Climate Resilient Moisture Conservation Practices for Dryland Farming

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ABSTRACT
The impacts of climate change are global, but countries like India are more vulnerable in view of the high population depending on agriculture. India is a country with 15 agro-climatic zones, diverse seasons, crops and farming systems. For a majority of the people in India, agriculture is the main source of livelihood. Agriculture is most vulnerable to climate change because it is inherently sensitive to climate variability. The changes in the intensity of rainfall and prolonged hydrological drought during monsoon season could be some of the reasons which can be attributed to climate change effects in Indian agriculture. Successful crop production in frequently drought and flood prone areas depends upon how effectively we conserve the deficit rainfall and manage the excess rainfall and soils to retain the moisture for longer periods for successful arable crop production. Even though the effects of climate change is felt in different kinds of agricultural production systems, they are more pronounced in dryland areas where the agriculture is mostly dependent on rainfall. The climate change effects related to less water availability on dryland crops due to dry spells can be mitigated to a great extent by adopting various in-situ soil and water conservation techniques.

INTRODUCTION
In situ soil moisture conservation entails capturing rain water and retaining it in soil for in situ plant utilization for growth and increase in grain and biomass yield. This is achieved through rain water harvesting on-farm where crops or fodder are planted to benefit from the conserved rainwater. There are a variety of methods that can be used to conserve
soil moisture. The main objective of soil moisture conservation is to minimize the amount of water lost from the soils through evaporation (water loss directly from the soil) and transpiration (water loss occurring through the plants) – or combined, the evapotranspiration. Preserving soil moisture is important means to maintain the necessary water for agricultural production and also helps to minimize the irrigation needs of the crops. This is especially important in areas where rainwater or groundwater resources for irrigation are scarce or decreasing due to climate change or other causes. Location specific in-situ moisture conservation measures are important concern in managing water sustainably over long period.

**Different in-situ moisture conservation practices**

**Deep tillage:** Deep tillage is performing tillage operations below the normal tillage depth to modify the physical or chemical properties of a soil. Deep tillage is accomplished by fracturing the compacted soil without disturbing the top soil, plants and surface residue. Deep tillage may be done as part of the regular land preparations and/or planting operations, except on land that is to be reforested. deep tillage can help increase porosity and permeability of the soil to increase its water absorption capacity.

**Subsoiling:** Breaking the hard and impermeable subsoil with a subsoiler up to a depth of 30-60 cm at a spacing of 90-180 cm to conserve more rain water and improving the physical condition of the soil. It does not involve soil inversion and promotes greater moisture penetration into the soils, reduces both runoff and soil erosion.

**Mulching:** Mulch is a layer of organic (or inorganic) material that is placed on the root zone of the plants. Examples of mulch materials include straw, wood chips, peat. Inorganic mulch in form of plastic sheeting is also used. Mulching is most suited for low to medium rainfall areas, and less suited for areas with very wet conditions. It is one of the simplest methods to conserve soil moisture. Mulches protect the soil from erosion and reduces the compaction from the impact of heavy rains.

**Compartmental bunding:** The entire field is divided into small compartments with a predetermined size to retain the rain water where it falls and arrest soil erosion. The compartmental bunds are formed using bund former. The size of the bunds depends upon the slope of the land. Compartmental bunds provide more opportunity time for water to infiltrate into the soil and help in conserving soil moisture. It helps in reducing the formation of cracks and suitable for lesser rainfall areas.

**Conservation furrows:** At the time of sowing or immediately after sowing, deep furrows of 20 cm depth are formed at intervals of 6 to 8 rows of crops. No crop is raised in the furrow. These furrows can also be formed between two rows of the crop, before the start of heavy rains (Sep – Oct). It can be done with wooden plough mostly in red soils. The conservation furrows increase the infiltration opportunity time

**Ridges and furrows:** It is an archeological pattern of ridges and troughs created by a system of ploughing used in Europe during the middle age, typical of the open field system. Ridges and furrows thus formed act as continuous barrier to the free movement of water downwards thus provides more infiltration time. Hence, the removal of soil along with nutrients is checked to a greater extent leading to increment in soil fertility and crop yield.

**Broad based bed and furrows:** In a broadbed-and-furrow system, runoff water is diverted into field furrows (30 cm wide and 30 cm deep). The field furrows are blocked at the lower end. When one furrow is full, the water backs up into
the head furrow and flows into the next field furrow. Between the field furrows are broad beds about 170 cm wide, where crops are grown. The broad bed and furrow system is laid within the field boundaries. These are laid using either animal drawn or tractor drawn ridgers and suitable when the slope of the land is < 3%.

**Basin listing:** In this method of soil and water conservation, basins are constructed using a special implement called basin lister. These basins are constructed across the slope. Basin listing provides maximum time to rain water for infiltration into the soil.

**Scooping:** Scooping the soil surface to form small depressions or basins help in retaining rain water on the surface for longer periods. They also reduce erosion by trapping eroding sediment. Studies have shown that runoff under this practice can be reduced by 50% and soil loss by 3 to 8 t/ha.

**Benefits of moisture conservation practices**

**Environmental Benefits:** The benefits of many soil moisture conservation methods, depending on the material used, may include better control of weeds, provision of additional nutrients to the soil, soil temperature control and protection of soil surface from the impacts of heavy rain and wind. Active reuse of waste organic materials as mulch also reduces waste management needs, returning the residue crops and plants to the soil through decomposition.

**Socioeconomic Benefits:** Potential to reduce water irrigation needs, increase crop productivity and improve soil quality. By extension, reduced irrigation needs may also reduce the costs and energy requirements of water pumping for irrigation.

**Opportunities and barriers**

Improved soil moisture goes hand in hand with improved soil quality thus potentially improving harvest and reducing soil degradation. Many soil conservation methods are relatively low cost and complexity approaches, primarily relying on the presence of required materials and technical capacity locally. They may create new income and synergies between different crop variety farmers (e.g. using palm oil production residues for mulching). In some settings crop residues are not necessarily ‘residues’, and may already be used for animal fodder, thus necessitating additional investment for soil conservation purposes. Planting of new cycle of crops through mulch or other crop residues may be difficult for non-mechanized agriculture, thus may not be suited in all locations.

**Conclusion and Future Strategies**

The dryland regions of the country have huge potential to produce the food grains, vegetables and spice crops. This region may work as a huge potential to produce several kind of crops in mass to meet the increasing demand of fast increasing population of the country. This dream and targets may be achieved by developing and providing reliable scientific approaches, technologies and knowledge to the farmers like to protect / survive their crops in harsh and hot climatic conditions of the region. There is desperate need to develop and adopt such kind of vegetable production technologies like bunding, mulching, summer tillage, crop rotations, proper plant spacings, rain water harvesting, conservation approaches and further research is needed to develop varieties which are resistant to water stresses. Water use efficiency systems like sprinkler and drip irrigations, ground water treatments should be encouraged in such areas. The desirable targets of the crop production can be achieved by reaching to farmer’s field to understand their problems and to provide the suitable technical
support to nullify the same. Further there is urgent need to develop value added production and a local market to sell the farmer’s produces.

REFERENCES


