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Challenges of dryland areas and community-based technological solutions for drought proofing

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Abstract: *Vulnerability to climate change and drought are closely related with each other. Inter-related variables like demographic pressure, change of land use, and food supply and demand, contribute toward prevalence of drought. It negatively affects dry land communities by entrapping them in a vicious cycle of poverty. Limited water availability and poverty cause further depletion of natural resources through overexploitation.*

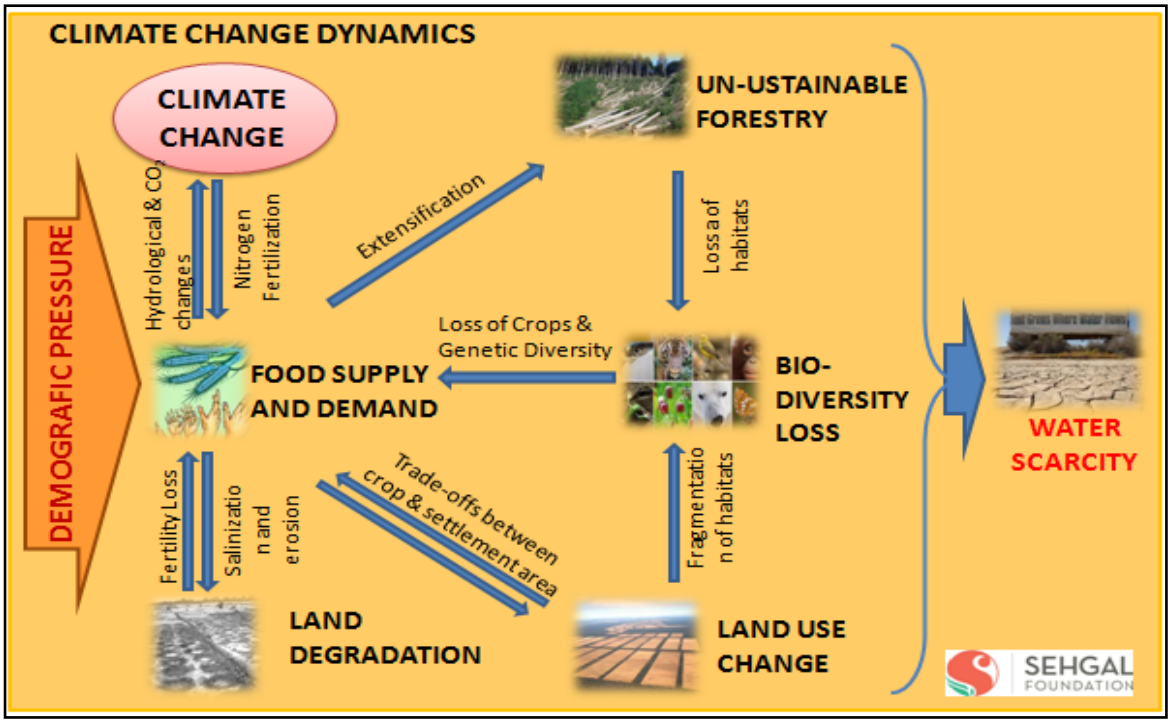
Women and children are among the firsts to suffer this stress. Vulnerability to drought and its social, economic, and environmental stresses, widen the gap between the impact of climate change and the ability of vulnerable population to cope with the change. The situation may lead to a new set of sustainability challenges, including community conflicts over declining natural resources.

Most often, the root cause of the worsening situation is water scarcity. It calls for management of water on both demand and supply side. Sehgal Foundation, a Gurgaon-based NGO, has developed innovative interventions to deal with water scarcity at various levels. These interventions are successfully practiced in semi-arid topography and are highly replicable in dry land areas.

I. Introduction

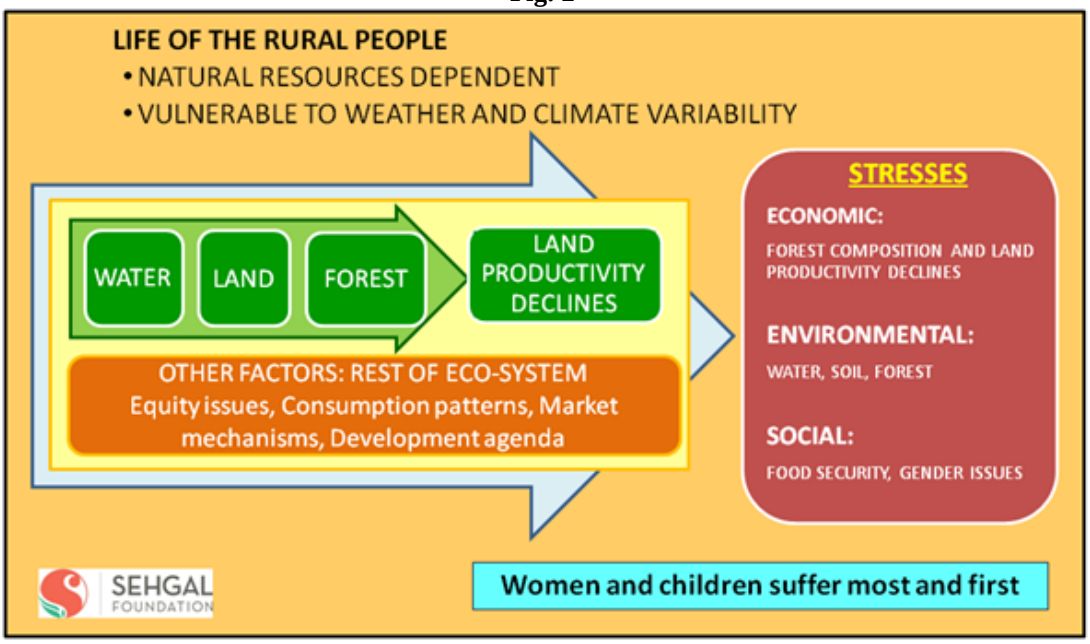
Changing climate has a potential to change crucial aspects that determine the prevalence of drought in any region. Projected changes in the climate would lead to an increase in the drought like condition in water-stressed areas of India (Somanathan & Somanathan, 2009). There are a number of variables triggered by demographic pressure, which ultimately results in water scarcity. For example, if the demographic pressure increases, the demand for food grains will also increase. It, in turn, means that either more area will be used for cultivation or intensification techniques will be employed to increase crop productivity, or both.

Fig. 1



As more and more area is required for urbanization and agriculture, unsustainable measures of intensification or unchecked change in land use exert pressure on forest resources. It could lead to the loss of biodiversity and affect food supply, resulting in land degradation. Even though the factors depicted in Fig. 1 are not exhaustive, they outline the complex nature of drought determinants. The immediate impact of drought is a reduction in agricultural yields, but there is also a loss of livelihood and a negative impact on rural economy (World Bank, 2011). Moreover, this has a bearing on the lives of poor communities living in the rural areas.

Fig. 2



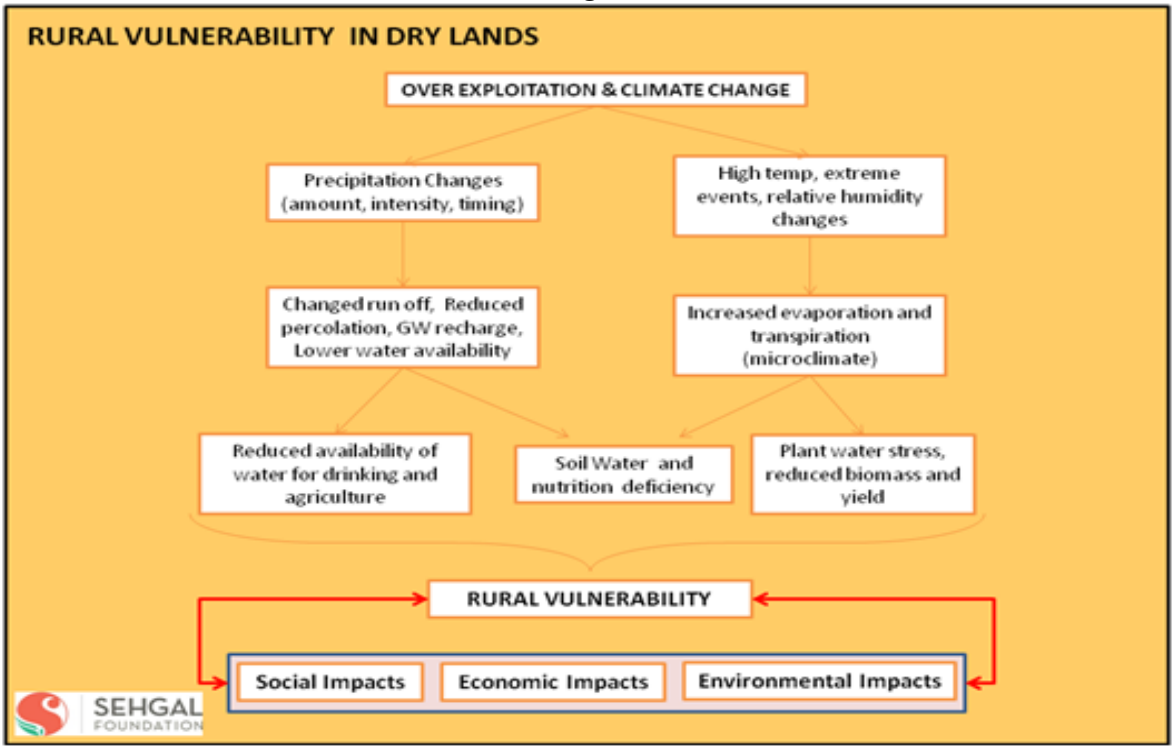
If we look at the lives of rural poor, their livelihood is intricately dependent on natural resources, such as land (agriculture, grazing, fuel etc), water, and sensitive agri-ecology associated with farming, throughout their lifetime. Any change in these natural resources increases sensitivity to stress, which can be classified as economic, environmental, or social. Fig. 2 depicts this typical relationship.

Within the community, women and children are especially prone to social implications caused due to these stresses (Olsson et al., 2014). For example, children's education suffers in case of financial crunch or increased work pressure. Similarly, women are the worst sufferers of reduction in available water. To ease the situation for women and children, we need to emphasize developmental needs of women and children.

II. Climate Change And Drought

Climate change and drought vulnerabilities are inherently dependent. The communities residing in arid or semi-arid areas, like Mewat, are primarily dependent on groundwater for daily consumption. Working together with rural communities of Mewat at Sehgal Foundation, we have observed that, in Mewat, intensity of rainfall is increasing whereas number of rainy days is decreasing. These conditions generate larger runoffs but the groundwater recharge, already minimal due to high ground gradient, is reduciing further. Runoff water flows out fast, limiting the time of water concentration for percolation.

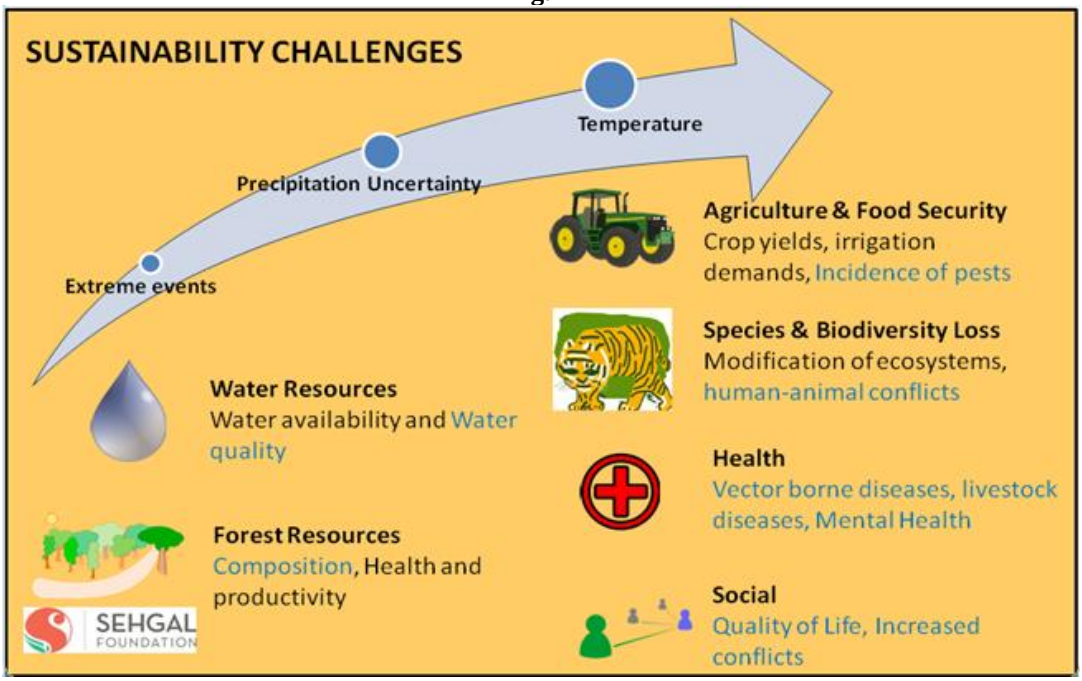
Fig. 3



Reduced recharge causes lower availability of water in such areas, leading to increased vulnerability of small and marginal farmers. Hence, the lower availability of water for irrigation changes soil moisture regimes and decreases farmers' capacity to cope with the situation. Fig. 3 shows how climate change leads to vulnerability loop.

To address this ever-widening gap between the impact and ability to adapt, we need to tackle each of these interrelated factors, besides including new sustainability challenges confronting us. Possible dangers like increase in incidence of vector-borne diseases, risks to livestock health, and even the impact of changing environment on human mental health, are new avenues that need to be explored. Fig. 4 depicts the sustainability challenges arising due to climate changes.

Fig. 4



Poverty trap, formed by climate caused drought-like conditions, aggravates social, economic, and environmental stresses. Overall, it affects the quality of life and well-being of people. Cases of unrest arising over water resources are evident in Mewat (Sharma, Satyavada, & Chowdhury, 2012). In future, it may also lead to inter- and intra-community conflicts over resources.

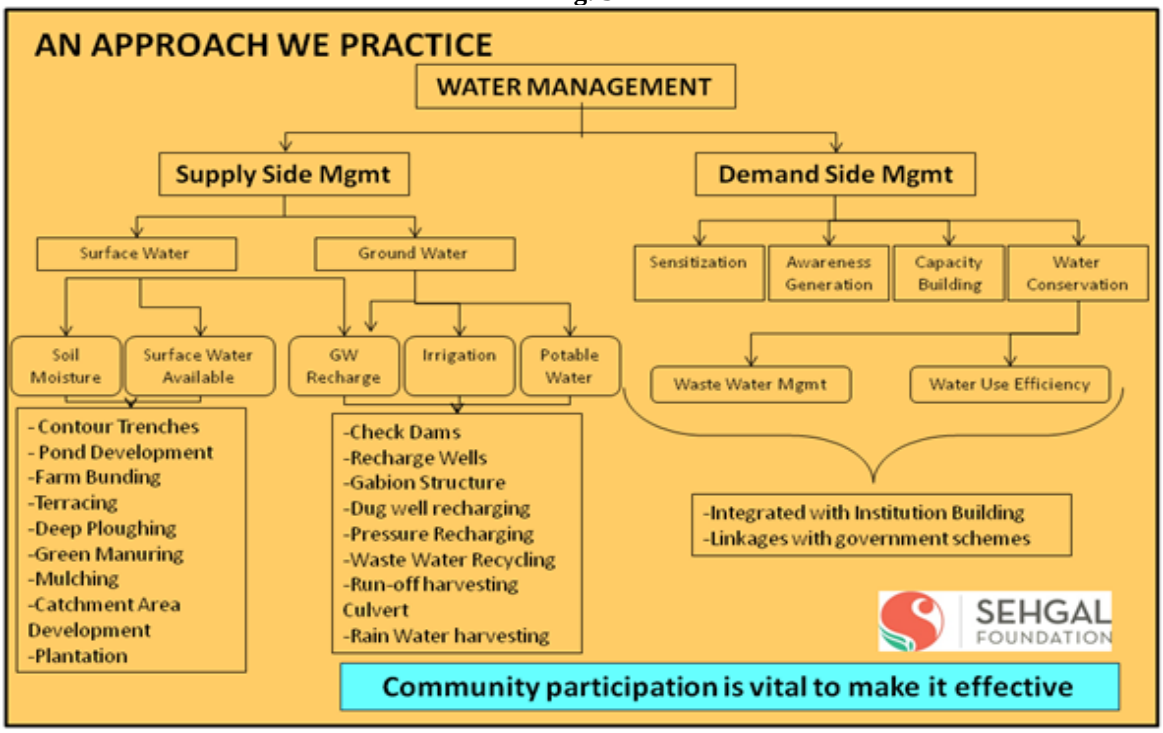
III. Approach of Sehgal Foundation

Sehgal Foundation, an NGO, works on both supply and demand side of water management. It is crucial to work on both the ends because if you only increase the availability of water, it will lead to an increase in demand, and thereon, consumption. For instance, with more available water resources, farmers can switch to water-intensive cash crops. It may even worsen the water situation in the region. Hence, we have to address both demand and supply components simultaneously.

Emphasizing the conjunctive use of surface and groundwater on supply side, Sehgal Foundation works on soil moisture, irrigation, surface, and groundwater, besides potable water. Fig. 5 lists some of the successful interventions of Sehgal Foundation in past.

On demand side, sensitization activities among community members are of prime significance. The community needs to realize that water scarcity is bound to happen in semi-arid regions and it is only going to worsen in future due to climate changes and demographic pressure. With this realization, community can start working by designing needed solutions, considering the future hikes and demands, employing local traditional knowledge. It will increase the preparedness of communities to adapt counter measures.

Fig. 5



Generating awareness and capacity building is the next step. Once the community members are aware of present and upcoming water situation and know that some measures need to be taken, they will also start conserving water and use it effectively. To support and sustain such community initiatives, Sehgal Foundation integrates capacity building with institution building at village level and link these with the government mechanisms.

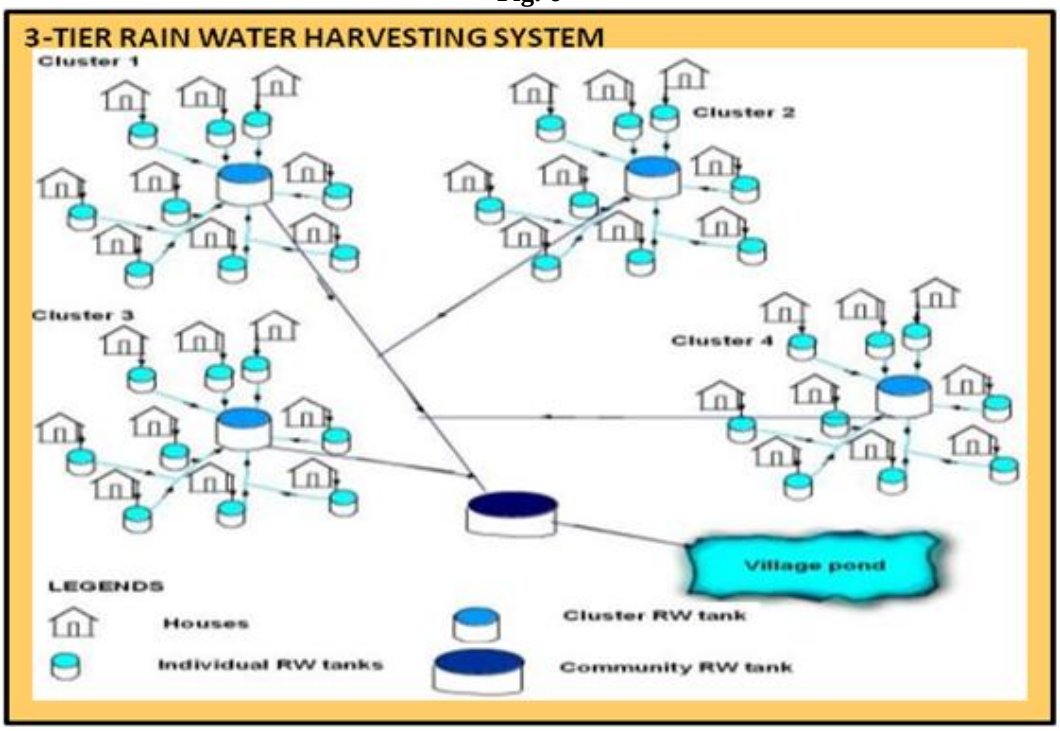
Few innovative interventions Sehgal Foundation demonstrated in Mewat for adaptation are:

IV. Tier Rain Water Harvesting System

In three-tier rainwater harvesting system, water from rooftops of houses is collected in a household tank of 20,000 litres capacity. Surplus water from this tank is collected in another cluster tank of 100,000 litres capacity. Once the cluster tank is full, its surplus is collected in a village tank with 300,000 litres capacity.

Unlike cluster and household tanks, water collected in village tank is not fit for drinking. It can be used for other household purposes. Post monsoon, once the water in the village tank gets over, water from village pond is channelled to the village tank to meet water demand of villagers. It is passed through a roughening filter.

Fig. 6

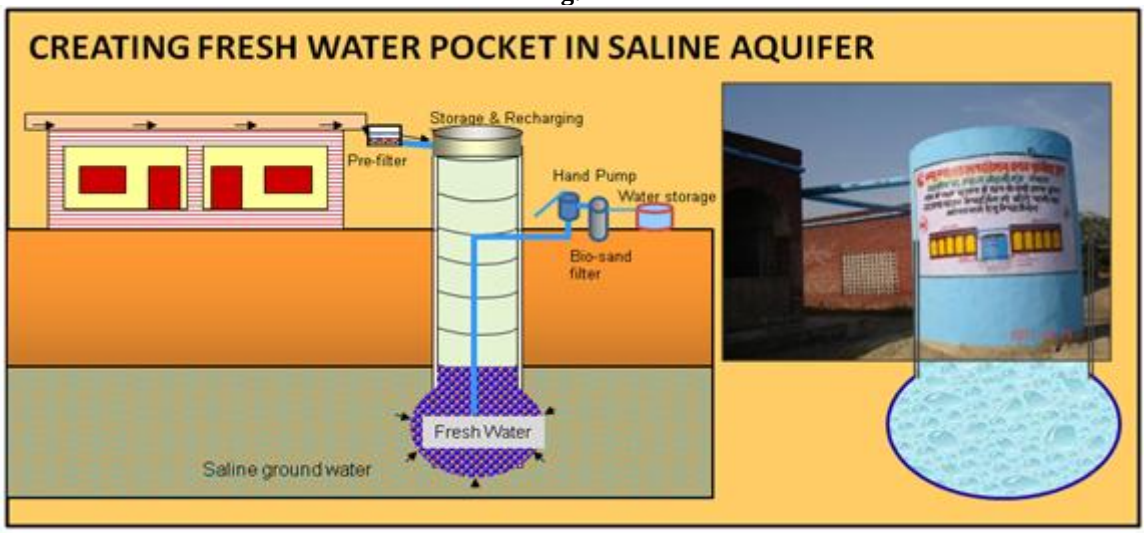


V. Creating freshwater pocket within saline aquifer

Groundwater salinity is a widespread problem around the world with adverse consequences on health, soil quality, and overall eco-systems. The major consequences are scarcity of water even for domestic use and rise in the level and spread of groundwater salinity. Sehgal Foundation developed an innovative technique of creating a pool of fresh groundwater within saline aquifer. It creates freshwater pocket within saline aquifer by recharging harvested rain water to address the need of potable water. Through this innovative recharging, the recharged rainwater does not get mixed with the existing saline groundwater. Instead, it forms a pool of fresh water in saline aquifer. Water from this pool can be extracted without getting it mixed with saline groundwater. This innovation also eliminates the need of cost-intensive provisions of water storage structures to store rainwater for fulfilling the domestic water needs. Thus, saline aquifer rendered otherwise unsuitable or useless, can be used.

The model is a sustainable solution for creating potable water availability in saline groundwater areas (Sharma, 2014). The model has high replication and scaling potential in regions with saline groundwater and coastal areas where seawater ingress poses major salinity challenge.

Fig. 7



VI. Revival Of Traditional Village Structures

Sehgal Foundation's Water Management program is able to revive traditional water structures with the help of community members.

Fig. 8

The structure shown in the photo (left) is a 500-years-old stepped well, which had lost its capacity to catch and hold monsoon runoff and store it for dry seasons. After revival, the structure helps in recharging groundwater using rains.

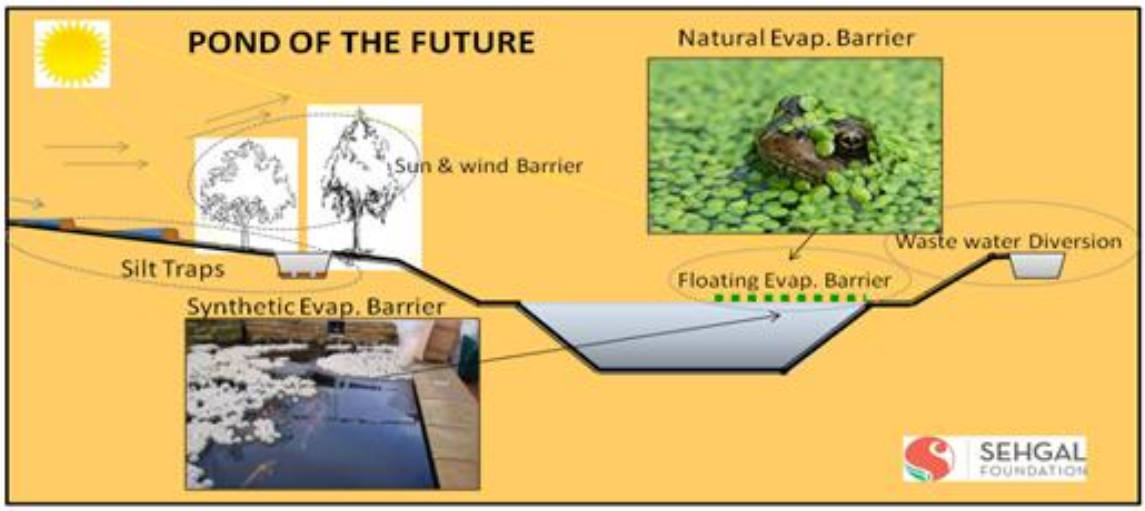
In India, almost all arid and semi-arid areas have such structures, located at strategic locations to form good harvesting point. Unfortunately, these structures are in bad shape and in dilapidated condition cannot hold monsoon runoffs. With little efforts, we can rejuvenate these structures and make them potential sites of rainwater harvesting.

A village pond is important due to its multiple uses. The use of water in a pond is much more efficient than any other water structure as it can be re-used several times. As shown in pictures, these ponds have dense tree cover on its edges. It is a traditional technique to prevent water loss due to evaporation. It works by cutting sunlight, casting shadows and diverting the winds. Orientation of the tree lines is across the movement of sun, so that the water will remain under shadow. Trees will deflect wind from pond, and thus, will help in reducing the loss of water due to evaporation.

Fig. 9

Sehgal Foundation also plans to minimize the loss of water due to evaporation by using other techniques like synthetic floating water surface covering. A floating evaporation barrier is very useful in checking the evaporation rate. Sehgal Foundation used duckweed to cover the surface of pond to reduce loss of water due to evaporation. It also plans to experiment with a synthetic evaporation barrier to cut the water loss by 80%. Most of the village ponds today have become a dumping place of wastewater. A diversion drain can divert this wastewater from storage and catchment area of pond and recycle it. To trap silt flowing into the pond, silt traps (contour walls) can be used. They help in sustaining the pond storage capacity and thus enhance the effective life of the structure.

Fig. 10



VII. Turning road culvert into runoff harvesting structure

A curved wall on the upstream of culvert is used to prevent erosion due to gully formation in downstream fields. It collects runoff water and allows its percolation into ground, before water starts overflowing. This point recharge augments groundwater recharge.

Fig. 11

The concentration of runoff is reduced on downstream, helping in preventing loss of fertile soil due to erosion by increased runoff pressure. Such a process is highly effective and needs minimal cost input.
Culverts can:

- Collect run-off on upstream side
- Recharge collected run-off

It reduces:

- Erosion of top fertile soil
- Gulley formation in agriculture fields

VIII. Converting abandoned wells into recharge structures

Converting abandoned wells into recharge structures by diverting runoff is another simple and efficient technique to recharge groundwater. Using abandoned dry wells, which are well connected with aquifer, is a simple and cost-effective intervention.

Community involvement in these interventions is the backbone of success of every project. Sehgal Foundation employs tools, such as water literacy campaigns, demonstrations using live models, street theatre, and participatory means, to develop and ensure community participation.

Fig. 12

IX. Conclusion

Climate change can potentially affect rural communities in dry land areas through varying availability of water for domestic and agricultural purposes. Scarcity of water causes economic, social, and environmental stresses that have an adverse effect on the lives of rural poor, including women and children. Making water available is a prerequisite of development in such regions. An emphasis is laid on the conjunctive use of water resources and adequate demand and supply management to regulate the use of limited water resources. The Sehgal Foundation demonstrated a few community-based innovative interventions on water management in Mewat. The approaches used for such interventions can improve the overall quality of life and well-being of rural people. These initiatives are helping rural communities to prepare for future challenges, like mitigating drought risk projected under changing climatic conditions. To ensure water security in dryland areas, w
e recommend mass replication of such low-cost and community-driven water management techniques
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