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From The President's Desk

India with 2.4% of the world's total land Area and 4% of the total replenishable fresh water has to cater 17% of the world's population. The task is rendered even more difficult as no respite is foreseen in population increase in the future. Besides, projected urbanization and industrial growth, improvement in the living standard and changing in the food habits are likely to have a cascading effect on water demand of the urban, industrial and agriculture sectors.

There will be ever increasing demand and competitions for water in different sectors like Domestic, Agriculture and Industrial because of rapid population growth and expectations of better life. Demand will also be increased for many environmental concerns like aquatic life, wild life, refuges and recreation. Changing global climate patterns coupled with declining per capita availability of surface and ground-water resources have made sustainable agriculture production a great challenge in India. With increasing water demand from other sectors, agricultural water use in India will face stiff competition for the scarce water resources in future. Therefore, resources of available water would not be sufficient to fulfill water needs of all sectors, if water is used efficiently and utilizable quantity is increased by all possible means. In order to enhance the water productivity in agriculture following strategies need to adopted.

1. Improving the status of on-farm irrigation infrastructure.
2. Efficient water management in rainfed and dryland agriculture.
3. Watershed management for high water use efficiency.
4. Using modern tools for developing cultivars of higher water productivity (biotechnology), monitoring and managing water resources (irrigation commands / watersheds through remote sensing and geographic information system).
5. Formulating regulatory mechanism for groundwater resource development and utilization.
6. Emphasizing on integrated and conjunctive use of rain-, surface-, ground-, and waste-waters.
7. Development of cost effective and eco-friendly technologies for sustainable high production.
8. Reducing the gap between the irrigation potential created and utilized.

9. Providing incentives for adoption of water-wise technologies including use of agro-chemicals and additives.
10. Sensitizing farmers to the value and scarcity of resources and negative implications of improper use of water.
11. Use of low cost water saving and conservation technologies such as drip, sprinkler, System of Rice Intensification (SRI), Direct-Seeded Rice (DSR) and conservation agriculture (CA).
12. Institutional mechanism for recovery of operation and maintenance costs through realistic pricing of water for different stakeholders.
13. Promoting use of renewable energy e.g. solar energy for pumping and other agricultural purposes.
14. Promoting multiple use of water through identification of cropping / farming systems which can enhance water productivity.
15. Development of crop-specific fertigation schedules to enhance nutrient use efficiency.
16. Gearing the extension agencies / line departments for speedy transfer of improved technologies.
17. Use of weather forecasting and ICTs for efficient water use.
18. Development of user-friendly Decision Support Systems for real time decision making for irrigation.

Soil Moisture Dynamics for Sustainable Agriculture

RAJAN BHATT AND S.S. KUKAL

Delineation of the soil moisture dynamics is most important area of research. Scientists evaluated technologies which improved moisture status at farmer's fields. viz. mulching, soil matric potential based irrigation scheduling, precision land levelling, direct seeded rice, zero tillage and mechanical transplanting of rice being advocated as resource conservation technologies (RCTs) for moisture conservation vis-a-vis sustainable agriculture. However, performance of these technologies is site and situation specific thus one must be very careful in selecting and adopting them on his or her field. Delineation of soil moisture dynamics prevailing under a particular technology is very important in this regard, not only during the cropping season but also during the intervening period. Only then a particular RCT should be recommended to him for improving his land and water productivity even under stressed conditions arises soils might be because of lowering of water table as in central Punjab or under saline-sodic soils. Under evapo-transpiration (ET) component, RCTs which lessen the evaporation (E) and partition higher fraction of ET water towards transpiration (T) component finally improved the grain yields.

From instrumentation point of view which generally used in evaluating the soil moisture dynamic are time domain reflectrometer (TDR), lysimeter, soil thermometers and tensiometers. However, following aspects require due consideration:

1. *Time domain reflectrometer* directly measured volumetric soil moisture content under a particular RCT at different soil depths viz. 7.5cm, 15 cm and omitting the tedious jobs of gravimetrical method. However, its calibration part is equally important.
2. *Lysimeters* are used for measuring the soil water evaporated under different establishment methods or under a particular imposed treatment during the last 24 hours. It is effective, cheap and reliable method and covering the general disadvantage of already used methods.
3. *Soil thermometers* are used to measure the energy available to cause evaporation under a particular RCT. Lesser the energy, lesser the phase change of liquid to gas and finally partition greater fraction of ET water towards the transpiration (T) component which finally improves the land as well as water productivity viz. mulched plots had lower soil temperature, evaporation and finally higher grains.
4. *Tensiometers* are used for irrigating a crop depending upon the soil moisture tension or as per crop demand. Generally, farmers used to frequent irrigate their crops which further reported to coupled with lower nutrient use efficiency, lodging and lower yields. However, tensiometers delineate the soil moisture dynamics prevailing under different RCTs at differential depths and guide us when to irrigate under different RCTs for improving the both land and water productivity.

By adopting these techniques, we could better delineate the soil moisture dynamics prevailing under different RCTs in texturally divergent soils. Only then these RCTs transferred to the farmers for made significant improvement in their livelihoods even under water stressed conditions.


TDR


Tensiometer


Lysimeter

Policy Perspectives for Improved Water Use in Agriculture

Some of the possible interventions for enhancing the efficiency of water in the context of food, nutrition and environmental security are:

1. Water management in agriculture has to be looked into holistically including crop production, horticulture, fishery and livestock. There is urgent need to optimize water use and enhance water productivity in all these sectors. Economic water productivity (Rs. m^{-3}) in addition to physical productivity (kg m^{-3}) should also be considered.
2. Besides water availability, its accessibility is also a major concern. Water availability needs to be converted into accessibility through technological options and policy support.
3. About 30 M ha of the created irrigation potential is not fully utilized, therefore revitalization of irrigation systems should be implemented on priority basis.
4. Water management technologies play a key role in saving water and increasing crop production, relooking at technology options according to the regions and their up-scaling mechanisms, therefore, should be taken up on priority basis. Up-scaling micro-irrigation in different states needs special purpose vehicles such as Gujarat Green Revolution Company. The micro-irrigation subsidy norms need re-examination to make it more effective.
5. In the case of rainfed eco-systems, as rainfall uncertainty is increasing due to climate change, options to provide 1-2 supplemental irrigations should be explored through the development of small-scale storage structures such as farm ponds and percolations ponds.
6. In the race of modernization, several time-tested water management methods are either on the verge of extinction or neglected. There is a need to adequately blend indigenous knowledge with modern approaches to enhance the water productivity.
7. So far the focus has been mostly on irrigated agriculture. However, management of water in the rainfed and dryland agriculture should be given more importance. Increasing water productivity in irrigated, limited irrigated and dryland production systems should be the key to enhance agricultural productivity.
8. Over-exploitation of groundwater is a major concern. Thus, national groundwater improvement initiative should focus on aquifer mapping and participatory stakeholder aquifer management.
9. Climate change is a major challenge for agricultural productivity and food security. Water holds the key for adaptation and mitigation of climate change. Moisture-stress tolerant crop varieties should be developed to enhance their adaptive capacity and improved water management technologies should be adopted to mitigate greenhouse gas emission. Water management research and outreach programmes in the country should be reworked to address the impacts of climatic variability and climate change.
10. As water harvesting has seen limited success, de-silting of reservoir / rivers may be a better option to increase the availability of eater and increase storage capacity. This would have multiple service functions such as in flood control, increase in irrigated areas and increased diversification.
11. There is an urgent need to look into the water management perspective of the Himalayan region considering its agro-ecology, topography and vulnerability.
12. Along with water availability, energy availability and accessibility are important for overall development in which eastern India in particular is severely deficient. Solar energy may open vast opportunities for water use in agriculture and increase efficiency and productivity.
13. Availability of quality data and harmonization of data on water from various sources are the major concern to develop adequate strategy and policy options. Thus, there is need for robust quality data base and adequate planning to acquire quality data.
14. Draft National Water Policy (2012) should include various policy dimensions related to agriculture since more than 80% of freshwater is used in agriculture.
15. Location specific sustainable practices and technologies should be validated and up-scaled through the development of more effective farmer-oriented capacity building programmes.

(*State of Indian Agriculture Water, NAAS 2015*)

Impact of Soil Organisms on Soil Physical Conditions

Soil organisms play very important role in soil physical condition improvement which affects plant growth by influencing root distribution and the ability to take up water and nutrients. Good physical condition facilitates oxygen and water infiltration and can improve water storage, increasing fertilizer use efficiency in plants, ultimately, improves productivity of soil. The physical condition of the soil plays a large role in influencing the nature of biological and chemical reactions. Physical, chemical, and biological reactions occur in the soil continuously and are closely interrelated. The physical form of the soil plays a large role in influencing the nature of biological and chemical reactions. The discussion of soil physical environment begins with the sizes (texture) and arrangements (structure) of individual soil particles. These two characteristics intimately affect the pore space between the particles. The pore space is important as the conveyor of water, dissolved mineral nutrients, and air, as well as for providing space in which roots can grow. Finally, it is important to consider the whole soil mass, and how it changes with depth below the surface. The organisms not only help in the improvement of soil physical condition but also carry out a number of transformations, facilitating the availability of nutrients to the plants.

Soil physical condition can be grouped into five categories,

1) Changed soil-water regimes; 2) Root exudation; 3) Root entanglement; 4) Root penetration; 5) Dead root decompo-sition;

Plant roots also influence aggregation through modifying the soil water status in several ways. First, water uptake by plant causes a localized drying of the soil, which promotes the binding of root exudates on clay particles. Second, root exudation reduces the wetting rate by occluding pores or increasing pore tortuosity, thereby reducing slaking of aggregates. Third, water flows preferentially along living roots due to the presence of a saturated film of water along the roots.

The compressing action of growing roots decreases soil porosity in the zone between roots and reorientates clay particles along the root surface. Near the root surfaces, bulk density can be increased from 12 to 35% compared with that of the bulk soil. These modifications occur mostly within a 50-200/pm zone around the roots, inducing the formation of micro aggregates. In contrast, a decrease in macro aggregation after plant growth is partially due to the penetrating effect of roots into macrospores. It was found that, even at constant water potentials, roots decreased the proportions of already formed large water stable aggregates by 20-50%.

The entanglement of particles by roots forms and stabilizes macro aggregates. However, it is difficult to separate the influence of entanglement versus exudation by roots. In addition, arbuscular mycorrhizal (AM) fungi are often associated with root systems, further complicating the separation of the effects of roots versus AM fungi and their exudates.

As plant roots release organic material within the rhizosphere (rhizodeposition), they directly and indirectly affect soil physical condition. Mucilages produced by roots may stick soil particles directly together. Root mucilage such as polygalacturonic acid may stabilize aggregates by increasing bond strength. Roots can also alter the ionic and osmotic balance in the rhizosphere through nutrient uptake and rhizodeposition, which can affect aggregation. The degree of influence by roots on soil structure through root exudation is very variable as production and composition of mucilage depend on various factors such as water regime, plant species, soil depth and time.

During the decomposition of dead roots, soil structure will be promoted, resulting in improvement of soil physical condition, by increasing organic matter soil microbial activity, then decreasing bulk density, compaction thereby increasing soil porosity, water holding capacity or its availability and ultimately, increasing crop productivity.

Mechanical Binding of Soil Particles

Some organisms may be able to mechanically bind soil particles together. The improvement of soil physical conditions is brought about by the addition of organic matter, but organic matter additions have no effect unless soil organisms are present. Bacteria are involved in microaggregate stabilization of soil particles, while fungi are involved in binding together larger soil particles, *i.e.*macroaggregate. The role of fungi may be considered as both are aggregate forming and aggregate stabilizing. By ramifying through the fungal hyphae may bring soil particle together and force their contact with binding agents. Lichens and algae also formed surface crusts in sand through mucilaginous sheaths. In low rainfall areas, it was observed that the crust of sand were interwoven with algal filaments that had bacteria and fungi associates with them. Jastrow and Miller suggested that the soil microflora involved in soil aggregation in several ways. They reported that Micro-aggregates are 20—250/pm in size and are composed of clay microstructures, silt-size microaggregates, particulate organic matter, plant and fungus debris, and mycorrhizal fungus hyphae: these particles are stable in size. Roots and microbes combine microaggregates in the soil to form macroaggregates.

Adsorption of Cells to Soil Surfaces

There are three interactions between microorganisms and soil particles.

- Sorption between microorganisms and surfaces of large soil particles.
- Sportive interactions between cells and soil particles of smaller size.
- Sorption of very small particles to surfaces of microorganisms.

Management for Improving Soil Microbial Activity

Microbial activity can be increased by application of farmyard manure (FYM), because it increases the percentages of organic matter nutrient levels (providing a slow fertilization action over a long period of time), microbial biomass and improves the soils' physical properties (aeration, water holding capacity, etc.). Also the following activity occurs:

- Improvement of soil structure and improvement of water holding capacity.
- Improvement in soil aeration buffering of soil surface temperature.

- Reduction in soil losses due to erosion.

Green Manuring (GM) should be included in cultural practices as:

- It adds organic matter to soil. This simulates the activity of soil microorganisms.
- It improves the structure of the soil.
- It facilitates the penetration of rain water thus decreasing run-off and erosion.
- It holds plant nutrients that would otherwise be lost by leaching.
- It increases the availability of certain nutrients, like P, Ca, Mg and Fe.

The soil microbial population is closely associated with organic matter of soil. Immediately after incorporation into soil, plant materials are subjected to the transformation and decomposition process of heterotrophic microflora.

Plant roots create voids and microspores in the soil so that air and water can move through the soil. Plant roots supply food for microorganisms (especially fungus) and burrowing soil fauna that also keep the soil from compaction. Organic residues left behind by the decaying plants are lighter and less dense than clay, silt, and sand particles which ultimately decrease the average soil density. Soil microflora improves plant growth. Soil fauna improve aeration, porosity, infiltration, aggregate stability, litter mixing, improved N and C stabilization, C turnover and carbonate reduction and N mineralization, nutrient availability and metal mobility. Thus, soil physical condition can be improved through proper management of soil organism through addition of organic manures which ultimately enhance the growth of plants.

(Source: www.icar.org.in)

Watershed based Technology for Ravine

Land and Water Management

Land and water management have to be planned for the entire watershed starting from the ridge and including the table land which usually exists just below the ridge and above the ravinous land. The ravinous land is classified into three categories depending upon the depth of ravines, *viz*. (i) shallow ravines (less than 1m deep), (ii) medium ravines (1-3 m deep), and (iii) deep ravines (more than 3 m deep).

Table land: Usually it is flat or gradually sloping and thus run-off water may not cause serious erosion. However, to increase the productivity of such land through conserved water, field bunding in alluvial soils and graded bunding on black soils is necessary. If the average annual rainfall of the area is less then 500 mm and infiltration rate of the soil high, field outlets may not be necessary as most of the rain-water will seep into ground water quickly. In case of high intensity rain, the run off may flow over the stable (grassed) bunds. If bunds are constructed afresh, compaction of bunds and planting of grass should be done or natural grass be allowed to take over to create a vegetative cover on the bunds. Bunding will prevent the sheet and rill erosion by interfering with free flow of run-off over large areas, as the whole area is divided into many bunded fields.

Peripheral bund: Between the table-land and the ravinous land a peripheral or water diversion bund must be constructed to lead the excess run off from table land to a safe place (water reservoir, farm pond or a stable grassed waterway depending upon the location), without causing any soil erosion. Peripheral bund is essentially a graded bund the cross-section of which will depend upon the run off to be tackled and the type of soil. The bund should be covered with vegetation like grasses, agave (*Agave sislana*), munj (*Saccharummunja*), etc. on the upper side (the side along which water will flow) and the utility trees on the outer side (side facing ravine land). Suitable deep rooted tree species like babul (*Acacia species*), shisham (*Dalbergiasissoo*) or fodder-cum-fuel species like subabool (*Luciana leucocephala*) or fruit trees like ber (*Ziziphusmauritiana*), guava (*Psidiumguajava*), aonla (*Emblica officinalis*), jamun (*Syzygiumcumini*) etc. can be planted.

Shallow and medium gullies/ravines: If shallow and medium gullies/ravines are still active, *i.e*. they are increasing in depth and width with time and their head is still falling apart, following steps must be taken for their control and reclamation:

- Identification of main gully.
- Its bed-stabilization by a loose boulder structure or with a drop-structure (gabion) of appropriate size. On both sides of the structure, a bund of appropriate cross-section will be constructed to guide run-off in to the gully. Such structures with bunds on both sides, will be repeated at different points on the main gully. The gabion drop-structure with reverse filter will retain the silt up-stream and allow only run-off water to pass through. The level of gully-bed will rise as a result of silt-deposition and banks will be stabilized.
- By continuous deposition of silt against the structures (with rising crest-well if necessary), the area between two successive structures will take the form of a bench-terrace in due course of time, after a little land smoothening if necessary.
- Planting of munj (*Saccharummunja*) on the bunds to stabilize these.
- Construction of run-off collection ponds/tanks at suitable sites.

*Deep ravines:*Usually lower part of the watershed has deep and broad (U-shaped) main ravine/gully on alluvial soil and V-shaped deep gully with very steep slope of banks on black soil. It is necessary to reclaim them for their effective use because their banks are too vertical to plant any crop/tree on them and these are almost inaccessible. Also, the bed may not be utilized because it may be submerged under water not only during the rains but also later on because of 'back water flow' of rivulet/river into the gully/ravine.

For reclamation of deep gullies ravines, it is necessary to take 3 steps: (i) To identify the main gully, (ii) To stabilize the main gully and (iii) To treat suitably the deep side-gullies. To identify the main gully, either a relevant toposheet or a recent land at imagery of the area is used. Second step is to construct a series of gabion drop structures in the main gully to stabilize it. Care has to be taken not to keep the height of crest wall of the gabion above gully/ravine-bed more than 1 m to start with. The crest-wall can be raised every year suitably if necessary to tackle too much depth of the ravine. That is, no attempt should be made to raise the bed-level of the ravine to a desirable height just in one shot, because the calculated height of the crest-wall if maintained just in the first year, may impound too much water against the gabion which will not only be inconvenient to farmers' movement but may be too hard on the crest-wall of the gabion and it may bend or deform the gabion. As third step, if side gullies joining the main gully are also deep to very deep, it is necessary to stabilize these. Earthen gully-plugs earlier recommended for this were constructed by knocking down the sharp angular tops of the gully banks under National Initiative on Climate Resilient Agriculture (NICRA) project entitled 'Identification of efficient integrated modules for sustainable management of ravines (Chambal) and carbon sequestration for climate resilience in Madhya Pradesh funded by ICAR. But none of these could hold rain water against them as a hole developed at the point of original flow line on gully-bed and the bund collapsed subsequently. Similarly, a broad based bund made for the construction of a tank at the gully head also breached in the same manner as earthen gully plugs. Therefore, earthen gully plugs have to be replaced by masonry structures of appropriate design at appropriate sites. Thus, if peaks of deep side gullies were changed into a broad terrace and the soil removed was packed on gully bed, the side deep gully will change into a terrace-stable if arrangements have been made to hold the soil in place through suitable masonry/gabion structures. The terrace system can be stabilized by appropriate vegetative cover-grass on slopes and agri-horti system on level part of the terrace.

Cultivable land in our country continues to shrink and its long term effect could be disastrous with the country needing more and more foodgrains to support its growing population. Latest data from the agricultural ministry show that as many as 20 states reported decrease in cultivable land to the extent of 7,90,000 hectares in four years from 2007-08 to 2010-11. The decrease is mainly attributed to diversion of cultivable land to construction, industries and other developmental activities. Besides diversion, about 40 lakh ha area is under ravines-unsuitable for agricultural production. Gullies and ravines form an extensive network along Gomti, Yamuna, Chambal, Betwa, Sindh, Ken and Mahi rivers and their tributaries in Uttar Pradesh, Madhya Pradesh, Rajasthan and Gujarat states. These result not only in loss of non-renewable land and soil resources but also lead to other processes destructive to national economy such as floods in rivers, siltation of water reservoirs and consequent loss in their storage capacity, damage to railway lines, roads and other public properties. Ravines also encroach upon inhabited villages which have to be shifted to new sites to avoid loss of lives. Besides these economic losses, an important socio-economic problem created by deep ravines is providing shelter to dacoits and consequently making the area dacoit-infested. Thus, management of ravinous land so as to control ravine formation, and to reclaim the ravines already formed, is necessary for the survival of present and future generations.

Land Use Planning

Along with execution of land and water management works to control and reclaim ravines, sustainable livelihood systems have to be devised for different land capability classes to make the best use of land and water resources available in the watershed. Not only more remunerative crop plans have to be introduced but also the crop based system has to be replaced by mixed farming of any type suiting a particular farmer. Cropping with dairy animals, cropping with poultry, goat farming, piggery, cropping with fisheries (where run-off collection in a farm pond/tank has been done) or singhara cultivation, and development of silvipastoral system on a sloppy eroded soil by introducing improved grasses, shrubs and legumes, agri-horticulture system and bee keeping suiting the farmers' resources must be introduced. Various land-use plans for different types of land are suggested as follows.

Table land: More remunerative crops such as clusterbean, sesame, groundnut and pigeonpea on alluvial soil and soybean on black soil must be raised. As soil under ravinous land is very susceptible to water-erosion, emphasis must be laid on raising suitable *kharif* crop on sloppy land at least, as a good crop-cover (like that of soybean or pulses) is the cheapest soil conservation measure. There is immense potential to increase their yields by choice of proper varieties, timely sowing and adopting other improved practices of crop production.

Shallow ravines: Shallow ravines can be reclaimed just by establishing proper vegetative cover. The vegetation should be selected such that it provides not only a good soil-cover but is more remunerative also and makes the best use of land and water resources. Agri-horticulture system is most suitable for management of shallow ravines. Fruit plants such as guava, grafted plum, aonla, drumstick and karonda can be planted intercropped by *kharif*crops such as blackgram, greengram, soybean, groundnut, etc depending upon topography of the land.

Aloe vera planting in the inter-tree spaces of plum trees also gave good net return.

Medium ravines: On the land with medium ravines, silvipastoral or hortisilvipastoral system can be adopted for better utilization of land and water resources. Silvipastrol systems can be developed by growing grasses in washes and low level valleys and trees on higher spots (banks of gullies, mounds of soil, etc.). Suitable trees for this are ber (*Ziziphus jujube*) subabool (*Lucaenaleucocephala*), shelvia (*Sesbaniaaegyptica*), agasthi (*S. grandiflora*), sirus (*Albizzialebek*), babool (*Acacia nilotica*) and nilgiree (*Eucalyptus hybrida*). Various grasses for the system are dinanathgrass (*Pennisetumpedicellatum*), anjan (*Cenchrusciliaris*), peelaanjan (*C. setigerus*), marvel (*Dicanthiumannulatum*), mushel (*Isleimalaxum*), ponia (*Sehimanervosum*), tor (*Thalipogonaligans*), broom grass (*Thysanolaena maxima*) and lemon grass (*Cymbopogonflaxosus*) with legumes such as stilo (*Stylosantheshamat*), siratro (*Phaseolusatropurpureus*), pillipasara (*Phaseolustrilobus*), chipkani (*Desmodiumcontortum*) and shaora (*Alysicarpusrugosus*).

Deep Ravines: Afforestation of deep ravines is often recommended, but the land for planting is not accessible and afforestation by aerial seeding of Chambal ravines failed terribly. Afforestation as a single measure is no absolute cure for ravines as serious gullying is noticed even in some reserved forests. Hence, land development as discussed already is necessary. Also, planting of fruit trees with constant care by the owner is as good as or better than afforestation. With run-off collection suitably, beautiful orchards of mango and other fruit trees can be established.

After initial stabilization and reclamation work, agri-horticulture and silvi-pastoral systems can be tried. Alternatively, afforestation with Drumstick (*Moringaoleifera*), Custard apple (*Annona squamosa*), Neem (*Azardirechtaindica*), Gugul (*Commiphorawightii*), Karanj (*Pongamiapinnata*), Siris (*Albizialebbeck*), Shisham (*Dalbergiasissoo*) and Babool (*Acacia nilotica*) can be undertaken. Bamboo plantation is also remunerative and helps in stabilisation of deep ravines.

Run-off Collection and Recycling

Run-off collection and its recycling is very important component of ravine reclamation and control technology. Run off collection can be done in several ways depending upon the site in watershed. Run off will get stored temporarily against submersible check dams, the construction of which will be necessary for stabilization of gully-bed. Also, farm ponds or tanks can be constructed to store runoff. Construction of a tank at gully-head will be very appropriate to hold silt and water. The tank bund has to be of an appropriate cross-section according to the catchment above bund. It should be compacted and protected by planting munj (*Saccharummunja*) agave (*Agave sislana*), grass, etc. Further, it must be provided with a waste-weir of appropriate type and size just above the original flow line of the gully, to dispose off excess of run-off. This tank will serve double purpose of holding water (for recycling/charging) and reclaim and control ravines.

The cultivable land - a basic resource for agriculture is shrinking fast due to not only diversion to non-agricultural use but also due to different types of chemical and physical degradations. Water erosion accounts for the biggest degradation and ravine formation is the most severe form of water-erosion. Since ravines are formed by erosive action of run-off water, rainwater management on watershed basis is the appropriate approach for ravine reclamation and control.

(Source: www.icar.org.in)

What do Soils do for us?

The former President of the United States of America, Franklin Delano Roosevelt, said "The nation that destroys its soil, destroys itself".

There are a wide variety of different soils across the world providing a range of environmental, economic and social benefits to the local human population. Soils are largely hidden from sight and as such can be taken for granted by large sectors of Society.

Did you know?

Soils provide not only the surface on which we live but also a building material. Across the world soil has been and is still used as a primary building material from cob. Houses on the west coast of England, adobe built Pueble homes in the south western United States of America to rammed earth huts in Africa. One half of the world population (~ 3 billion people) lives or works in buildings constructed of soil.

Soils provide the basis of the agricultural and forestry industries. The world's population is expected to expand by 50% to more than 9 billion within the lifespan of today's children – feeding all these people will rely on good soil management and care of our soil resources.

Soils can act as a giant sponge storing water and preventing flooding. Some soils can store in excess of 400 mm of rainfall in the 1st m of soil this information helps engineers control and assess flooding risk, however, poor management resulting in compaction can lead to unexpected flooding.

Soils are efficient 'cleansing agents' and help protect water and air from the worst effect of many pollutants. All the water we drink will have passed through soil, however, we need to take care that we are not exceeding the capacity of some soils to absorb and "lock away" harmful pollutants and thereby become damaged themselves.

Some soils store huge amounts of carbon. It is estimated that there are 15 gigatonnes (15 thousand million) of carbon in the world's soils – three times more than in all vegetation and forests. Current climate warming may accelerate the release of soil carbon into the atmosphere therefore speeding up the climate warming process.

Soils make a substantial contribution to biodiversity. Soil provides a vital habitat for many forms of life ranging from microbes to earthworms and moles. It also provides an interface for all other forms of life.

Soil is essentially a non renewable resource!

Copy from: http://www.soils.org.uk/what-do-soils-do-us

Climate Change Impacts of India

India is faced with the challenge of sustaining its rapid economic growth while dealing with the global threat of climate change. Climate change may alter the distribution and quality of India's natural resources and adversely affect the livelihood of its people. With an economy closely tied to its natural resource base and climate-sensitive sectors such as agriculture, water and forestry, India may face a major threat because of the projected changes in climate. Recognising that, India adopted National Action Plan on Climate Change (NAPCC) to firstly, adapt to climate change and secondly, to further enhance the ecological sustainability of India's development path. Eight National Missions (Solar, Enhanced Energy Efficiency, Sustainability Habitat, Water, Sustaining the Himalayan Eco-system, Green India, Sustainable Agriculture and Strategic Knowledge for Climate Change) have been specially outlined to advance climate change related objectives of adaption.

India is already facing high degree of climate variability and may face additional challenge because of climate change. The incidence of extreme weather events is likely to increase because of climate change.

Trends: Although there is no significantly long term trend in monsoon rainfall or floods in the summer monsoon season at all India level, a warming of 0.4^{0}C in surface air temperature has been noticed over the period 1901-2000. Total frequently of cyclonic storms forming over Bay of Bengal has, however, remained almost constant over 1987-1997. It has been noticed that the Gangotri glacier, one of the largest in the Himalayas, has been retreating since long and more sensitive to global warming. The accelerated melting which these glaciers are experiencing as a result of the earth's warming may have a profound effect on future water availability.

Predictions: it is projected that, by the end of 21st century, rainfall in India may increase by 15-40% with high regional variability. Warming may be more pronounced over land area with northern India experiencing maximum increase. The annual mean temperature could increase by 3^{0}C to 6^{0}C over the century. The United Nations Environment Programme ranks India among the first 10 of the 27 countries that are most vulnerable to sea level rise. Simulations with climate models as well as observations data have indicated that droughts and spells of excessive rain like the deluge that struck Mumbai in 2005 are likely to become more frequent in India with the warming of the world. Any sharp rise in sea level could also have a considerable impact on India.

Although the impact of climate change on water resources has not been accurately quantified, various studies indicate that the likely impact of climate change on water resources could contribute to further intensification of the extreme events. Further, the features of water resources – both the availability and the quality may also be considerably affected by the changes in the land use in the form of urbanization, industrialization and changes in the forest cover. The likely impact of climate change on water resources could be in the form of:

- Decline in the glaciers and he snowfields in the Himalayas;
- Increased drought like situations due to overall decrease in the number of rainy days in many parts of the country;
- Increased flood events due to overall increase in the rainy day intensity;
- Effect on groundwater quality in alluvial aquifers due to increased flood and drought events;
- Influence on groundwater recharge due to changes in precipitation and evapo-transpiration;
- Increased saline intrusion of coastal and island aquifers due to rising sea levels.

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e-mail: soilcsi@gmail.com, bhan_suraj1945@yahoo.com; *Website:* www.soilcsi.in