| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580| A Monthly Double-Blind Peer Reviewed Journal |

| Volume 8, Issue 8, August 2021 |

Soil and Water Conservation Techniques for Sustainable Agriculture in Western Rajasthan

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ABSTRACT: In Western Rajasthan Soil conservation is the prevention of loss of the topmost layer of the soil from erosion or prevention of reduced fertility caused by over usage, acidification, salinization or other chemical soil contamination.

Slash-and-burn and other unsustainable methods of subsistence farming are practiced in some lesser developed areas. A consequence of deforestation is typically large-scale erosion, loss of soil nutrients and sometimes total desertification. Techniques for improved soil conservation include crop rotation, cover crops, conservation tillage and planted windbreaks, affect both erosion and fertility. When plants die, they decay and become part of the soil. Code 330 defines standard methods recommended by the U.S. Natural Resources Conservation Service. Farmers have practiced soil conservation for millennia. In Europe, policies such as the Common Agricultural Policy are targeting the application of best management practices such as reduced tillage, winter cover crops,[1] plant residues and grass margins in order to better address soil conservation. Political and economic action is further required to solve the erosion problem. A simple governance hurdle concerns how we value the land and this can be changed by cultural adaptation.[2] Soil carbon is a carbon sink, playing a role in climate change mitigation.[3]

In Western Rajasthan Water conservation includes all the policies, strategies and activities to sustainably manage the natural resource of fresh water, to protect the hydrosphere, and to meet the current and future human demand (thus avoiding water scarcity). Population, household size and growth and affluence all affect how much water is used. Factors such as climate change have increased pressures on natural water resources especially in manufacturing and agricultural irrigation.[1] Many countries have already implemented policies aimed at water conservation, with much success.[2] The key activities to conserve water are as follows: any beneficial reduction in water loss, use and waste of resources,[3] avoiding any damage to water quality; and improving water management practices that reduce the use or enhance the beneficial use of water.[4][5] Technology solutions exist for households, commercial and agricultural applications. Water conservation programs involved in social solutions are typically initiated at the local level, by either municipal water utilities or regional governments.

KEYWORDS: western, Rajasthan, soil, water, conservation, management, government, policies, resources

I. INTRODUCTION

In Western Rajasthan, Aims of water conservation efforts include:

- With less than 1% of the worlds water being freshwater,[6] one aim is ensuring the availability of water for future generations where the withdrawal of freshwater from an ecosystem does not exceed its natural replacement rate.
- Energy conservation as water pumping, delivery, and wastewater treatment facilities consume a significant amount of energy. In some regions of the world, over 15% of the total electricity consumption is devoted to water management.
- Habitat conservation where minimizing human water usage helps to preserve freshwater habitats for local wildlife and migrating waterfowl, but also water quality.[7]

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- Avoiding any damage to water quality.
- Improving water management practices that reduce the use or enhance the beneficial use of water.[4][5]

In Western Rajasthan ,one of the strategies in water conservation is rain water harvesting.[8] Digging ponds, lakes, canals, expanding the water reservoir, and installing rain water catching ducts and filtration systems on homes

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are different methods of harvesting rain water. Many people in many countries keep clean containers so they can boil it and drink it, which is useful to supply water to the needy.[8] Harvested and filtered rain water can be used for toilets, home gardening, lawn irrigation, and small scale agriculture.[8]

Another strategy in water conservation is protecting groundwater resources. When precipitation occurs, some infiltrates the soil and goes underground.[9] Water in this saturation zone is called groundwater.[9] Contamination of groundwater causes the groundwater water supply to not be able to be used as a resource of fresh drinking water and the natural regeneration of contaminated groundwater can take years to replenish.[10] Some examples of potential sources of groundwater contamination include storage tanks, septic systems, uncontrolled hazardous waste, landfills, atmospheric contaminants, chemicals, and road salts.[10] Contamination of groundwater decreases the replenishment of available freshwater so taking preventative measures by protecting groundwater resources from contamination is an important aspect of water conservation.[8]

An additional strategy to water conservation is practicing sustainable methods of utilizing groundwater resources.[8] Groundwater flows due to gravity and eventually discharges into streams.[9] Excess pumping of groundwater leads to a decrease in groundwater levels and if continued it can exhaust the resource.[8] Ground and surface waters are connected and overuse of groundwater can reduce and, in extreme examples, diminish the water supply of lakes, rivers, and streams.[10] In coastal regions, over pumping groundwater can increase saltwater intrusion which results in the contamination of groundwater water supply.[10] Sustainable use of groundwater is essential in water conservation.

A fundamental component to water conservation strategy is communication and education outreach of different water programs.[11] Developing communication that educates science to land managers, policy makers, farmers, and the general public is another important strategy utilized in water conservation.[11] Communication of the science of how water systems work is an important aspect when creating a management plan to conserve that system and is often used for ensuring the right management plan to be put into action.[11]

The conservation of water is extremely important in order to preserve wildlife habitats. There are many organisms in temperate regions who are affected by shortages in water.[12] Additionally, many freshwater organisms are increasingly feeling the impacts of water pollution as it disrupts the ecosystem.[12]

"World Water Day" is celebrated on 22 March.[13]

Water conservation programs involved in social solutions are typically initiated at the local level, by either municipal water utilities or regional governments. Common strategies include public outreach campaigns,[14] tiered water rates (charging progressively higher prices as water use increases), or restrictions on outdoor water use such as lawn watering and car washing.[15] Cities in dry climates often require or encourage the installation of xeriscaping or natural landscaping in new homes to reduce outdoor water usage.[16] Most urban outdoor water use in California is residential,[17] illustrating a reason for outreach to households as well as businesses.

One fundamental conservation goal is universal water metering. The prevalence of residential water metering varies significantly worldwide. Recent studies have estimated that water supplies are metered in less than 30% of UK households.[18] Although individual water meters have often been considered impractical in homes with private wells or in multifamily buildings, the US Environmental Protection Agency estimates that metering alone can reduce consumption by 20 to 40 percent.[19] In addition to raising consumer awareness of their water use, metering is also an important way to identify and localize water leakage. Water metering might benefit society by providing a financial incentive to avoid waste in water use.[20]

Some researchers have suggested that water conservation efforts should be primarily directed at farmers, in light of the fact that crop irrigation accounts for 70% of the world's fresh water use.[21] The agricultural sector of most countries is important both economically and politically, and water subsidies are common. Conservation advocates have urged removal of all subsidies to force farmers to grow more water-efficient crops and adopt less wasteful irrigation techniques.[22]

New technology poses a few new options for consumers, features such as full flush and half flush when using a toilet are trying to make a difference in water consumption and waste. It is also possible to use/"pollute" the water in stages (keeping use in flush toilets for last), hereby allowing more use of the water for various tasks within a same cycle (before it needs to be purified again, which can also be done in-situ). Earthships often use such a setup.

Also available are modern shower heads that help reduce wasting water: Old shower heads are said to use 5-10 gallons per minute, while new fixtures available use 2.5 gallons per minute and offer equal water coverage.[23] Another method is to recycle the water of the shower directly, by means a semi-closed system which features a pump and filter. Such a

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setup (called a "water recycling shower") has also been employed at the VIRTUe LINQ house. Besides recycling water, it also reuses the heat of the water (which would otherwise be lost).[24][25]

Contrary to the popular view that the most effective way to save water is to curtail water-using behavior (e.g., by taking shorter showers),[26] experts suggest the most efficient way is replacing toilets and retrofitting washers; as demonstrated by two household end use logging studies in the US.[27][28]

Water-saving technology for the home includes:

- Low-flow shower heads sometimes called energy-efficient shower heads as they also use less energy
- Low-flush toilets, composting toilets and incinerating toilets. Composting toilets have a dramatic impact in the developed world, as conventional Western flush toilets use large volumes of water
- Dual flush toilets include two buttons or handles to flush different levels of water. Dual flush toilets use up to 67% less water than conventional toilets
- Faucet aerators, which break water flow into fine droplets to maintain "wetting effectiveness" while using less water. An additional benefit is that they reduce splashing while washing hands and dishes
- Raw water flushing where toilets use sea water or non-purified water (i.e. greywater)
- Wastewater reuse or recycling systems, allowing:
  - Reuse of graywater for flushing toilets or watering gardens
  - Recycling of wastewater through purification at a water treatment plant. See also Wastewater - Reuse
- Rainwater harvesting
- High-efficiency clothes washers
- Weather-based irrigation controllers
- Garden hose nozzles that shut off the water when it is not being used, instead of letting a hose run.
- Low flow taps in wash basins
- Swimming pool covers that reduce evaporation and can warm pool water to reduce water, energy and chemical costs.
- Automatic faucet is a water conservation faucet that eliminates water waste at the faucet. It automates the use of faucets without the use of hands.

Smart water meters are also a promising technology for reducing household water usage. A study conducted in Valencia, Spain, shows the potential that smart meter-based water consumption feedback has for conserving water in households. The findings showed that households that were equipped with smart water meters increased their water savings. This technology works to show people how much water they were using in their household, suggest ways they can reduce water usage, and incentivize water savings with physical rewards.[29]

II. DISCUSSION

In western Rajasthan, and many other places, many water-saving devices (such as low-flush toilets) that are useful in homes can also be useful for business water saving. Other water-saving technology for businesses includes:

- Waterless urinals (also can be installed in schools)
- Waterless car washes
- Infrared or foot-operated taps, which can save water by using short bursts of water for rinsing in a kitchen or bathroom
- Pressurized waterbrooms, which can be used instead of a hose to clean sidewalks
- X-ray film processor re-circulation systems
- Cooling tower conductivity controllers
- Water-saving steam sterilizers, for use in hospitals and health care facilities
- Rain water harvesting
- Water to Water heat exchangers.

It is important to consider implementing water-conserving changes to industrial and commercial application use. It was found that high-income countries use roughly 59% of their water for industrial usage while low-income countries use 8% for industrial usage.[30] One big change that industrial and commercial companies can implement are to improve the

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assessment and maintenance of water systems.[31] It is easy to add water-efficient applications but it is the proper maintenance and inspection of it which will lead to long-term changes. A water conservation plan can be created, including adding various goals and benchmarks for both the employees and the company.[31] Another change that industrial and commercial companies can make are to check water-consuming systems at regular intervals for any leaks or problems.[31] By doing this, it will ensure that water is not unnecessarily being lost and there is no excess money being spent on utility bills. A third change that industrial and commercial companies can implement is installing a rain sensor. This sensor should be able to detect when precipitation is occurring and stop the program which would normally irrigate the land. After the rain ends, the sensor should turn the program back on and resume to its normal watering cycle.[32]

Water is an essential part of irrigation. Plants always take a lot of ground water thus ground water should be replenished. For crop irrigation, optimal water efficiency means minimizing losses due to evaporation, runoff or subsurface drainage while maximizing production.[33] An evaporation pan in combination with specific crop correction factors can be used to determine how much water is needed to satisfy plant requirements. Flood irrigation, the oldest and most common type, is often very uneven in distribution, as parts of a field may receive excess water in order to deliver sufficient quantities to other parts. Overhead irrigation, using center-pivot or lateral-moving sprinklers, has the potential for a much more equal and controlled distribution pattern. Drip irrigation is the most expensive and least-used type, but offers the ability to deliver water to plant roots with minimal losses. However, drip irrigation is increasingly affordable, especially for the home gardener and in light of rising water rates. Using drip irrigation methods can save up to 30,000 gallons of water per year when replacing irrigation systems that spray in all directions.[34] There are also cheap effective methods similar to drip irrigation such as the use of soaking hoses that can even be submerged in the growing medium to eliminate evaporation.

As changing irrigation systems can be a costly undertaking, conservation efforts often concentrate on maximizing the efficiency of the existing system. This may include chiselling compacted soils, creating furrow dikes to prevent runoff, and using soil moisture and rainfall sensors to optimize irrigation schedules.[19] Usually large gains in efficiency are possible through measurement and more effective management of the existing irrigation system. The 2011 UNEP Green Economy Report notes that "[i]mproved soil organic matter from the use of green manures, mulching, and recycling of crop residues and animal manure increases the water holding capacity of soils and their ability to absorb water during torrential rains",[35] which is a way to optimize the use of rainfall and irrigation during dry periods in the season.

Water shortage has become an increasingly difficult problem to manage. More than 40% of the world's population live in a region where the demand for water exceeds its supply. The imbalance between supply and demand, along with persisting issues such as climate change and population growth, has made water reuse a necessary method for conserving water.[37] There are a variety of methods used in the treatment of waste water to ensure that it is safe to use for irrigation of food crops and/or drinking water.

Seawater desalination requires more energy than the desalination of fresh water. Despite this, many seawater desalination plants have been built in response to water shortages around the world. This makes it necessary to evaluate the impacts of seawater desalination and to find ways to improve desalination technology. Current research involves the use of experiments to determine the most effective and least energy intensive methods of desalination.[38][39][40]

Sand filtration is another method used to treat water. Recent studies show that sand filtration needs further improvements, but it is approaching optimization with its effectiveness at removing pathogens from water.[41][42] Sand filtration is very effective at removing protozoa and bacteria, but struggles with removing viruses.[43] Large-scale sand filtration facilities also require large surface areas to accommodate them.

The removal of pathogens from recycled water is of high priority because wastewater always contains pathogens capable of infecting humans. The levels of pathogenic viruses have to be reduced to a certain level in order for recycled water to not pose a threat to human populations. Further research is necessary to determine more accurate methods of assessing the level of pathogenic viruses in treated wastewater.[44]

III. RESULTS

For soil conservation in western Rajasthan, Contour ploughing orients furrows following the contour lines of the farmed area. Furrows move left and right to maintain a constant altitude, which reduces runoff. Contour plowing was practiced by the ancient Phoenicians for slopes between two and ten percent.[4] Contour plowing can increase crop yields from 10 to 50 percent, partially as a result of greater soil retention.[5] Terracing is the practice of creating nearly level areas in a hillside area. The terraces form a series of steps each at a higher level than the previous. Terraces are protected from erosion by other soil barriers. Terraced farming is more common on small farms. Keyline design is the enhancement of contour farming, where the total watershed properties are taken into account in

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forming the contour lines. Tree, shrubs and ground-cover are effective perimeter treatment for soil erosion prevention, by impeding surface flows. A special form of this perimeter or inter-row treatment is the use of a "grass way" that both channels and dissipates runoff through surface friction, impeding surface runoff and encouraging infiltration of the slowed surface water.[6] Windbreaks are sufficiently dense rows of trees at the windward exposure of an agricultural field subject to wind erosion.[7] Evergreen species provide year-round protection; however, as long as foliage is present in the seasons of bare soil surfaces, the effect of deciduous trees may be adequate. Cover crops such as nitrogen-fixing legumes, white turnips, radishes and other species are rotated with cash crops to blanket the soil year-round and act as green manure that replenishes nitrogen and other critical nutrients. Cover crops also help suppress weeds.[8] Soil-conservation farming involves no-till farming, "green manures" and other soil-enhancing practices which make it hard for the soils to be equalized. Such farming methods attempt to mimic the biology of barren lands. They can revive damaged soil, minimize erosion, encourage plant growth, eliminate the use of nitrogen fertilizer or fungicide, produce above-average yields and protect crops during droughts or flooding. The result is less labor and lower costs that increase farmers' profits. No-till farming and cover crops act as sinks for nitrogen and other nutrients. This increases the amount of soil organic matter.[8]

Repeated plowing/tilling degrades soil, killing its beneficial fungi and earthworms. Once damaged, soil may take multiple seasons to fully recover, even in optimal circumstances.[8]

Critics argue that no-till and related methods are impractical and too expensive for many growers, partly because it requires new equipment. They cite advantages for conventional tilling depending on the geography, crops and soil conditions. Some farmers have contended that no-till complicates pest control, delays planting and that post-harvest residues, especially for corn, are hard to manage.[8]

The use of pesticides can contaminate the soil, and nearby vegetation and water sources for a long time. They affect soil structure and (biotic and abiotic) composition.[9][10] Differentiated taxation schemes are among the options investigated in the academic literature to reducing their use.[11] Alternatives to pesticides are available and include methods of cultivation, use of biological pest controls (such as pheromones and microbial pesticides), genetic engineering (mostly of crops), and methods of interfering with insect breeding.[12] Application of composted yard waste has also been used as a way of controlling pests.[13]

These methods are becoming increasingly popular and often are safer than traditional chemical pesticides. In addition, EPA is registering reduced-risk pesticides in increasing numbers.

Cultivation practices include polyculture (growing multiple types of plants), crop rotation, planting crops in areas where the pests that damage them do not live, timing planting according to when pests will be least problematic, and use of trap crops that attract pests away from the real crop.[14] Trap crops have successfully controlled pests in some commercial agricultural systems while reducing pesticide usage.[15] In other systems, trap crops can fail to reduce pest densities at a commercial scale, even when the trap crop works in controlled experiments.[16] Release of other organisms that fight the pest is another example of an alternative to pesticide use. These organisms can include natural predators or parasites of the pests.[14] Biological pesticides based on entomopathogenic fungi, bacteria and viruses causing disease in the pest species can also be used.

IV. CONCLUSIONS

In soil conservation, in western Rajasthan, when worms excrete feces in the form of casts, a balanced selection of minerals and plant nutrients is made into a form accessible for root uptake. Earthworm casts are five times richer in available nitrogen, seven times richer in available phosphates and eleven times richer in available potash than the surrounding upper 150 millimetres (5.9 in) of soil. The weight of casts produced may be greater than 4.5 kg per worm per year. By burrowing, the earthworm improves soil porosity, creating channels that enhance the processes of aeration and drainage.[21]

Other important soil organisms include nematodes, mycorrhiza and bacteria. A quarter of all the animal species live underground. According to the 2020 Food and Agriculture Organization's report "State of knowledge of soil biodiversity – Status, challenges and potentialities", there are major gaps in knowledge about biodiversity in soils.[22][23]

Degraded soil requires synthetic fertilizer to produce high yields. Lacking structure increases erosion and carries nitrogen and other pollutants into rivers and streams.[8]

Each one percent increase in soil organic matter helps soil hold 20,000 gallons more water per acre.[8]

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