical Assistant

Supporting (SSS)
- Sh. Dhan Singh
- Sh. Tirath Ram
- Sh. Ranbir Singh
- Sh. Naveen Kumar
- Sh. Narendra Kumar
- Sh. Ravinder Singh
- Sh. Rajesh Kumar Joshi
- Sh. Ramesh Kumar

Division of Human Resource Development & Social Science
Scientist
- Dr. Bankey Bihari, Pr. Scientist & I/c Head
- Dr. Ambrish Kumar, Pr. Scientist
- Dr. Lekh Chand, Sr. Scientist & OIC (Res. Farm Selaqui)
- Dr. (Mrs.) Indu Rawat, Scientist
- Dr. (Mrs.) Trisha Roy, Scientist
- Sh. Rajesh Bishnoi, Scientist(on study leave)
- Sh. Madan Singh, Scientist

Technical
- Sh. Suresh Kumar, Asstt. Chief Tech. Officer
- Sh. A.K.Chauhan, Asstt. Chief Tech. Officer
- Sh. K.R. Joshi, Sr. Tech. Officer
- Sh. M.P. Juyal, Tech. Officer
- Sh. Sonu, Technician(T-1)

Administration
- Sh. S.N. Gupta, P.S.

Supporting (SSS)
- Sh. Ramesh Prakash Yadav
- Sh. Gajendra Pal Singh
- Sh. Dinesh Chandra

Project Monitoring and Evaluation Cell

Scientist
- Dr. Pradeep Dogra, Pr. Scientist

Technical
- Dr. (Mrs.) Sangeeta. N. Sharma, Chief Tech. Officer
- Dr. Matish Chandra, Chief Tech. Officer & OIC (Pub. Cell)
- Sh. S.K. Sinha, Asstt. Chief Tech. Officer
- Ms. Ankita Kishore, Technical Assistant

Administration
- Mrs. Meenakshi Pant, PA

Supporting (SSS)
- Sh. P.S. Rawat

Library
- Mrs. Seema Khanna, Asstt. Chief Tech. Officer & OIC (Library)
- Sh. Ajay Joshi, Tech. Officer
- Ms. Santoshi Rawat, Technician(T-1)

Building and Maintenance
Technical
- Sh. S.K. Sharma, Asstt. Chief Tech. Officer
- Sh. C.S. Tiwari, Asstt. Chief Tech. Officer
- Sh. Ishwar Singh, Tech. Officer
- Sh. Ajay Pal Singh, Tech. Assistant
- Sh. Bipin Chand Bisht, Sr.Tech. Assistant
- Shri Pramod Kumar, Sr.Tech. Assistant

Supporting (SSS)
- Sh. Vijay Kumar
- Sh. Mahendra Singh
- Sh. Ramesh Kumar

Administration
- Sh. S K. Gajmoti, Chief Administrative Officer
- Sh. P.K. Singh, Sr. Fin. and Accounts Officer
- Sh. K.P. Sharma, Admn. Officer
- Sh. Gajanand Yadav, Admn. Officer
- Mrs. Kamla Rawat, Asstt. Admn. Officer
- Sh. T.S. Rawat, Asstt. Fin. and Accounts Officer
- Sh. Md. Irfan, Jr. Fin. & Account Officer
- Mrs. Manjula Dobhal, PA
- Sh. Manjeet Singh Rawat, PA
- Mrs. Kamla Bargali, Assistant
- Sh. Lallan Mishra, Assistant
- Sh. Sanjay Kumar Pant, Assistant
- Sh. Alok Khandelwal, Assistant
- Sh. Santosh Kumar, Assistant
- Mrs. Suman Dimri, Assistant
- Sh. Fakir Chand, UDC
- Sh. Satvinder Singh, UDC
- Sh. Manish Negi, Steno.
- Sh. Ajay Khatri, UDC
- Sh. Anar Chand, UDC
- Mrs. Rani, LDC
- Ms. Ekta Rawat, LDC
- Mr. Asheesh Chauhan, LDC
- Mr. Devender Singh Bhandari, LDC
- Mr. Mukul Singh, LDC

Supporting (SSS)
- Sh. R.P. Dabral
- Sh. Chandra Pal
- Sh. P. N. Rana
- Sh. Kamal Singh
- Mrs. Parvati
- Sh. Bhagat Ram
- Sh. Vikram Singh
- Sh. Aditya Singh
- Sh. Gopal Singh Bisht

Vehicle Section
- Sh. Swarn Singh, Tech. Officer
- Sh. Hukum Singh, Tech. Officer
- Sh. Sarvesh Kumar, Sr. Tech. Assistant
- Sh. Vikram Singh, Sr. Tech. Assistant

Guest House
- Sh. Kamal Singh, SSS
- Sh. Tej Bahadur, SSS
- Sh. Om Pal, SSS

Farm Management
Technical
- Sh. Rakesh Kumar, Asstt. Chief Tech. Officer & F.S.
- Sh. Chatar Singh, Tech.Officer
- Sh. Pramod Kumar, Security Officer
- Sh. Subhash Kumar, Sr. Tech. Assistant
- Sh. Hukum Singh, Tech. Assistant
- Sh. Ramesh Chand, Sr. Technician
- Sh. Shashank Kandwal, Technical Assistant
- Sh. Dharmpal, Technician(T-1)

Administration
- Sh. Kuldeep Singh, UDC

Supporting (SSS)
- Sh. Rajpal
- Sh. Om Prakash
- Sh. Vikram Singh
- Sh. Gajendra Singh
- Sh. Madan Pal
- Mrs. Sumitra
- Mrs. Savitri Devi
- Sh. Ram Prasad
- Sh. Pradeep Kumar
- Sh. Rajnish Kumar

Agra

Dr. S.K. Dubey, Pr. Scientist & Head

Soil Science & Agronomy
- Dr. R.K. Dubey, Sr. Scientist
- Sh. R. B. Meena, Scientist (on study Leave)
- Dr. Rama Pal ,Scientist
- Sh. A.K. Nitant, Sr. Tech. Officer
- Sh. Narayan Singh, Tech. Officer

Plant Science
- Dr. A.K. Parandiyal, Pr. Scientist

Social Science
- Dr. D. C. Meena, Scientist & OIC (Training)

Hydrology & Engineering
- Dr. K. K. Sharma, Pr. Scientist
- Sh. Suresh Chandra, Asstt. Chief Tech. Officer & OIC(B&M)

Farm Management
- Sh. Bhagwati Prasad, Asstt. Chief Tech. Officer & OIC(Farm)
- Sh. Krishan Kumar, Tech. Officer
- Sh. Than Chandra Sharma, Tech. Officer
- Sh. S. P. Singh, Tech. Officer

PME Cell, Documentation & Publication
- Sh. B.P. Joshi, Sr.Tech. Officer &OIC(PME and Store)

Administration
- Sh. A. S. Bimli, Asstt. Admn. Officer

Supporting (SSS)
- Sh. Munna Lal
- Sh. William
- Mrs. Asha Devi
- Sh. Kali Charan
- Sh. Ramesh Pal
- Sh. Ajab Singh
- Sh. Janak Singh
- Sh. Raghu Vir Singh
- Sh. Virendra Pal
- Sh. Ram Singh
- Sh. Shyam Lal
- Sh. Gaya Prasad
- Sh. Ved Ram
- Sh. Lakhan Singh
- Sh. Bhanwar Singh
- Sh. Sukh Ram
- Sh. Hori Lal
- Sh. Manglu

Bellary

Dr. S.L. Patil, Pr. Scientist & Head

Soil Science & Agronomy
- Dr. H. Biswas, Sr. Scientist
- Mrs. M. Prabhavathi, Scientist

Plant Sciences
- Sh. M.N. Ramesha ,Scientist
- Sh. Morade Amrut Sanjay, Scientist

Hydrology & Engineering
- Sh. B.S. Naik, Scientist
- Sh. M. Balakumar, Tech. Officer

Agricultural Economics
- Sh. Suresh Kumar, Scientist
- Dr. Ravi Dupdal, Scientist

Human Resource Development & Social Science
- Sh. K.N.Ravi, Scientist

Farm Management
- Sh. K. S. Rao, Sr. Tech. Officer & I/c. F.S.
- Sh. B.N. Seshadri, Tech. Officer

Administration
- Smt. T. Padmaja Gupta, Asstt. Admn. Officer.

Supporting (SSS)
- Mrs. Eramma
- Sh. K.H. Vrushubendrappa
- Sh. B. Venkatesh
- Mrs. Fathima Bi
- Sh. D. Desappa
- Sh. G. Venkatesh
- Mrs. Shanthamma
- Mrs. Chowramma

Chandigarh

Dr. V.K.Bhatt, Pr. Scientist & I/c Head

Soil Science & Agronomy
- Dr. (Mrs) Sharmistha Pal, Scientist
- Dr. (Mrs) Sathiya. K, Scientist
- Dr. Nyonand, Chief Tech. Officer

Plant Science
- Dr. Ram Prasad, Pr. Scientist
- Dr. Pankaj Panwar, Pr. Scientist

Hydrology & Engineering Section
- Dr. V.K. Bhatt, Pr. Scientist

Economics & Project Planning
- Dr.(Mrs.) S.L. Arya, Pr. Scientist
- Mrs. Nirmala Sarhadi, Chief Tech. Officer

Farm Management
- Sh. H.C. Sharma, Sr. Tech. Officer
- Sh. Basu Deo, Tech. Officer
- Sh. A.K. Chauhan, Tech. Officer
- Sh. A.N. Gupta, Tech. Officer
- Sh. Budh Singh
- Sh. Rohit Kumar

Administration
- Mrs. Neha Dobhal, Asstt. Admn. Officer
- Mrs. Sarbjit Kaur
- Sh. Krishan Kumar, Cashier
- Mrs. Ruchika Raina

Supporting (SSS)
- Mrs. Satya Devi
- Sh. Ram Abhilakh
- Sh. Rakesh
- Sh. Ram Saran
- Sh. Ram Khilawan
- Sh. Munna Lal
- Sh. Daya Ram
- Sh. Sukh Lal
- Sh. Rama Kant
- Sh. Santosh Kumar Singh
- Sh. Amrit Lal
- Sh. Kallu
- Sh. Nanda
- Sh. Raj Kishore

Datia

Dr. R. S. Yadav, Pr. Scientist & Head

Soil Science & Agronomy
- Dr. Dev Narayan, Pr. Scientist
- Dr. Rajeev Ranjan, Scientist (Sr. Scale)
- Dr. Dinesh Kumar, Scientist
- Dr. Govind Prasad, Chief Tech. Officer
- Sh. Gautam Singh, Tech. Assistant
- Sh. Anil Kumar Dohare, Tech. Assistant

Hydrology & Engineering
- Mrs. Monalisha Pramanik, Scientist (on study leave)
- Sh. Pramod Kumar, Tech. Officer

Farm Management

- Sh. B.D. Kushwaha, Sr. Tech. Assistant
- Sh. C.S. Samele, Tech. Assistant
- Sh. Lakhan Lal, Sr. Technician

Administration
- Sh. Ashok Kumar, Asstt. Admn. Officer
- Sh. Rakesh Kumar, LDC

Supporting (SSS)
- Sh. Ram Nath
- Sh. Awadh Saran
- Sh. Ratiram
- Sh. Ram Swaroop
- Sh. Balwant

Koraput

Dr. M. Madhu, Pr. Scientist & Head

Soil Science & Agronomy
- Sh. Praveen Jakhar, Scientist
- Dr. P.P. Adhikary, Scientist

Plant Science
- Dr. Karma Beer, Scientist

Hydrology & Engineering
- Dr. D.C. Sahoo, Pr. Scientist
- Dr. (Mrs).Ch. J. Dash, Scientist

Administration
- Sh. L.S. Rawat, Asstt. Admn.Officer
- Mrs. H.N. Lakra, U.D.C.
- Mrs. Annapurna Nayak, U.D.C.
- Sh. R. Siva Prasad, U.D.C.

Technical
- Sh. G. B. Naik, Sr.Tech. Officer
- Sh. G. W. Barla, Tech. Officer (on study leave)
- Sh. N. K. Das, Sr.Tech. Assistant
- Sh. S. Kindal, Sr.Tech. Assistant
- Sh. Surender Kumar, Tech. Assistant
- Sh. Anjit Kumar, Technician
- Sh. Gaurav Kumar, Technician

Supporting (SSS)
- Sh. Gangadhar Khinbudi
- Sh. Dibakar Jena
- Sh. Kailash Yadav

Kota

Dr. R.K. Singh, Pr. Scientist & Head

Soil Science & Agronomy
- Dr. B.L. Mina, Pr. Scientist
- Dr. G.L. Meena, Scientist
- Dr. Kuldeep Kumar, Scientist
- Dr. I. Rashmi, Scientist
- Ms. Anita Kumawat, Scientist

Plant Science
- Dr. H.R. Meena, Sr. Scientist
- Dr. S. Kala, Scientist

Hydrology & Engineering
- Dr. A.K.Singh, Pr. Scientist
- Dr. Shakir Ali, Pr. Scientist
- Sh. P.R. Raibole, Tech. Officer

Human Resource Development & Social Science
- Dr. Ashok Kumar, Pr. Scientist
- Sh. V.K. Jain, Sr.Tech. Officer
- Sh. Kamlesh Kumar, Sr.Tech. Officer

Farm Management
- Sh. B.B. Singh, Sr.Tech. Officer

Administration
- Sh. A. K. Bagassi, Asstt. Admn. Officer
- Sh. Ghanshyam Amer, PA
- Sh. K.K. Lalwani, Assistant

Supporting (SSS)
- Sh. Bhanwar Lal
- Smt. Sushila Bai
- Sh. Shyam Singh
- Sh. Rameshwar Prasad
- Sh. Sachianand
- Sh. Kamla Kishore

Udhagamandalam

Dr. O.P.S. Khola, Pr. Scientist & Head

Soil Science & Agronomy
- Dr. K. Kannan, Pr. Scientist
- Dr. K. Rajan, Pr. Scientist
- Dr. P. Raja, Pr. Scientist
- Dr. V. K. Thilagam, Scientist
- Sh. M. Sivalingam, Tech. Assistant
- Sh. Sibin Koshy, Technician(T-1)

Plant Science
- Dr. Hombe Gowda, Sr. Scientist

Hydrology & Engineering

- Dr. S. Manivannan, Pr. Scientist
- Ms. V. Selvi, Scientist
- Sh. A. Murugesan, Sr. Tech. Assistant
- Sh. K. Sangili, Technician (T-1)

Human Resource Development & Social Sciences

- Dr. P. Sundarambal, Sr. Scientist

Farm Management

- Sh. George John, Tech. Officer & F. S.
- Sh. T. Shanmugam, Technician (T-2)

Administration

- Sh. V.A. Padmanabha, Asstt. Adm. Officer
- Mrs. N. Revathi, L.D.C.
- Sh. M. Viswanathan, L.D.C.
- Sh. D.Venkatesh, L.D.C.

Supporting (SSS)

- Sh. S. Thangaraj
- Sh. N. Somasundaram
- Sh. C. Malarasu
- Sh. D. Savarimuthu
- Sh. S. Sankaran
- Sh. Sounder Rajan
- Sh. S.Sundarraj
- Sh. R.Chandran
- Smt. T. Rani
- Sh. R. Srinivasan
- Sh. S. Sekar
- Mrs. D. Neelavathy
- Sh. M. Veluswamy

Vasad

Dr. P.R. Bhatnagar, Pr. Scientist & Head

Soil Science & Agronomy

- Dr. D. Dinesh, Scientist
- Dr. Dinesh Jinger, Scientist

Plant Science

- Dr. V.D. Kakade, Scientist

Hydrology & Engineering

Appendix -2

The metrological data recorded at Research Farm Selaqui (DehraDun) and Research Centre's during 2018-19

Parameters	Apr.18	May.18	Jun.18	Jul.18	Aug.18	Sep.18	Oct.18	Nov.18	Dec.18	Jan.19	Feb.19	Mar.19
Dehra Dun												
Rainfall (mm)	42.7	11.8	136.8	548.8	611.3	366.9	2.9	12.3	2.9	28.2	96.6	28.4
Number of rainy days	5	4	8	17	20	13	1	3	0	2	6	2
Mean Maximum Temp (°C)	33.5	37.3	34.9	31.8	30.4	30.8	30.7	26.0	21.9	20.6	24.1	29.6
Mean Minimum Temp (°C)	14.7	17.8	23.2	24.1	23.7	21.4	11.7	8.5	2.4	2.8	6.6	9.6
Average Wind Velocity (km/hr)	1.4	2.1	1.1	0.6	0.4	0.5	0.4	0.5	0.5	0.7	0.9	1.3
Average Daily bright sunshine (hrs)	7.0	5.9	4.5	2.7	1.5	4.1	7.6	5.5	4.9	4.4	5.6	7.1
Average Daily Evaporation (mm)	4.5	5.9	4.4	2.4	2.3	2.1	2.3	1.3	1.0	1.1	1.6	3.3
Av. relative humidity (%) (0719 hrs.)	79.4	64.8	85.3	93.5	96.1	96.2	93.3	93.4	92.1	90.4	90.4	90.3
(1419 hrs.)	29.1	27.3	56.3	73.6	81.0	72.1	44.3	48.3	42.3	39.4	39.9	27.9
Agra												
Rainfall (mm)	31.9	22.4	38.0	370.0	216.6	86.9	0.0	0.0	0.0	15.0	12.5	6.8
Number of rainy days	2	2	2	15	9	9	0	0	0	2	2	1
Mean Maximum Temp (°C)	38.2	41.3	41.1	35.2	33.5	32.4	35.5	29.6	23.4	21.8	23.2	29.8
Mean Minimum Temp (°C)	21.0	24.5	29.3	26.9	26.3	24.0	17.8	11.8	5.8	6.0	9.4	13.1
Average Wind Velocity (km/hr)	3.4	3.6	5.2	2.9	1.6	2.0	0.7	1.0	0.9	2.3	3.0	3.2
Average Daily bright sunshine (hrs)	8.9	9.3	6.9	5.3	3.4	4.7	8.2	7.5	7.3	7.0	5.7	7.9
Average Daily Evaporation (mm)	6.5	7.2	8.7	4.0	2.9	2.8	3.0	1.9	-	-	-	-
Av. relative humidity (%) (0719 hrs.)	71	69	74	93	96	93	78	93	92	92	92	87
(1419 hrs.)	33	42	54	78	86	75	40	45	53	55	65	35
Ballary												
Rainfall (mm)	0.0	0.0	0.6	33.9	46.8	22.8	17.2	69.3	0.0	0.0	0.0	0.0
Number of rainy days	0	0	0	4	4	2	1	4	0	0	0	0
Mean Maximum Temp (°C)	30.5	32.7	36.6	38.5	38.0	35.0	33.3	32.3	30.1	30.0	34.1	38.0
Mean Minimum Temp (°C)	16.2	17.7	21.2	24.4	24.8	24.4	24.1	23.1	17.7	14.6	16.6	20.6
Average Wind Velocity (km/hr)	3.5	7.4	-	-	-	6.6	9.8	9.1	3.1	3.4	5.2	4.9
Average Daily bright sunshine (hrs)	9.1	9.4	7.9	8.9	7.8	5.9	3.4	4.5	7.3	9.0	9.6	9.7
Average Daily Evaporation (mm)	5.4	6.8	8.9	9.3	9.5	8.3	7.7	7.3	5.3	5.6	7.9	9.3
Av. relative humidity (%) (0723 hrs.)	80	75	70	63	72	75	75	82	87	79	72	63
(1423 hrs.)	33	25	21	23	32	43	47	55	49	36	28	24
Chandigarh												
Rainfall (mm)	24.1	16.3	93.7	387.6	352.8	286.0	12.2	7.2	6.0	24.3	71.3	27.6
Number of rainy days	09	06	10	17	15	12	02	01	02	05	09	04
Mean Maximum Temp (°C)	34.7	38.1	36.5	32.0	31.6	30.7	30.7	26.4	21.8	19.8	20.4	24.4
Mean Minimum Temp (°C)	17.4	20.7	24.1	24.4	24.2	21.6	14.7	10.6	4.9	5.0	8.1	10.0
Average Wind Velocity (km/hr)	3.1	3.7	3.1	1.5	1.2	0.9	1.3	0.9	0.7	1.0	1.7	1.4
Average Daily bright sunshine (hrs)	8.1	7.9	6.0	3.9	4.1	5.0	8.6	7.1	7.1	5.4	5.0	6.9
Average Daily Evaporation (mm)	5.5	6.8	7.4	4.2	3.3	3.4	3.3	2.2	1.6	1.2	1.5	2.6
Av. relative humidity (%) (0723 hrs.)	62	48	70	86	92	92	76	87	90	91	93	86
(1423 hrs.)	31	27	49	70	74	69	39	41	43	49	56	47
Datia												
Rainfall (mm)	13.3	8.90	10.0	356	200	291	0.00	0.00	0.00	1.20	30.0	0.0
Number of rainy days	2.00	1.00	5.00	15.0	13.0	6.00	0.00	0.00	0.00	0.00	4.0	0.0
Mean Maximum Temp (°C)	39.7	43.5	41.2	33.4	31.8	31.3	35.6	30.3	24.7	23.2	25.1	31.3
Mean Minimum Temp (°C)	21.1	25.5	29.2	25.8	24.9	22.6	16.6	11.8	5.90	5.90	9.80	13.3
Average Wind Velocity (km/hr)	3.70	4.50	6.90	3.90	3.20	3.90	1.70	1.02	1.10	1.60	2.40	2.4
Average Daily bright sunshine (hrs)	9.90	10.0	7.70	4.10	2.90	6.00	10.2	8.10	7.30	7.30	7.70	10.3
Average Daily Evaporation (mm)	13.3	10.6	10.7	3.60	2.80	3.60	3.90	2.70	1.40	1.50	1.90	4.0
Av. relative humidity (%) (0716 hrs.)	56.0	53.0	61.0	88.0	92.0	90.0	76.0	86.0	91.0	91.0	91.0	82.0
(1416 hrs.)	28.0	27.0	40.0	73.0	77.0	68.0	30.0	39.0	42.0	47.0	47.0	34.0
Koraput												
Rainfall (mm)	102.6	99.6	126.1	483.1	722.7	289.8	18.1	2.6	51	0.5	0	1.3
Number of rainy days	7	7	9	20	18	12	1	1	2	0	0	0
Mean Maximum Temp (°C)	33.44	32.89	29.37	25.41	24.75	27.86	29.18	28.84	24.77	26.15	29.64	33.06
Mean Minimum Temp (°C)	17.84	19.39	20.49	20.02	19.63	18.95	14.67	11.74	10.46	6.62	11.46	16.89
Average Wind Velocity (km/hr)	1.19	0.80	1.59	2.84	2.24	1.01	0.59	0.27	0.49	0.40	0.92	1.08
Average Daily bright sunshine (hrs)	11.77	7.15	3.02	1.01	0.71	3.74	7.76	7.77	5.85	8.00	7.79	8.42
Average Daily Evaporation (mm)	4.90	4.30	2.85	1.88	1.67	2.32	2.84	2.73	1.94	2.45	3.49	4.83
Av. relative humidity (%) (0659 hrs.)	94	92.48	94.77	96.10	95.84	95.53	95.39	95.23	97.03	94.97	93.43	92.16
(1359 hrs.)	58.17	65.45	78.03	178.52	164.55	128.57	89.10	93.80	87.55	63.45	30.46	28.61
Kota												
Rainfall (mm)	0	0	79.8	279.4	254.8	184.0	0.0	0.0	0.0	0.0	9.2	
Number of rainy days	0	0	8	18	15	12	0	0	0	0	1	
Mean Maximum Temp (°C)	39.8	43.2	40.7	33.4	31.9	31.0	35.5	30.5	24.5	22.6	25.0	
Mean Minimum Temp (°C)	20.5	24.9	28.8	26.5	25.7	22.5	17.4	11.7	5.5	5.5	9.4	
Average Wind Velocity (km/hr)	2.5	3.0	5.4	3.9	3.4	2.3	0.8	0.7	1.1	1.4	2.3	
Average Daily bright sunshine (hrs)	8.7	7.2	5.2	2.9	3.4	5.2	9.0	8.1	7.3	7.7	7.5	
Average Daily Evaporation (mm)	7.8	9.6	9.4	5.8	4.9	4.1	3.7	2.6	2.1	2.1	3.2	
Av. relative humidity (%) (0727 hrs.)	51.9	45.0	62.3	83.7	86.3	90.0	85.6	91.0	89.1	89.0	86.5	
(1427 hrs.)	16.1	15.6	33.7	68.4	71.1	65.7	26.7	30.8	31.6	41.2	38.3	

भा.कृ.अनु.प.
I.C.A.R.

ICAR-Indian Institute of Soil and Water Conservation

218-Kaulagarh Road, Dehra Dun-248 195, Uttarakhand

ISO 9001:2015

Udhagamandalam													
Rainfall (mm)		23.7	247.4	299.4	275.2	305.4	101.0	207.8	111.9	4.0	0.0	18.2	0.0
Number of rainy days		2	15	13	16	13	8	14	11	1	0	2	0
Mean Maximum Temp (°C)		23.4	22.6	19.5	18.3	18.2	21.2	20.5	20.5	20.8	21.4	21.5	23.7
Mean Minimum Temp (°C)		13.1	13.4	12.8	12.4	12.0	12.3	11.9	11.4	7.6	4.4	7.4	9.8
Average Wind Velocity (km/hr)		3.4	2.2	4.9	6.4	8.3	3.0	2.9	4.1	2.0	2.3	4.2	4.3
Average Daily bright sunshine (hrs)		7.8	5.4	2.1	1.7	1.5	5.1	5.5	5.8	6.0	8.7	8.1	8.7
Average Daily Evaporation (mm)		4.4	3.4	2.2	2.3	2.4	3.6	3.7	3.3	3.4	4.7	4.6	6.0
Av. relative humidity (%)	(0723 hrs.)	89.1	92.6	92.8	92.8	93.0	89.7	89.5	83.8	77.2	62.3	81.2	80.9
	(1423 hrs.)	64.2	70.5	80.5	81.2	82.1	72.7	72.7	66.9	58.0	41.6	55.3	54.6
Vasad													
Rainfall (mm)		0.0	0.0	118.2	366.4	293.1	48.8	0.0	0.0	0.0	0.0	0.0	0.0
Number of rainy days		0.0	0.0	2	13	9	2	0.0	0.0	0.0	0.0	0.0	0.0
Mean Maximum Temp (°C)		39.7	41.6	38.8	31.4	31.4	32.3	36.3	33.3	28.6	28.1	30.4	34.6
Mean Minimum Temp (°C)		26.6	25.9	27.4	24.7	24.2	22.5	18.5	14.0	8.5	6.2	8.6	11.8
Average Wind Velocity (km/hr)		3.68	5.43	7.59	5.51	5.52	3.45	1.25	2.02	3.23	3.40	3.77	3.79
Average Daily bright sunshine (hrs)		10.0	8.3	6.8	1.3	2.3	7.0	9.3	8.9	8.4	8.9	9.0	9.6
Average Daily Evaporation (mm)		7.4	8.5	7.8	2.4	3.0	3.8	4.2	3.2	3.0	3.3	4.5	6.6
Av. relative humidity (%)	(0741 hrs.)	68.7	70.2	76.2	95.7	90.5	89.9	85.0	84.4	83.0	83.5	78.0	65.9
	(1441hrs.)	26.1	31.0	45.8	82.8	74.6	61.8	37.2	38.8	42.9	34.0	28.7	30.5