SOIL CONSERVATION SOCIETY OF INDIA

# SOIL AND WATER CONSERVATION Today

Vol. 14 No. 3 ISSN 0975-4059 July - September 2019

## IN THIS ISSUE





## FROM THE PRESIDENT'S DESK

India ranks first among the rainfed agricultural countries of the world in terms of both extent and value of produce. In India, about 60% of total net sown area comes under rainfed lands, whereas, rainfed crops account for 48% area under food crops and 68% under non-food crops. In other way 90% of water in our country is consumed in farming and 80% of this is used for irrigating water-demand crops like rice, wheat and sugarcane. India's farmers, even in drought-prone areas, grow these water-intensive crops because these crops have a steady demand due to government assured procurement and Minimum Support Price (MSP). India is the largest user of groundwater in the world with over 60% of irrigated agriculture and 85% of drinking water supplies dependent on aquifers. Again inefficient and dilapidated canal irrigation systems have led to a spurt in groundwater development. Reducing this number is the most effective way of solving India's water problem. At the national level, groundwater based schemes are increasing but surface water schemes are declining. The total cultivable land of the country is about 144 million hectares of which 56% (80.6 million hectares) is degraded due to faulty agricultural practices and the dense forest cover has been reduced to 11% (36.2 million hectares) of the total geographical area. Again there is the lack of community ownership/people's participation to sustain conservation activities since these are seen to be more a Government intervention than people's participation.

Government of India has launched the **Jal Shakti Abhiyan** (JSA) to revive India back to a sustained system of water conservation and efficient irrigation. It is a time bound campaign with a mission mode approach intended to improve conditions in around 1500 Blocks that are drought affected, water stressed or over-exploited falling in 254 districts with water conservation related central programmes and 23 of these districts are aspirational districts. The Jal Shakti campaign is running through citizen participation during the monsoon (July 1-September 15). An additional phase II will run from October 1 to November 30 for states receiving the

northeast retreating monsoons. The conservation efforts will be supplemented by initiatives like developing block and district water conservation plans and 'krishi vigyan kendra melas' to promote efficient water use for irrigation and better crop choices. Teams have been constituted, and engineers and technical staff have been placed in blocks to take stock of the groundwater levels, the state of aquifers, and ponds and water bodies that may have been encroached upon over the last two decades, whereas, in urban areas, plans with time-bound targets for wastewater reuse for industrial and agricultural purposes. In 'Mann Ki Baat', the prime minister also said 'one-size-fits-all' approach is not required in the conservation of water. One of the major outputs of Jal Shakti Abhiyan is to develop district water conservation plan. This is essentially a strategy to conserve, recharge and improve water use efficiency. The District Water Conservation Plan is developed by compilation of block level conservation plans, which is essentially the compilation of water conservation plans of respective Gram Panchayats (GPs) within the block. Reuse of water is a very important intervention to mitigate effects of depleting water availability. Water used once can in many cases be reused for multiple purposes like recharge ground water and reuse of grey water. All these can be done through watershed management which involves *in- situ* soil and water conservation, water resource development through drainage line treatments, productivity enhancement, livelihood strengthening and capacity building. Awareness generation and community based institution building by way of Watershed Development Committees is also an integral part of watershed management. The Programme launched by the Government is a very good programme and promising step in the right direction and will surely succeed if the way forward like (i) need for a paradigm shift requiring a transition from 'supply-and-supply-more water' provision to measures which lead towards improving water use efficiency, reducing leakages, recharging/restoring local water bodies as well as applying for higher tariffs and ownership by various stakeholders; (ii) Promotion of aquifer recharge and rainwater conservation through **community ponds and recharge wells** with involvement of gram sabhas. Lessons can also be drawn from the work of **Sankalpa Rural Development Society** (SRDS) which has been training farmers of Karnataka on revival of defunct borewells; (iii) Need of **Participatory Governance** to govern water resources will be taken carefully. India's rivers and groundwater can be protected only if the integral interconnectedness of catchment areas, rivers and rural and urban aquifers is properly recognized.

**Dr. Suraj Bhan**
President, Soil Conservation Society of India

# BIOENGINEERING WATER CONSERVATION TECHNIQUES: VIABLE POLICY INTERVENTION IN WATER DEFICIT ZONES

Susama Sudhishri[1], Anchal Dass[2] and Man Singh[1]

The climate change has emerged as a serious threat to the sustainability of natural resources in rainfed as well as irrigated areas which causes frequent occurrence of droughts, floods, severe soil erosion, acute water scarcity etc., leading to decrease in crop productivity and soil and water quality. Approximately 7100 $km^3$ $year^{-1}$ is consumed globally to produce food, of which 5500 $km^3$ $year^{-1}$ is used in rainfed agriculture and 1600 $km^3$ $year^{-1}$ in irrigated agriculture. In developing countries, rainfed grain yields average 1.5 t $ha^{-1}$, compared with 3.1 t $ha^{-1}$ in irrigated agriculture. India ranks first among the countries that practice rainfed agriculture both in terms of extent and value of production. Out of the total geographical area of the country of 329 Mha, about 146 Mha is degraded and 85 Mha is rainfed arable land. Out of 140.3 Mha net cultivated area, 60% is rainfed, contributing 45% of the total food grain production. It is estimated that even after achieving the full irrigation potential; nearly 50% of the net cultivated area will remain dependent on rainfall. Integrated watershed management has the vast potential to combat these problems. Also, Government of India has launched now the **Jal Shakti Abhiyan** with five aspects - water conservation and rainwater harvesting, renovation of traditional and other water bodies, reuse of water and recharging of structures, watershed development, and intensive afforestation to tackle these problems. To implement the component water conservation some of the techniques developed and tried at ICAR-Indian Agricultural Research Institute are given here for its adoption to increase the productivity.

## Measures of *In-situ* water harvesting

### 1. *In-situ* water conservation methods

Three years of experimentation for evaluation different conservation measures viz. trench-cum-bund (TB) (20 cm depth of trench and 20 cm height of bund), bund (30 cm height), ridge and furrow (RF) (15 cm height), skip row (SR) (3:1), basin tillage (BT) (45 cm x 45 cm) which showed that basin tillage method was better followed by RF, TB, bund, SR. w.r.t. availability of more soil moisture, less crop water stress, high relative water content, other biophysical parameters, and yielded 1.25 to 1.5 times more due to more soil moisture.

### 2. Ridge and furrow/Raised bed and furrow

Different sizes of ridge and furrows (RF)/raised bed and furrow viz. 30:30, 45:30, 60:30, 75:45, 90:45 (Bed:furrow) in Pearl millet (Bajra), Maize and Soybean can be used for enhancing soil water and nutrient availability under rainfed conditions. However, Raised bed of 90:45 cm can be used in pearl millet, maize and soybean to increase the crop yield by 1.5 times. Again to enhance more productivity Cowpea


on bed, fodder maize, Bajra and jowar on bed and furrow can be sown to enhance the productivity and nutrition.

*Plate: Bajra, Maize and soybean under different ridge and furrow water conservation system*

### 3. Basin tillage method of water conservation

Basin tillage (BT) method of in-situ water conservation practice in Pearl millet (bajra) and Maize crops in pits (45 cm x 45 cm x 15 cm) and cowpea/Guar as inter crop with 75 cm and 90 cm spacing between pits were tried and it was found that interspacing of 75 cm performed better yielding 25-28 q/ha pearl millet + 22-45 q/ha guar/cowpea.

*Basin tillage*

*Only Bajra*

*Bajra + Cowpea*

*Bajra+Guar*

Above water conservation practices can also be abetter option in rainfall area < 400 mm.

### 4. Water Conservation practice in alternate landuse system (Agroforestry horti-agri system)

Legumes and fodder production can be enhanced by growing in interspaces of any orchards. Intercropping of legume crops (soybean, moong bean and cowpea) as well fodders like bajra, maize and sorghum in *bael* orchards with different water conservation practices (ring basin (1.5 m radius), micro-catchment (1 m radius) and trench (45 cm x 15 cm) yielded 29 q/ha cowpea and 19 to 34 q/ha *bael.* (wood apple). Trenches in upstream of tree

enhanced cowpea yield by 1.5 times. Total gross return from *bael* + cowpea was Rs. 2,59,300/ha compared to sole cowpea of Rs. 94,300/ha only.

### 5. Other methods:

Conservation techniques like zero-tillage, raised-bed planting, laser leveling, precision farming and drip or sprinkler irrigation have shown good results in soil and water conservation but needs further improvement in technology for wider acceptance. Conservation agriculture plays a vital role to enhance the crop productivity, soil fertility, organic carbon and water savings. At IARI different systems were tried to replace the most water demanding cropping system Rice-wheat. viz. cotton-wheat, pigeonpea-wheat and maize-wheat under conservation agriculture with broad, and narrow bed system. Water savings was varying from 32 to 64% under broad bed system. Water savings in terms of monetary value was calculated taking into account the horsepower of pump and energy consumption due to drafting and withdrawal of water from tubewell w.r.t transplanted rice-wheat and also w.r.t. respective best treatments under different cropping systems. Cost savings due to water savings is highest in maize-wheat cropping system compared to transplanted rice-wheat cropping system but compared to individual cropping system. It is highest in rice-wheat followed by cotton-wheat system. Rice-wheat(Moongbean residue-Direct seeded rice DSR-zero tillage wheat+rice residue+summer mungbean)-wheat), cotton-wheat, pigeonpea-wheat and maize-wheat ZT+Broad bed with residue) which shows water savings of 51 to 63% and cost savings of 25371-31143 whereas it was for transplanted Rice-wheat as water savings of 33% and cost savings 16232 (Rs./ha/year. **System of Rice Intensification (SRI)** has been adopted by several farmers especially in Bihar and Andhra Pradesh as a water-conserving method of paddy cultivation.

### Way Forward:

The above technique needs a bigger push from the Government to make more adoptability by making a policy in terms of subsidy. But anyway people's participation and Government policy in terms of incentives together can bring the success in adoption of water conservation practices.

## PLANT TREES TO CONSERVE SOIL AND ENVIRONMENT

**Prof. (Dr) R.D. Gupta and Sanjay Arora**

*"A person who does not possess any affection to a plant or a tree is just a kin to a garden having no flowers. Like this garden, he is quite bare and dull."* Thus, man has now realized the significance of the plants and trees i.e. vegetation on the environment. And deep concern is now being expressed all over the world about the preservation and restoration of the environment and ecological balance through maintenance of vegetation. The vegetation is, infact, known to have a dominant influence over the environment. It is more so in the hilly states like Jammu and Kashmir, Himachal Pradesh, Uttrakhand and north hill states. It is an established fact that if the vegetation or the forest dies the mother earth will not survive for long. But it is a great pity that about one third of the forests or vegetative covers have already been depleted causing unusual climate change and affecting the rainfall pattern throughout the world.

A large expanding human and livestock population accompanied with large scale poverty have exerted unrelenting pressure on forests. As a result the forest area in India has been left only about 21.54 percent of the total geographical area of the country against 33 percent of the total area of every region in plains and 60 percent in Himalayan region. Forest area of the hilly states, has also been much depleted. In Jammu and Kashmir, it has left only about 10 percent of the total area as per the studies of satellite imageries. It, therefore, has become an imperative to restore the depleted vegetative cover of hill mountain slopes. Although it becomes the responsibility of the Government to restore such forest cover, yet the cooperation of the people is essentially needed in maintaining vegetative cover and, thereby, environment.

The State of Jammu and Kashmir was well noted for its environment and sylvan beauty owing to the presence of thick forests, lush green meadows dashing mountains, cold

and hot springs and streams, beautiful lakes and various kinds of flora and fauna. But unfortunately, the whole of the State has lost its charming beauty in about 50 years. As per the present situations, the danger of this hilly state to become desert is on the high level. The indiscriminate felling of trees in the state has caused more degradation of forests in Jammu region than Kashmir valley where felling of trees has already been curbed to some extent in certain areas of tourism importance. According to some forest experts that whichever forest cover has left would be totally denuded by 2033 AD if present pace of deforestation continues without following any remedial measures.

In the light of the above, drastic measures are necessary not only to check any further destruction of the vegetative cover and the environment but also repair the damage which has already taken place. Such control measures shall naturally entail some hardships on the people and resource crunch on the Government. The people however, should be contented with the minimum supply of timber to meet the genuine and urgent requirement.

### Control measures

* As the vast tract of the hilly area of Jammu and Kashmir, particularly the Karewas in Kashmir and Kandi belt in Jammu has almost completely denuded/eroded so call of the hour is to have better forest management through afforestation. Local tree species are required to be afforested. For example, in deforested areas of Kandi, *Acacia nilotica*, *A. modesta*, *A. catechu*, *Dalbergia sisso*, *Butea monosperma* should be planted.
* Not an inch of soil should lie bare as it is the bare soil that erodes much. Grasses and legumes are more effective against erosion so these must be grown. They are easy to grow and establish fully in a few months. Legumes enchance fertility of soils by fixing atmospheric nitrogen thorough Rhizobia.
* All the three kinds of soil erosion control measures *viz*. agronomic practices, engineering techniques and biological measures should be followed.
* Practice of raising pure forest crops should be discouraged instead mixed indigenous species should be discouraged instead mixed indigenous species should be grown for the long term interest.
* Grazing should be stopped totally from forest areas. Overgrazing of the pastures and forest fires are required to be checked.
* As the process of development takes a heavy toll on the green cover so it should not be at the cost of felling of trees.
* Apart from the blanket ban of cutting trees, closing all saw mills located within 10 km of the damaged forest areas or shift them beyond this area.

## 68th Foundation day of Soil Conservation Society of India

The 68th Foundation day of Soil Conservation Society of India was organized on 24/09/2019 in the premises of the society's head quarters. A meeting was held under the Chairmanship of Dr. Suraj Bhan, President, SCSI and discussed diverse activities undertaken by the society during the last year. Thereafter, members and staff present on the occasion participated in the plantation activity in the NASC Complex. A pledge was taken to work more dedicatedly for the cause of natural resource management environmental and protection of the country. The programme ended with vote of thanks to the chair.

*Photographs of plantation activity*

## Tree Plantation Drive Organized by Bihar Chapter of SCSI

The 68th foundation day of Soil Conservation Society of India was commemorated by the Bihar Chapter of the Society by organizing a tree plantation drive in the premises of the Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Sabour, Bhagalpur on 24th September 2019. A total of 110 saplings were planted in the open spaces on the periphery of the buildings and approach roads. The drive was initiated by plantation of the first sapling by Dr.

N. Chattopadhyaya, Chairman, Department of Soil Science and Agricultural Chemistry and assisted by Dr Anshuman Kohli, Secretary, Bihar Chapter, SCSI. Mr Bipin Bihari, a senior Ph.D. student of the department, coordinated the plantation drive and ensured the plantation of the rest of the saplings by various members of SCSI-Bihar Chapter, faculty members and post graduate students of the department. In order to ensure survival of all planted saplings, each post graduate student was given the responsibility to take care of and ensure the survival of four saplings.


# INNOVATIVE PRACTICES TO CONSERVE SOIL AND WATER RESOURCES IN HIGHLANDS OF MEGHALAYA

**Sanjay-Swami**
School of Natural Resource Management, CPGS, CAU(I), Umiam (Barapani), Meghalaya, India

The North Eastern Region (NER) of India represents three provinces (East Himalayas, Brahmaputra Valley, and North East Hills) that cover about 7.7% of the total geographic area of the country. Around 56% of the cultivated area of the NER is under low altitude (valley or lowland), 33% under mid-altitude (flat upland), and the rest under high altitude (upland terrace). The environment, local conditions, socio-economic and socio-cultural life of different tribal communities and the rituals associated with agricultural practices have developed many indigenous farming systems, which have in-built eco-friendly systems for conservation, preservation and utilization of natural resources. However, with the passage of time, some of these practices have been further refined and modified to cater the location specific needs of present day for conserving soil and water resources. The traditional practice of shifting cultivation and bamboo drip irrigation are also now being practiced with some innovative modifications in Meghalaya. These traditional practices along with modified systems are discussed here under:

## Shifting cultivation:

Cultivating a plot for a few cropping until it becomes exhausted, then moving is an age old practice of cultivation in NER. The agricultural system which is characterized by a rotation of fields rather than of crops, by short period of cropping (one to three years) alternating with long fallow periods (up to twenty or more years, but often as short as six to eight years) and clearing by means of slash and burn is known as "slash and burn" agriculture or shifting cultivation or *Jhum* and this is the most prevalent form of agriculture in NER. It is practiced on about 0.88 M ha area. Traditionally *Jhum* cultivation was productive and sustainable. However, over the past two decades, due to increasing human population, the *Jhuming* cycle in the same land, which extended to 20-30 years in older days, has now been reduced to 3-6 years. Deforestation and biomass burning in *Jhum* aggravate soil erosion and ecosystem degradation. Annual soil erosion on steep slopes (44-53%) under shifting cultivation can be as much as 40.9 Mg/ha along with attendant losses (in kg/ha) of 702.9 of soil organic carbon (SOC), 63.5 of phosphorus

(P) and 5.9 of potassium (K). Soil erosion, during the 1st and 2nd years on the abandoned land has been estimated at 147, 170, and 30 Mg/ha, respectively. Steep slopes, cultivation along the slope, with negligible nutrient replacement and high rainfall are among the major causes of land degradation in Meghalaya. The annual soil loss and carbon content in different land use systems are presented in Table 1.

**Table 1:** Soil loss and carbon content in different land use systems

| S. No. | Land use system | Soil loss (t/ha/yr) | Organic carbon (%) |
|---|---|---|---|
| 1. | Shifting cultivation | 30.2–170.2 | 1.24-2.54 |
| 2. | Agriculture | 5.10–68.20 | 1.96-2.70 |
| 3. | Livestock based land use system | 0.88–14.28 | 1.80-2.94 |
| 4. | Natural-fallow | 0.37–1.83 | 2.84-3.25 |
| 5. | Agri-horti-silvi-pastoral | 0.38–1.22 | 2.01-3.22 |
| 6. | Natural forest | 0.04–0.52 | 2.92-3.05 |

## Modified shifting cultivation ensuring soil conservation

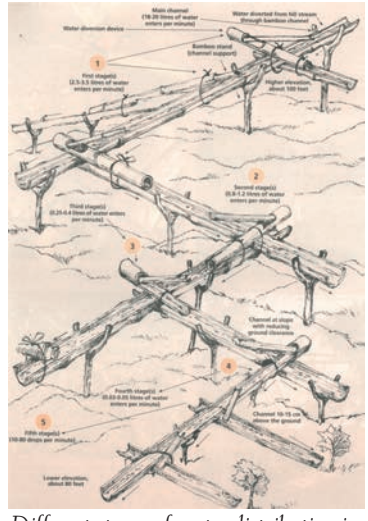
Bun cultivation is a modification of shifting cultivation and is mostly followed in the Meghalaya plateau since last four decades. In this system, the crops are grown on a series of raised beds of 0.15-0.30 m height and 0.75-1.0 m width with almost equal width under sunken area made along the slopes, locally referred to as "Bun". While preparing buns, biomass is burnt under the soil, and the land is abandoned after two or three years. It provides an improved production system, helps conserve soil moisture, and prevents land degradation and soil erosion. In this system, bench terraces are built on the hill slopes running across the slopes. The gap between each bun is leveled using the cut and fill method. The vertical break between each terrace is one meter. Such measures help in preventing erosion and retaining maximum rainwater within the slopes. It also helps in safely dispose-off the additional runoff from the slopes to the lower areas.

Meghalaya is well-known for having the highest rainfall in the world of about 11500 mm recorded annually. This makes Meghalaya the wettest places on earth. Though, the state gets plenty of rainfall during the monsoon season, a well-managed irrigation system is required during the dry spell. Hill farming is subject to a number of serious constraints such as undulating topography, steep-slops, poor and shallow soils (prone to erosion). Majority of the fields in the region are situated across the hilly slopes. Therefore, the water-retention capacity of the terrain is poor and bringing water from distant water sources to the fields is a big challenge for the farmers in the rural areas. Ground channeling is also impractical due to the harsh landscape. Confronted with such adverse conditions for irrigation, the traditional farmers of Meghalaya have come up with an innovative way. The farmers of the Jaintia and Khasi hills have developed unique bamboo drip irrigation system of trapping springs and stream water normally to irrigate the betel leaf or black pepper crops planted in areca nut orchards or in mixed orchards.

## Bamboo drip irrigation system

The bamboo drip irrigation system is based on gravity and the steep slopes facilitate in implementing it. Water from an uphill source is trapped and brought to the plantation by a main bamboo channel. Usually these water sources are far off from the plantations and the main bamboo channel runs hundreds of meters - in some cases even few kilometers. The water is then regulated through a complex bamboo network of secondary and tertiary channels to all the parts and corners of a plantation, right up to the bottom of the hill.

Bamboos of varying diameters are used to build the channels, support structures, diversion pipes and strips. Channels are held above the ground by bamboo or wooden Y shaped sticks. About a third of the outer casing in length and internodes of bamboo pieces have to be removed while fabricating the system. One stretch of channel is lashed to another by thin bamboo strips. Indigenous tools like a *dao*, a type of local axe, and chisels of various shapes and design are used to build the bamboo network. Two laborers can construct a network covering 1 hectare of land in 15 days. They are built with such skill that water wastage by leakage is minimal. The construction is based on a simple thumb rule that the ratio of diameter of primary channel to tertiary channel determines the quantity of water which will reach the trees. It is a subtle skill which comes with years of observation and experience. It is so perfected that about 18-20 litres of water entering the bamboo pipe system per minute gets transported over several hundred metres and finally gets reduced to 20-80 drops per minute at the site of the plant.



*Different stages of water distribution in bamboo drip irrigation system*

The cost involved in building the system is minimal. Bamboo is available freely in this region. Usually the farmer himself sets up the system in his plantation with some help from 1 or 2 labourers. The region gets heavy rain and as a result each installation lasts for about 2-3 years. After the rainy season the undergrowth is cleared and reinforcements are provided. Old bamboo is left to rot, which over time returns to the soil as humus. Cooperatives are formed and each farmer provides his skill and labour to build and maintain the system. The distribution of water from one plantation to another is done by diverting water at fixed

*Modified bamboo drip irrigation system*

timings. This avoids the occurrence of conflicts between various farmers. By this method the whole community works harmoniously - sharing the limited resources judiciously.

## Modified bamboo drip irrigation system

The bamboo drip irrigation system has been further refined and modified to increase water use efficiency and to irrigate filed crops apart from plantation crops. Since the region faces lot of water scarcity during dry period due to hilly terrain and steep slope, and as most of the crops are cultivated in upland condition, water harvesting tanks (*Jalkunds*) at the top of the hills can be the solution of this problem. During wet period, water can be collected by making small ponds or tanks and can be saved for dry spell. Since water in bamboo drip irrigation is actually conveyed from higher elevation to the downstream with the help of gravity up to plantation crops, water harvesting tank should also be constructed at the top of the hills or above the cultivated crops so that water can be easily conveyed through bamboo with the help of gravity.

Bamboos are laid down from the water source which is the mainline and from there lateral line bamboos are connected. Bamboos are laid just above the properly spaced crop plants with the hole so that water can just drip on the particular plant only. The height of bamboo placed above the plant should be enough for the farmers to move under for inter-culture operations like manual weeding. Both the end of the mainline should be closed. Holes are made in the mainline through that water is conveyed to the laterals. The laterals also consist of small holes just above the individual plant to drip water. For efficient utilization of water, tying of some woolen thread with the cap in the holes of the laterals is also recommended to manage the speed of drip or to irrigate only the desired particular crop area. If the wetting is completed, it can be pulled down for seizing the flow of water for its efficient utilization. In the mainline, holes can be either closed with the help of mud or thread just like in the laterals for seizing the flow with respect to particular plant. It leads to better utilization of rainwater which would have been washed out if not harvested during rainy season. It has also been observed that about 25-30% water can be saved by modified bamboo drip irrigation followed by straw mulching, although it is cost effective only for cash crops like potato, capsicum, tomato, strawberry, etc. which are grown with definite spacing.



**Journal of Soil and Water Conservation**, quarterly Editorial Board published by Soil Conservation Society of India is now available on-line at www.indianjournals.com and on officialwebsite of society www.scsi.org.in



Published by Secretary General, Soil Conservation Society of India, National Societies Block A/G-4, National Agricultural Science Centre (NASC) Complex, Dev Prakash Shastri Marg, Pusa, New Delhi 110 012; Tel.: 011-25848244, 21520082; e-mail: soilcsi@gmail.com, bhan_suraj1945@yahoo.com; Website: www.scsi.org.in