Principles and Practices of Rainwater Management in the Rain-fed Cultivable Lands in the context of Water and Soil Conservation

Need for Management

Rain Water Management is a concept of controlling, channelising, conserving and effectively utilising the total precipitation falling in a village / watershed. Rainfall is the ultimate source of water for our planet earth. Rain falls as precipitation everywhere as the primary input to the hydrologic cycle. Normally, we allow the falling rainwater to flow down over the land surface finally to the rivers as floodwater and expect the government to bring it back to our fields as irrigation water. This running water need to be appropriately conserved in the upstream rain-fed areas along its flow path for their retention as soil water, ground water or surface water to cater to the green water demand of the forests and crop lands.

Traditionally over the past several generations, the farmers have developed the infrastructure to do cropping during monsoon season followed by pulses with the residual moisture. One cannot say that the people who have performed this feat, apparently without any support, are devoid of any vision.The classification of land quality by Revenue Department and recorded in Record of Rights is not based on size, shape or land levels. It is based on the duration for which moisture is retained in the soil. The land revenue is higher for lands having capacity to support crops of longer duration or for having the capacity to support more than one crop. What does it indicate? Mere change in plot shape and size by leveling and bunding is not real land development. It must also improve the moisture status of the land.

Current Approach

The current approach to soil and water management practices is found to be inadequate for making use of the runoff generated in the non-arable part of the watershed for the benefit of the unirrigated uplands, which are mostly owned by the poor and marginalised section of the society. Wherever sincere attempts have been made to conserve rainwater *in-situ* or *ex-situ* with the prevailing SWC measures, there has been some rise in the ground water table. However, this has not been able to provide a really drought free environment for a *Khariff* crop over the entire rain fed landscape / watershed. Hence, a more simple, practical and novel approach on scientific line is required on the flow path of runoff, to make the soil water available naturally throughout the season, for the crops and other vegetation to take care of the *Khariff* dry spells and aspire for a *Rabi* crop without constructing major water harvesting surface storage structures like farm ponds.

The reason being, conventionally, we have always looked towards surface storage without studying its limitations of (a) storage capacity, (b) recharging capability, (c) evaporation loss and (d) subsurface / base flows. In addition, attempts are made to reuse drainage water by check dams, which benefits a part of low and medium lands but never uplands. There has been no systematic effort (*Ridge to Valley*) to explore the possibility of recharging and using the vast naturally available potential of sub-surface storage in the disintegrated zone lying under the arable part of the watershed. This necessitates conceptualising and using the novel water conservation and management technologies thus discussed hereunder.

Scientific Background

When rain falls on the soil surface, a small portion of it percolates into the soil profile and trickles down due to gravity, but stops at the bedrock or impervious layer. Storage of water inside the soil slowly builds up to a level known as Water Table. We see this water in open dug wells. This water is known as Saturated or Gravitational water and is used by animals and humans. A part of the water stored is pulled up by capillary force of the soil up to the top layer of soil and retained there as soil moisture. This portion of soil water is called the Unsaturated or Capillary water, which is used by the vegetation.

This process of natural recharge, normally of about 10% of rainfall, is increased artificially by the novel technology to about 50% by appropriate runoff channelisation and management along the flow path. The underground, which has about 50% (*30% to 60%)* available empty porous space, is thus utilised to store the extra rainwater thus put into the ground. The capacity of this storage space is so large that it can store up to two to three years of total rainfall under Odisha situation. Since this is stored inside the ground as Soil Moisture within the plant roots' reach, the plants make use of it most efficiently to convert this blue water to green water. When needed, water is lifted through shallow dug wells as the availability of underground water (both quality and quantity) improves over the seasons. Moreover, the farmers do not have to pay water tax / electricity bill for utilisation of the moisture stored under his field. In addition, he is not required to be on the empathy of an outsider for supply of water for his crops. Social conflicts avoided for supply and distribution of water. Optimum quantity of water is available naturally to his crop free of cost and in time. In such innovations, the dependence on surface storage / farm ponds reduced unless required for a specific purpose like rearing fish, bathing etc.

The Novel Technology

The quantity of normal rainwater availability (about 1500 mm/year) in Odisha is enough to support crops throughout the year. Cultivable lands are best suited for rapid percolation by managing the runoff water and / or rainwater. They are precisely laid and properly bound. In many completed projects with such novel technologies, farmers have been using the area for growing crops with rainwater only, without any external water source. The treated lands can retain water for a long time. Also, the top soil is worked several times to prevents crust formation inducing for rapid recharge. The farmers are convinced of such water conservation technology and are appreciative of the development done to their fields / village in a participatory manner. This technology can easily be implemented at field level through MGNREGA or Watershed programs by building the technical capacities of the field personnel.

Management Technique

Rainwater management technique can be applied to all type of field conditions be it hilly or plain land. This process can be applied in landscape and watershed scale following the principles of *Ridge to Valley* treatment.

The runoff generated due to rains is allowed to flow in a controlled manner with proper diversions. The runoff flow path is designed / modified in such a way that the flow length as well as the *Time of Concentration* of flow to reach the outlet increases and the water is retained in the field for a longer period to induce maximum rainwater recharge and reduced flash floods. The runoff water is not impounded but allowed to flow at very slow speed over very long distances which augment natural recharge. It is done in three parts by: (a) managing external runoff; (b) managing the rain falling inside the treated area; (c) preventing the loss of soil water through seepage from the treated area. The development processes are as follows.

I) Usually, external runoff comes from the hills and or forest areas located above the treated area. One robust earthen bund is laid above the treated area to prevent the entry of runoff directly into the cultivable area. This bund is laid in a mild grade so that it guides the runoff laterally in slow pace. During the process, most of the water percolates and the balance, if any, is safely guided into the nearby *Nallah* or the field below. This percolated water seeps laterally to low lands under the ground and on the way provides root zone irrigation to crops on the lands below the bund. The debris and rubbish coming down the hill slopes are arrested by it. The bund also protects the low lands from the wrath of flash floods and sand casting. Thus, both runoff and soil loss are managed.

II) On the second part, highlands are bounded with strong field bunds to conserve rainwater falling on individual plots. The excess water, if any, is guided laterally but not down below. This conserves enough rainwater even if no external runoff water is available for the area. Due to *in-situ* moisture conservation, all plots are charged with enough soil moisture regardless of their undulations. All the high lands of the landscape / village are developed to grow light duty crops, fruit trees and most importantly facilitate artificial recharge.
Gullies are controlled by earthen bunds above the gully (horseshoe shape) to prevent runoff entering into it. Larger wider gullies are bunded downstream to convert them into Water Harvesting Structures (WHS) and surplus water released over flatter lands to facilitate infiltration. Sub-surface dykes (SSD) are provided at the outlet of deep gorges to prevent loss of ground water through seepage and maintain ground water table.
Mediums lands are usually having steep slopes and are thoroughly bunded with high bunds. If necessary, Surplus Structures on the plot's boundary may be provided to divert the excess water to side plots but never to plots below. Crops in medium land get root zone irrigation from the rainwater impounded there and from underground flow of in filtered water of highlands flowing down to lowlands.
Lowlands are relatively flatter and never fall short of moisture. Their problem is breaching field bunds by gushing water from highlands and forest / hills above. This is tackled by the work done in the highlands, which absorb part of runoff and moderate the flash floods. Farmers are freed from drudgery of closing the frequent breaches on the fields and bunds during the rainy season. Shallow dug wells can be dug in low lands to pump out water to (i) grow summer vegetable in adjoining medium land and (ii) free low land of water logging to grow legumes instead of summer paddy.

III) Rainwater recharged (naturally and artificially) into the ground does not stay there but slowly drains out of the area through valleys / streams (drainage lines) coming from the catchment. In case of hilly areas, this drainage process is rapid and hence sloppy lands dry up quickly compared to plain or flat lands. This results in *ground water drought* (decreased groundwater levels under the cropped area that result in water-related problems) causing loss of crop production. To prevent this Subsurface dykes / Groundwater dams are built across streams at tactical locations to conserve ground water even after rains. These dams, being underground, do not obstruct normal flood discharge. Obviously, due to treatment to the catchment the flood discharge is also reduced substantially.

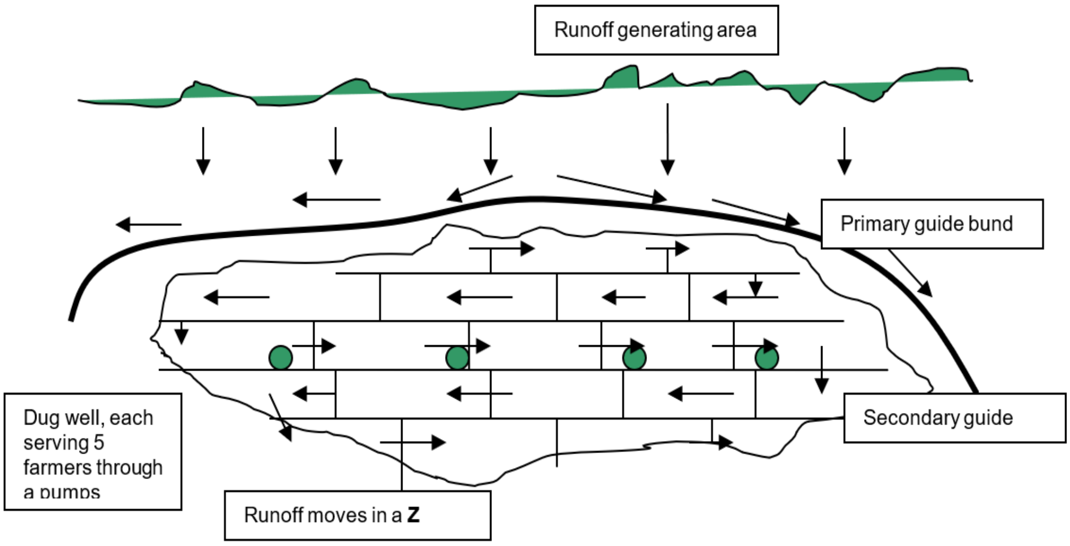

Fig. A: Schematic Diagram of the Development Process of the Novel Technology

Projected Outcome

1. Flash flood coming down the hillside and casting sand and debris in crop field is checked.
2. Damage to field bunds in lowlands due to flash flood checked.
3. The Plants look greener and shining.
4. Crop yield increase by 50 to 100%.
5. Leaf shedding reduced and delayed. This is prominent in case of *Mahul* tree where the base of the tree remains clean while flowers fall and collected
6. In the crop fields, soil surface look dry but plants remain green. In case of bamboo bush, one cannot find dry leaves.
7. Climate remains cooler than neighbouring villages.
8. Rise in water table observed from open wells and ponds hence fish farming viable.
9. Rise in goat / sheep population.
10. In the crop fields, soil clods become soft and break easily.
11. Dilution minimises bacteria and Fluorides contamination of ground water.

Constraints

1. Needs participatory approach to execute and maintain the project.
2. Organic farming will ensure good soil condition and efficient functioning.