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Experimental Evaluation of Sundaram Verma's one litre Water Technique for Afforestation in the Thar Desert of Rajasthan, India

Adhi Daiv

Class 12
The Shri Ram School, Moulsari, Gurgaon-122002(Haryana)
Mail id:-adhidaiv204@gmail.com
Name of Mentor: **Sundaram Verma**
Rajasthan, India

ABSTRACT

Each vegetation in every climatic zone has different ecological adaptations and to supplement them with new and innovative techniques the proliferation of growth of vegetation can be enhanced. This is the Case of Arid zone of Rajasthan which is the largest state of India and occupies major parts of the Thar Desert. The state, including the Thar Desert faces various problems, the most prominent of which, are the scarcity of water for drinking and irrigational purposes, wide degradation of lands, deterioration of water quality, lowering of the water table due to net differences in annual recharge and water use, and deforestation/continuously decreasing number of trees in the forests and cultivated area. The total annual rainfalls are far lesser than the actual water requirements and the failure of monsoon rains is also common. The high temperatures and evaporation rates cause further losses in addition to runoff water.

The village women along with their young daughters must spend the whole day fetching drinking water for their families, which leaves no time for education. This situation has brought so many social problems to the area like low litreacy, low income, high unemployment rates, malnourishment, gender disparity, and a lack of social facilities. Despite governmental help and many supporting programs, the conditions remain grim.

However, there might be one solution that can combat all these problems including afforestation and agroforestry. This particular solution aims to solve technical as well as social problems through afforestation. Growing more plants will only improve the environment, provide employment to the families in the area, and increase income, all resulting in better social parameters. However, the major constraint for afforestation and agroforestry is the scant availability of water. Thus, this situation warrants an evolved plantation technique that requires minimal amounts of water to work.

The one-litre water technique is a unique plantation technique invented by Sundaram Verma. He is the recipient of the Padma Shri Award, which is India's fourth highest civilian award, along with many national and international awards. He acted as a mentor for the duration of this research. The one-litre technique, like all other scientific theories, needed experimental testing for confirmation. For this purpose, the present research study was undertaken during April 2021 to May 2022.

Methodology:-

The selection of the fields/sites was done before the start of the monsoon season at five villages of the Sikar district in Rajasthan, namely Gramin Mahila Shikshan Sansthan Samiti, Shree Gopal Goshala Danta, Govt. Upper Primary School Kabriyawas, Govt. Primary School Bawari, Govt. Sen. Sec. School Banathala, and Govt. Sen. Sec. School Lamiya. The ploughing of the land was done 5-6 days after the first rain for the removal of weeds and rainwater percolation. Approximately five-six months-old healthy saplings (About 30cm in height) of Ardu (Ailanthus excelsaRoxb.), Shisham (Dalbergia sissoo), Neem (Azadirachta indica), Rohida (Tecomellaundulata), Moringa (Moringa oleifera), Ber (Ziziphus mauritiana), and Khejri (Prosopis cineraria) plants were brought and transplanted in pits of about 15cm diameter and 30-45 cm depth (dug in the prepared soil). One litre of water was applied immediately after plantation and no water was given later during the entirety of the experimental period. Plant parameters of sustainability, number of branches, height, and girth were recorded twice.

The data proved that the one-litre technique was successful in growing all the above-mentioned local plants. The sustainability of plants varied between 90 to 100%. The growth of plants was good with no significant constraint

recorded in this regard.No negative effect on the soil was observed. Rather, it had improved certain characteristics like better soil moisture, organic matter, and phosphorus in the soil. Plants were able to increase soil moisture below the soil – the values of which were much higher in comparison to bare soil nearby. All planned aims and objectives of the project were successfully met.

Future scope:

The study will not stop, and it is recommended that scholars should continue researching the effectiveness of the one-litre water technique on other plants, especially those with higher water requirements. What remains to be studied is the assessment of these techniques under various qualities of water and different soil characteristics like soil texture, salinity, and alkalinity. The researcher will be putting all efforts into studying these areas. Further, the policymakers and respective government departments should run the programs for wider adaptation of this technique. The technique can be broadly used all over the world under conditions similar to that of Rajasthan – drylands and hot arid zones in particular.

The only source of annual renewable water is the scant precipitation.

Situated in the rain-shadow regions of the Aravalli Mountains, Rajasthan only receives an average rainfall of 40 to 48cm, and that too only during the normal monsoon season. The Aravalli Hills run parallel to the Arabian Sea branch, and thus do not form any barrier to intercept the winds. The winds therefore pass-through Rajasthan without causing any rainfall.

Studies of Manwani and Chauhan (2021) indicated that 30 years (1989 to 2018) average rainfall (mm) of the Rajasthan state for the monsoon months; June, July, August, and September are 51.5, 156.1, 144.7, 61.9 respectively. Whereas the annual mean for the same period is 454.9mm. These four months of monsoon in the state therefore receives 12%, 38% (the maximum average), 35%, and 15% of yearly inceptions which total to 91% in the whole year. The remaining 8 months might receive only 9% of total for any year. A more detailed pattern of rainfall has been presented in the Figure 1. It is clear from the rainfall distribution map that most of the experimental areas receive scanty rainfall during monsoon.

The Thar Desert also comprises saltwater lakes like Sambhar, Kuchaman, Didwana, Pachpadra, and Phalodi in Rajasthan and Kharaghoda in Gujarat, which serves as sinks of rainwater during monsoons. This collected water evaporates during the dry season. Similarly, the monsoons are often irregular resulting in frequent droughts in the area.

The underground water level is 24.91 meters (Knoema, 2022). Hence, the Thar Desert includes areas of the state where scarcity of drinking water is a reality. There are only limited resources of water supply to grow plants in the area through normal modes. In some cases, certain thorny and xerophytic plants (Totalist, Juliflora, etc.) may grow on their own.

Figure 1: Natural rainfall pattern of the state of Rajasthan including the experimental area (Prepared by Manwani& Chauhan, 2021)

The continued conditions of water scarcity and associated factors have resulted in the constant decrease of forest area and has made growing of plantation through normal methods quite challenging in the region. In the last 50 years, the tremendous increase in human activity and population have only burdened the limited natural water resources further. The major reason for this outcome was the scanty and minimal water resources of Rajasthan which are just 1.16% of the total water resources of India (Stearns, 2009).

2. The constraints and their causes for restricted plantations/agriculture and the associated problems faced by the Rajasthan community

When plants are grown and plantations/forests are established in an area, countless benefits are expected. Plants control extreme temperatures, provide shade, fuel, and wood. Owing to the water that is absorbed from deep layers of the soil and then transpired into the air, the fully grown trees are also capable of causing an increase in rainfall in the area. The transpired water accumulates in the air, to come back down as rainfall. Thus, the water cycle of the area is greatly affected. On the other hand, desertification poses so many problems related to lands, environment, society, and the community. A few problems faced by the Rajasthan communities are detailed below.

2.1Scarcity of Drinking & Irrigation Water

Water is a symbol of life. No living being can sustain life without water. The insufficient and inefficient supply of water for drinking as well as the irrigation of plants is a peculiar problem faced by every individual living in most parts of Rajasthan. The severity of the problem is indicated by the fact that the per capita water requirement in Rajasthan is 1000m^3, whereas the availability per person is 780 m^3. As a result, drinking water is supplied from resources outside Rajasthan.

The women and girls residing in the rural and urban areas of Rajasthan are assigned the prime duty of collecting and bringing water from far. They walk for miles every day to fetch water for the family and their fields.

It is estimated that an average woman in western Rajasthan walks 2hundred thousand (lakh) kms in her life to fetch water for her household. They spend major parts of their days doing this exercise and are left with no time for school or skill development as a result (Picture 2).

Picture 2: Women carrying water (left) and waiting for their turn to draw water from a well

As per the data collected from the Government of India, the average annual recharge was lesser than the annual abstraction, resulting in groundwater moving deeper and deeper under the soil (Kumar et al., 2009). A more than 40% increase in water usage in agriculture is expected by 2050. This is a huge challenge for the state and its people, considering the growing population and the rapidly decreasing water levels leading to barren lands and deforestation.

2.2 Environmental problems, droughts, land degradation/desertification, and deforestation

Land degradation is a universal problem that's faced by arid regions all over the world. Desertification/degradation has already been observed/declared in 169 countries, directly impacting the lives of approximately 1.5 billion people. The rate of land degradation is expected to increase gradually and is estimated that 75% of global cultural lands might be desertified/degraded by 2050. It will become highly impossible to meet the food requirements of 9 billion people at that time, when 8.9% people of the world are already suffering from hunger (IPCC, 2019).

2.3 The community and Social Problems

Scarcity of water and rising desertification and land degradation in Rajasthan has led to many socio-economic problems in the region. Days spent in managing basic resources like water for crops and household activities prevent members of the rural communities from going to schools or skill development centres. This leads to a low litreacy rate and a high unemployment rate. Even if they find jobs, they are paid very poorly for it, resulting in a lower family income and a poor standard of life.

3. Mitigating Strategies to solve Desertification/Deforestation Problems in the dryland areas of Rajasthan

According to estimates, two-thirds of the Rajasthan state is almost barren and arid, while about one-tenth (9%) of the land is under forest. Therefore, this pressing issue requires immediate and careful attention. All necessary efforts should be concerted to rectify this problem. To suitably proceed in this direction, we'll first need to understand the causes of desertification so that they can be addressed through appropriate strategies.

3.1 Improving the quality of the soil and water management/storage

Soil is one of the most important elements of the ecosystem. It contains both biotic and abiotic elements.

A combination of geogenic (natural or geologic) and anthropogenic (or manmade) processes effect ground water chemistry and quality in Rajasthan. The groundwater is the major cause of land degradation due to its high content of salt and harmful contaminants like fluoride, nitrate, and uranium at levels that exceed both Indian and World Health Organisation (WHO) drinking water norms. The combination of an arid climate, existing geogenic risks where aquifer lithology generates contaminants, and human activities all may lead to multiple water quality issues, further exacerbating human health risks to the population that use groundwater as their major source of drinking water. This ground water must be managed in such a way that the prior removal of salts and contaminants becomes a regular practice before its use. We will be able to sustain the quality of the soil by adopting these measures as a regular practice.

3.2 The Drip Irrigation

Drip irrigation is the most modern method of irrigation in the state. It is the most efficient system of supplying water as and when required (the roots of plants). In this mode of irrigation, water drips slowly from pin-sized holes of a piped device onto the surface/sub-surface of the soil. This minimizes water loss, maximizes effectiveness, and can be delivered via a solar pump, thus also making it environmentally friendly. There is a dire need to help farmers to shift to this method of irrigation. Unfortunately, it is extremely expensive to install, with rates going up to 3,000 USD per acre for installation. This is the reason poor farmers are not able to benefit from such an innovative and sustainable practice. Now it is up to the government to make different policies to make it more accessible for the common people of the state through subsidies, interest free loans, etc. It is in the best interest of the people, as well as the development of the state of Rajasthan.

3.3 The Water Harvesting Techniques

The water harvesting and storage techniques is deeply rooted in the rural, social fabric of Rajasthan. Traditional ways of water conservation like digging and constructing kundis, johads, tanka, and jhalaras, etc., in rural communities has been an integral part of their lives for centuries. This water harvesting technique helps them in crop irrigation and the prevention of soil erosion. It also saves the huge expense of buying water in a time of water scarcity, in these water-scarce areas. If the runoff of rainwater is freely allowed in the absence of any water harvesting technique, it will not only be wasted but also erode the land moving it away and pushing it into waterways where it can also cause earthen choking. Whereas, the saved water can be used for irrigation of plants and crops in dry season times.

Some modern techniques of water harvesting like the ditch and furrow method, sub-surface barriers, etc., have been adopted by many farmers in Rajasthan. Some people in the rural areas also dig huge pits/depressions for this purpose and cover it with a polythene sheet to protect seepage through farm-pond scheme. The rainwater is then collected in this dug up area, and stored to be used later for agriculture, plantations, and livestock (Picture 4).

In Rajasthan, the rainwater harvesting system has also been effectively set up by many people in the rural and urban areas on their rooftops. Through this method, the rainwater on the rooftop is collected and then directed to the tank in the basement of the house for storage. Studies of Yosef and Asmamaw (2015) revealed that the in-situ and ex-situ rainwater harvesting techniques greatly help in improving soil moisture and ground water recharge, reducing water runoff, and increasing agricultural production and effective water resources management.

Picture 4: Using local stones (called magic stones in the area) for devising water harvesting systems

3.4 Agroforestry in drylands and arid areas like Rajasthan

Agroforestry is the combination of agricultural practices and growing plants together. The deliberate combination of woody plants into growing crop and livestock systems. Thus, this may not only increase the income of the farmers but also provide help to prevent land degradation. The land and water resources can thereby, be continuously used without any resultant land degradation. Studies by Prashant et. al. (2017) indicated that agroforestry can protect against soil erosion.

3.5 Afforestation

Afforestation is the best strategy to mitigate the widespread problems of the desert and barren waste lands of Rajasthan. The major limitation in implementing this plan is the availability of water, making it an urgent requirement to innovate an effective technique which requires minimal water for the plants' irrigation. Otherwise, it will only further pressurize the state's already overburdened water resources.

3.5.1 Expected benefits of forests and plantations within agricultural lands

Growing forest plants in any area can create a lot of benefits; the quantum of which are smaller in the beginning but increase as the plants grow bigger and bigger. The advantages are multi-directional, weather and climate, environmental, social, and use of water and marginal lands. A few of these are discussed in a little bit more detail below.

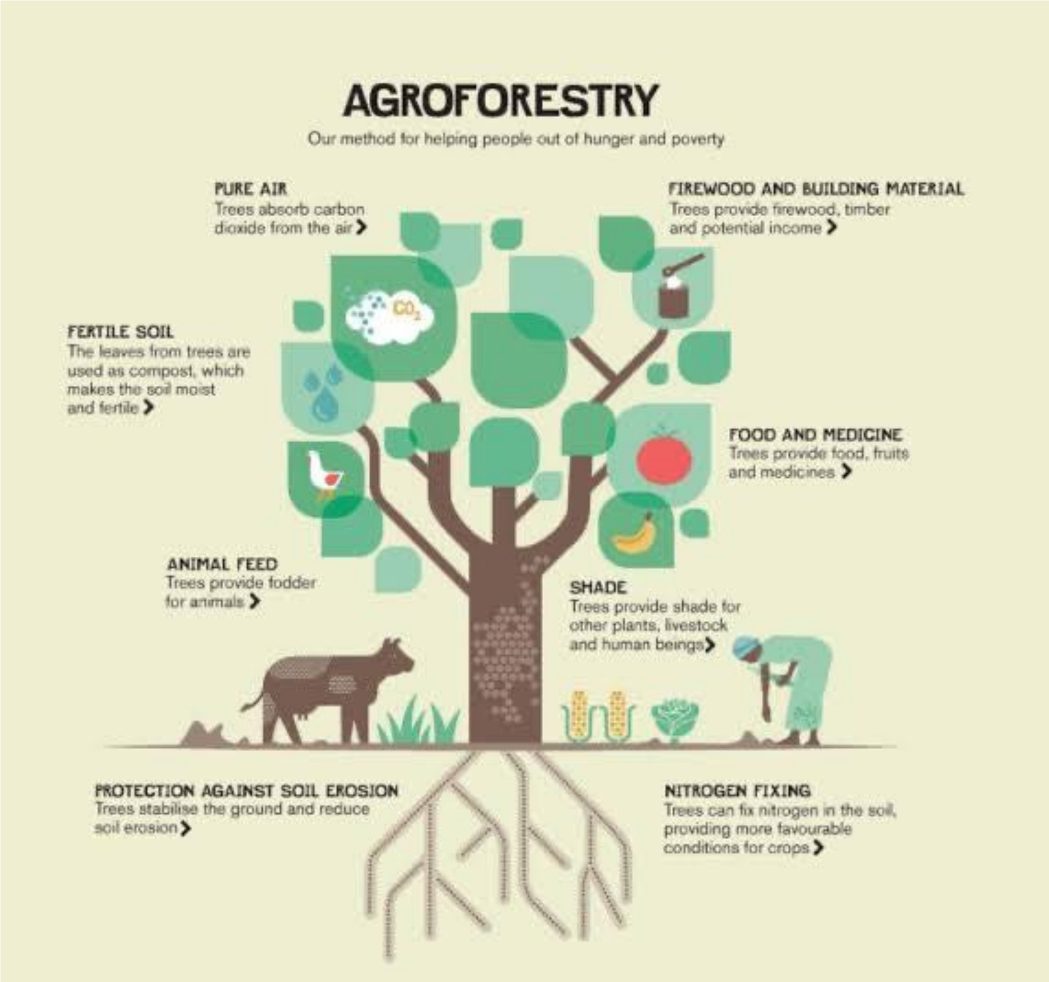


Figure 5: Idealizedoutcomes of Agroforestry

3.5.1.1 Lowering of temperature

The shading effect of plants keep the temperature of the ground lower as compared to the bare land which is open to the sun and its rays. Similarly, transpiration also helps in moderating the temperatures of the surface and air. EPA (2022) has reported that trees and vegetation can lower surface and air temperatures of an area because of shade and evapotranspiration. The tree shaded surfaces may be 11 to 25°C cooler than the peak temperatures of unshaded places. The Evapotranspiration, alone combined with shading, can reduce peak summer temperatures by 1 to 5°C. Therefore, growing trees is a good strategy to keep the temperature of an area comparatively low.

3.5.1.2 Atmospheric humidity, increase in rainfall, and improvement of the water cycle

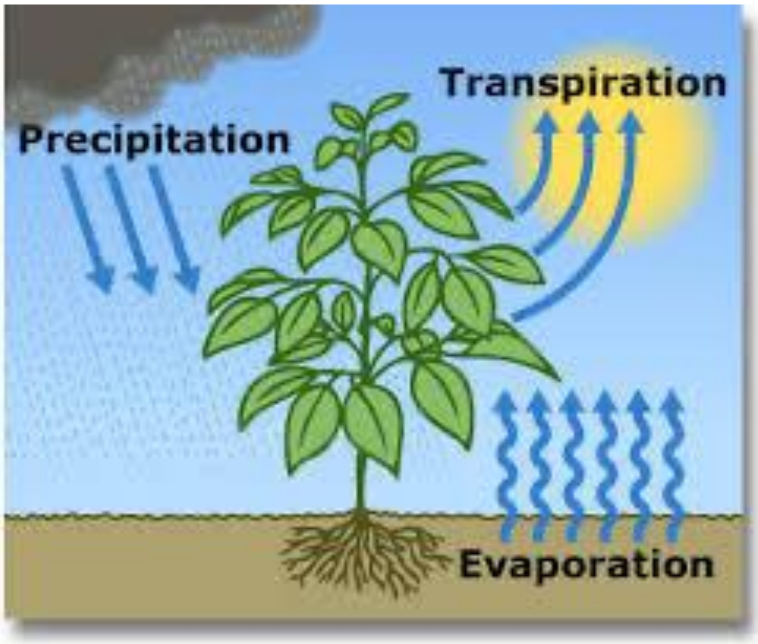
This phenomenon is like the evaporation of sea water causing rains in nearby areas. Therefore, when a reasonable number of trees are grown fully, they start affecting the water cycle of the area and the rainfall pattern also changes. There might be a net increase of yearly rainfall averages as well as an improvement in the frequency and intensity of rains (Fig. 6).

3.5.1.3 Enhanced biodiversity and increasing flora and fauna of the area

Under normal circumstances, an ecosystem exists between the fauna and flora of any area. Whenever these conditions are disturbed by consistent dry seasons, deforestation, excessive cutting of trees, grasses and other vegetation, overgrazing, and land degradation, the whole ecosystem is affected. Some species of fauna and flora may perish or can be destroyed while some others gain domination; thus, disturbing the availing biodiversity of that locality. However, under favourable conditions, especially in those typically created by trees and vegetation, the biodiversity in an area can increase owing to the number of new species that may be growing there. Hence, deforestation and land degradation are harmful to biodiversity while afforestation and revival of land, agriculture, and agroforestry positively retain and increase biodiversity.

3.5.1.4 Carbon Sequestration

It is a well-known fact that plants use carbon dioxide and release oxygen during the process of photosynthesis in the day light. On the other hand, the present lifestyle of people and highly changed human activities are causing carbon dioxide accumulation in the air. It is highly required that the excessively accumulating carbon dioxide be captured and stored elsewhere for other uses. This process is called carbon sequestration. There are plants that can cause carbon sequestration naturally and help maintain the natural environment which is being constantly threatened by human activities.



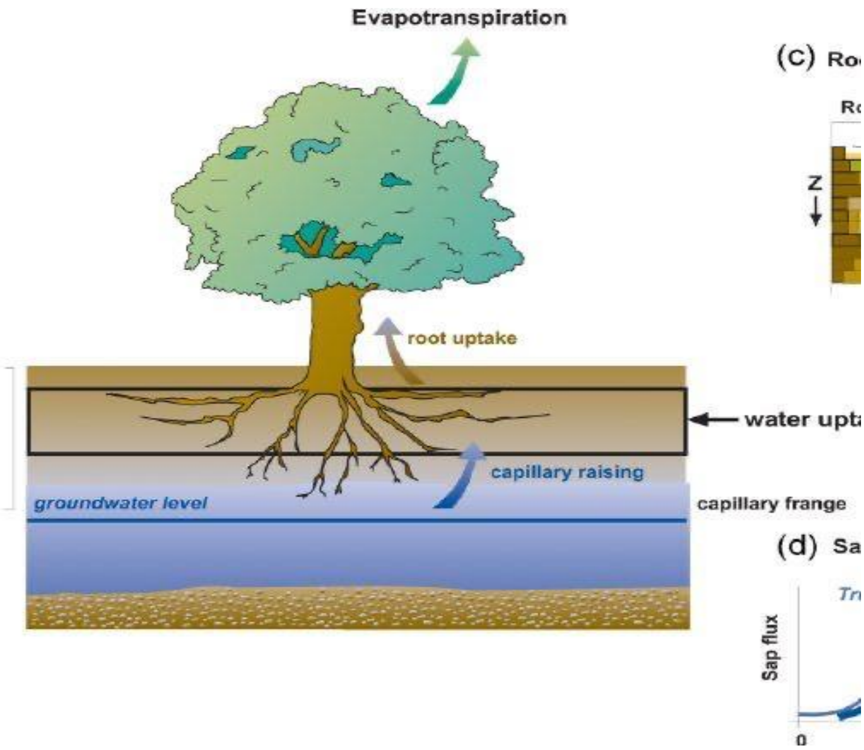


Figure 6: Idealized demonstration of impact of plantations on water cycle of the area

3.5.1.5 Higher crop yield in the area

Plantation requires lesser amount of water in comparison to conventional agriculture. The water requirements of afforestation are still lower in the one-litretechnique which can save more water for practicing agriculture in the area. The availability of more water can increase the crop yields due to the appropriate irrigation of crops. The leaves, twigs, and waste organic material from trees can be applied to the crops as manures. Thus, the increase in soil fertility will be providing more nutrients to the crop plants, thereby increasing their yields. This will not only increase the income of farmers, but also provide food security to the community. Therefore, a combined practice of growing crops and plants (the agroforestry) together will prove highly useful and help in solving social problems of low income, unemployment, gender inequality, and lower litreacy rate.

3.5.2 Afforestation using minimum quantities of water

The present project details planning ways to plant more trees with less water, as one of the best strategies to combat desertification and curb its rapid expansion. The roots of trees hold the soil together and help in reducing soil erosion from wind and rain. Afforestation (planting trees to establish a forest) is a great way for environmentalists and policymakers to solve the climate-related issues of an area that suffers from problems like scanty rainfall, water scarcity, high temperatures, and evaporation. It is also beneficial in the areas with low productivity/profitability due to a constraint of agricultural inputs (water, manure, fertilizer, labor, and implements/ machinery). Forests can improve soil health by reversing land degradation and maintaining clean water.

4. An Introduction to One-litre Water Technique

Mr. Sundaram Verma, recipient of the Padmashree award, India's fourth highest civilian award, is a 69-year-old innovative farmer from the Danta village of Sikar district in Rajasthan, India. Being born in an agrarian community of Rajasthan, he has closely witnessed the problems that farmers faced because of water scarcity in the region. He visualized and worked on a unique technique through which only one litre of water is used to grow any native plant in the desert wastelands of Rajasthan (Figure 7). This special plantation technique of dryland agroforestry can green the deserts of Rajasthan and similar areas of the world using minimal amounts of water. Now, it is possible to revive the desert areas which have been lying barren or degraded for various reasons. Planting on the desert area using the one-litre water technique will help in the conservation of soil and water, reverse some of the degradation of affected areas, promote the growth of green belts in the state, and help many of the socio-economic and environmental issues that affect the region. Mr. Sundaram Verma suggested the following steps/procedures for the execution of the one-litre water technique on ground: -

- Level the land of the project site, before forming a boundary wall with stones around the field where it needed to plant the trees. This will prevent the water from run off or drainage.
- The next step is deep ploughing the field 5-6 times after the first rain of the monsoon season. The depth of ploughing should be one foot deep so that it can remove the weeds and break the soil capillaries, letting rainwater seep into the ground that can be sucked by plant roots later.
- After the last rain of monsoon, again deep plough immediately to turn the upper soil to a deep soil layer for locking the water that was collected under the ground during the monsoons.
- Dig the pits approximately 5 inches wide and one-foot deep to plant the young saplings.
- The saplings are then put in these pits, ensuring that the roots are placed at least 20 cm below the surface of the soil, and covered with wet mud to lock in moisture for an extended time.
- The next sapling is planted in such a way as to leave 2 feet distance between each plant. This facilitates the plant to access all the ground water up to an area of 2 feet around it.
- Lastly, one litre of water is poured into each pit and plants are left to grow.
- One needs to ensure that these plants are protected from being eaten or uprooted by animals and children respectively.
- Last but not the least, it needed to practice weeding and hoeing every three months for the first year till the plants become strong and self-sustainable.

Sundaram Verma claims that he has planted trees like the Date palm, Jand, Neem, Babul, Indian jujube, Rohida, Moringa, Indian cherry, and Meswak along with eucalyptus (requires a lot of water during its growth) using his one-litre water technique of plantation in the arid regions of Rajasthan. This technique is effective in planting different kinds of trees – even those requiring a lot of water for survival and growth. Thus, a variety of vegetation can be grown to promote biodiversity in the arid regions of Rajasthan through this water saving plantation technique of dry land agroforestry. He says that his technique is useful for planting a variety of forest trees, fruit trees, and fodder trees. There is no doubt this technique perfectly matches the dire conditions necessitated by the changing climate, the growing water crisis, and the expanding desertification in Rajasthan.

It is believed that by modifying traditional farming techniques along with the use of Dry land Agro forestry, it can resolve the severe water crisis and growing desertification in the state as well as the world.

However, for large scale adaptations, implementation, and making recommendations based on scientific proofs, it is imperative to conduct experimentation as a planned project using the one-litre technique of dry-land agroforestry devised by farmer Sundaram Verma. This will help experts in the field of agroforestry accept and promote the technique in other parts of the world. For this purpose, This project was executed in the various fields of Rajasthan while growing a variety of native plants using this unique technique of plantation.

Figure 7: Mr. Sundaram Verma, a farmer working in the field visiting Neem plants

5. Planning of the Experimental Project and The Selection of Approaches

Children in the school are encouraged to imbibe and practice these values in their day-to-day life. (Figure 8).

Figure 8: School boys working in the field for growing/ protecting plants

This has helped me take a step in helping my community that faces problems like scarcity of water (for drinking as well as agriculture/planting), food shortage, illitreacy, gender inequality, lack of employment, widespread poverty, low water quality, overexploitation, and land degradation.

That is why all these background facts and problems were enlisted in detail (Sections 1, 2 & 3). The appropriate strategies to mitigate these issues were also identified (Section 3), to address them in a well-planned manner. All these factors have influenced and motivated me to help my community using the resources at my disposal (time, labour, and classroom knowledge and skills). In order to find a simple sustainable indigenous solution to all these problems. This led me to One-litrewater technique of dryland agroforestry.

5.1 Reasons to select the project/ Afforestation activity

It was seen women and young girls walking for miles to fetch water from distant places. Although this was school-going age for girls, they had neither the time, nor the resources for it. As these women walked for miles leaving their children behind, it undoubtedly took a physical and mental toll on them. To find a solution to their predicament, some good-earning people were requested to raise a small fund to arrange water wheels that brought water to these villages. Although this was a temporary relief, they were happy for it. However, It is sought a more permanent solution to this problem.

In the observations, It was discovered the vicious cycle of no vegetation and no water. It is hoped to turn this bereft cycle into a virtuous cycle of adequate rainfall, adequate vegetation, adequate greenery, fodder, and good climate.

Will it be possible to increase litreacy, employment, and educational opportunities, and bring a happier life to my area and community then? In order to get in depth study attended many seminars and conferences and travelled to meet well-acquainted members of the rural communities, and farmers in the state to find a plausible solution. Meeting Mr. Sundaram Verma (who later became my mentor), It was learnt of the One-litrewater technique capable of greening desertified and degraded lands with just one litreof water.

Plantation of native trees also helps to preserve the biodiversity in the region. Overjoyed and motivated, immediately it was decided to evaluate the study through field experiments so that in case of success, it can be confidently recommended and extended in the community. Preliminarily, a Pilot Project Urvara, was initiated by me in 2020, which later encouraged me to plan the current well-documented research project. Though this special plantation technique is developed by farmer Sundaram Verma, How ever was unable to find any journals, scientific or experimentation data, or success rates based on the standard procedures of this plantation technique. Therefore, it was decided to plan and conduct an experiment involving procedures identified under section 4 (Introduction to the One-litre technique). Local plants were to be grown and tested under the prevailing conditions of different plantation sites.

5.2 Approaches that can be adopted for the present study

There could have been three approaches to evaluate the One-litre technique of afforestation of the dryland of Rajasthan, although these approaches are applicable under similar conditions of the world.

I. The collection of online data regarding the subject, reviewing relevant studies available on the internet, and supporting the One-litre technique based on published data and research studies.
II. Planning and conducting the experiment in a single site, in which various plants could be grown and tested for survival and growth using procedures related to the One-litretechnique.
III. Planning and conducting the experiment on multiple sites where single or many types of plants can be grown and tested using the One-litretechnique of dry land agroforestry.

The third approach was selected for this field experiment during 2021-22 to produce a more cohesive, extensive, and viable result, indicative of higher values of reproducibility. This experiment has been planned on the desert barren lands of Government school playgrounds and Shelter for abandoned animals located in five villages and the main city of the Sikar district, Rajasthan. The estimate, assessment, and the significance of manual and time resources were made for all the operations of the planned experiment and are presented in Appendix 7.

Although, the study variable of the current study was only the quantity of applied water (one litrein the present case), the plants were exposed to many other factors that were not part of the experiment, as these plants were grown in open fields. Such factors included temperature (extreme highs and lows), climactic conditions like hailstorms, evaporation, intensity of winds, and water and wind erosion. Due to of the possibility of extreme weather deviating the long-term normal averages and appearing unseen and unexpectedly. Therefore ensured the protection of the plants using gunny bags (made of fibre or jute, Picture 9) during the experimental planning of the research project, in case of any unforeseen, abnormal weather extremes.

Picture 9: The Gunny bags

5.3 Aims and Objectives of the Project

The major and broad aim of this project is to experimentally test and evaluate the One-litreWater Technique of dry-land agroforestry for growing trees in the desert area of Rajasthan where the scarcity of water is a big problem, affecting the communities in multitudinous ways. This research will lay a sound foundation that explores whether this form of plantation using minimal amounts of water is possible or not. The data, information, and proofs generated through this project will be shared with the experts in the field of agro forestry. Hence, the broad aim of the study has been divided into smaller objectives which are as follows:

I. Testing of the One-litretechnique in the field for growing various types of native plants using only one litreof water during the entire plant growth study period and adjudging the level of success or failure of the technique.
II. To identify whether all kinds of local plants can be grown using one litre of water or not. The experiment also aim to monitor the disparity in the growth factor of different trees. Thus, enlisting plants that can be easily grown using only one litre of water. Additionally, we will also monitor and mention the details of the plants (with more water requirements like whether they are able to be sustained using the one-litretechnique).
III. To study the impact of the One-litretechnique on the sustainability of various plants. Some plants may not be able to absorb water from deep soil through its roots as efficiently as others. This may result in their death, requiring them to be replaced with plants that have shown a better growth rate.
IV. To assess the impact of the one-litreplantation technique on different soil parameters and record findings.
V. To make recommendations and share the data of our findings with all the stakeholders: policy makers, experts, researchers, farmers, and the international community of agroforestry. After the approval of the report from my school, the data and information will be submitted to an appropriate journal so that the project’s outcome, in its entirety, is shared with the international community. They can benefit of the results when the technique is applied under the similar conditions.

5.4 Significance of the Study

One third of the land’s surface is desert. Finding a way to use these wastelands productively can solve the global problems of food, energy, water, and climate change.

Our research project will be highly significant as it will verify the success or failure of the One-litre technique of plantation in desert lands. This can chart future courses of action in the realm of agriculture, aiding planters, and farmers of the desert region of Rajasthan and the world alike. In case this study finds that the specific plantation technique used doesn’t yield the desired results, there fore it is high time to take appropriate action to inform farmers and the rural community locale to not depend solely on it. The success of this unique plantation technique can solve so many problems like, deforestation, desertification, unemployment, and depleting food stores and feed supplies. Thus, the success of the study and its subsequent adaptation will help a lot to develop a more productive and conducive environment as well as social system.

6. Methodology, Procedures, Climatic Conditions, Soil Status, and Monitoring of Performance

The one-litrewater technique of plantation prevents rainwater runoff and evaporation and conserves water under the sub-surface of the soil, subsequently allowing mature plant roots to absorb the required amount of water. Therefore, major methodological requirements for this experiment include levelling the fields, placing stones

and earthen material on the boundaries, keeping the lands ploughed after the first monsoon shower, breaking the soil capillaries to check for evaporation, and eventually growing plants in pits (dimensions: 12-15 cm width and 30cm depth) dug in prepared soil. For preparing the soil, deep ploughing was done after 5-6 days of the first rains and weeds were destroyed. The purpose of deep ploughing is to break capillaries of soil for a second time when the monsoons are over. The plants were placed in the pits and subsequently coved with soil/ mud and one litrewater was applied. These are all major elements of the One-litretechnique of plantation.
Following steps were followed to complete the whole process:

- The selection of the fields/sites was done before the start of the monsoon season. The sites selected in different villages of the Sikar district in Rajasthan are Shree Gopal Goshala Danta, Govt. Upper Primary School Kabriyawas, Govt. Primary School Bawari, Govt. Sen. Sec. School Banathala, and Govt. Sen. Sec. School Lamiya. Soil samples were obtained from all sites and sent for analysis to the lab (Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, State Department of Agriculture).
- Ploughing of the land 5-6 days after the first rain. This is done to remove the weeds and facilitate the percolation of rainwater (Fig. 10)
- A small bed about one foot deep was made in the centre of the field as soon as the rains ended.
- Pits of about 15cm diameter and 30-45 cm depth on the marked spots were dug.
- During September 2021, the plant saplings were put in the pits (after removing polyethylene bags) in such a way that all the roots remain underneath the soil at 20-30 cm below the surface.
- The roots were then covered, leaving an area of 15 cm open at the top to facilitate watering. The entire operation (from digging the pit to planting saplings) should be finished in minimal time to avoid moisture loss (11).
- One litreof water was applied immediately to the saplings mixed with 2 ml pesticide. The saplings were then left to grow without any additional water or input, except weeding and hoeing. The sustainability of the plants was recorded, and dead plants were replaced by new ones (Appendix 4).
- The weeds around the plants were manually removed on a regular basis, especially with a regular interval of 15 days during the experimental period (September 2021 to March 2022). This is an important step that needs to be followed for the first year, until the plants become strong and self-sustaining.
- Plants were protected from hard weather, insects, and diseases (Fig. 12).
- Plants could successfully grow (Figure 13) for data recording.
- The major plant parameters like height and girth were first recorded during December 2021, and then towards the end of the experiment period in April 2022. Soil samples for the laboratory report were first collected in October 2021 and then again towards the end of the experiment. The soil samples were collected and sent to the lab for analysis.
- All operations were carried out under the guidance and instruction of my mentor, and all problems faced were immediately reported to him for further understanding.

Plants were covered with Gunny bags, allowing a small hole facing the direction of the sun to protect them from the winter cold and making sure that they still received enough sunlight to facilitate photosynthesis (Fig. 12). As these bags were made of jute (easily available in the villages), they did not help to retain the heat that much as plastic, which doesn't breathe, can trap moisture that can kill the plant in the cold. Although plastic could be used (even a plastic garbage bag), the covering will need to be removed in the morning. If a sudden cold front is forecasted, an old sheet or a layer of newspapers offers safer protection than plastic, which often does more harm than good.

It was noticed that some plants were not hardy and were more affected by the winter, causingthem to expire and be replaced. It was also noticed that the plants that were placed towards the lower ground level in the field of plantation were most affected by the winter. This was because the flow of wind moved from the upper to the lower direction, affecting the plants in that area more than others. The normal hard weather conditions are always expected during the winter, and these were anticipated. However, during the experimental period, the weather was rare, and temperatures touched -5C while in comparison to the usual -1C in normal years. These un-forecasted conditions affected some of the plants in the open field.The affected plants were replaced (Appendix 4). The subject of limitations of the study has been discussed in more detail under the section 9.

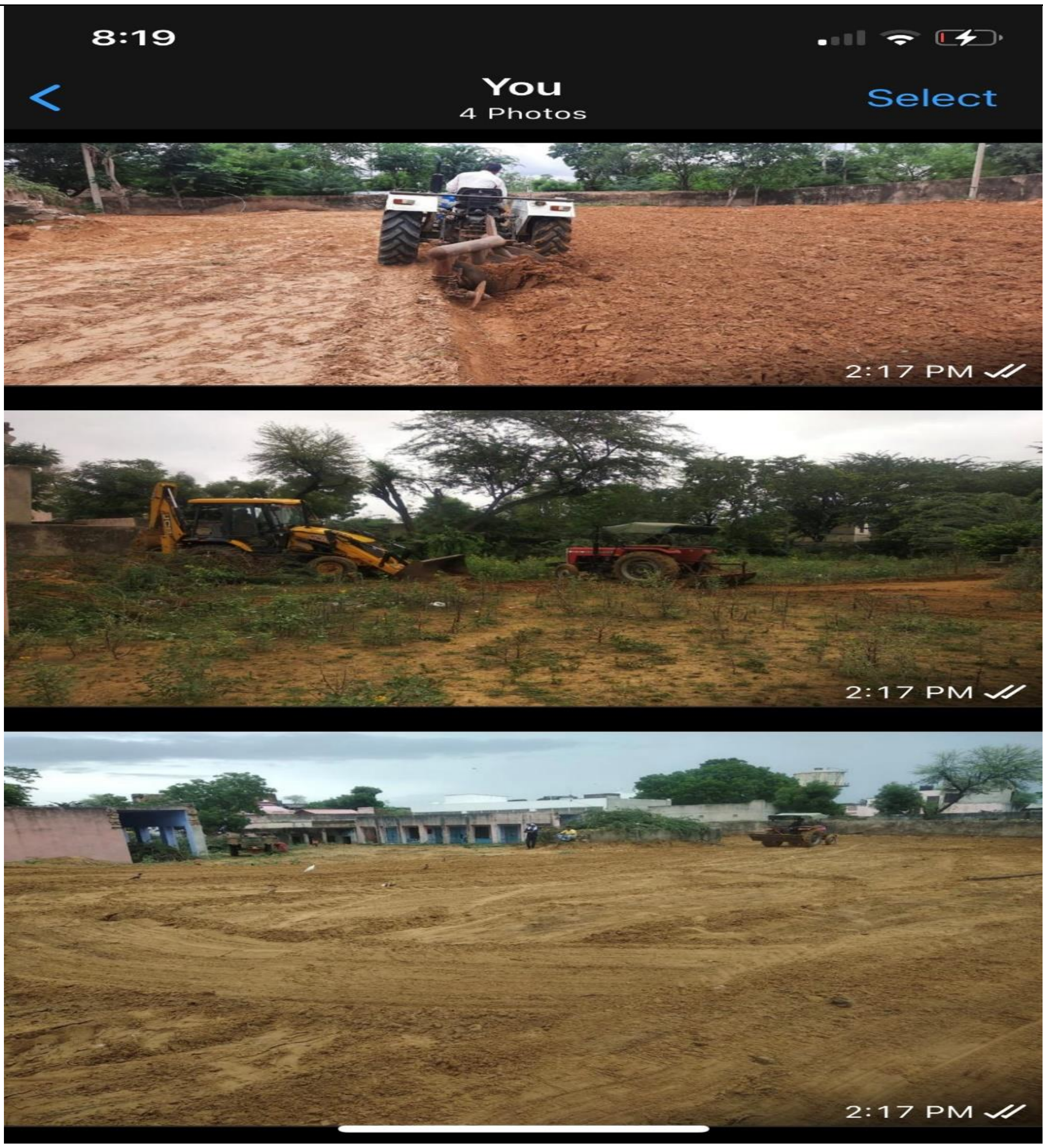


Figure 10: Land preparation for growing of plants

Figure 11: Digging of pits and transplantation of plants

Figure 12: Protecting of plants in summer (using gunny bags)

Figure 13: Well growing plants for data collection

Some more details of the procedure and the monitoring of climatic conditions and soil parameters are presented below:

6.1 Climatic conditions during the period of experimentation

The climatic data from Sikar weather station indicated a minimum temperature of 06.2^{0}C during January 2022 while the maximum temperature recorded was 37.7^{0}C in June 2021 during 14 months for the period March 2021 to April 2022 (Table 2), covering the entire period starting from planning of the experiment to its completion. A maximum rainfall of 208.8 mm was received during September 2021 when the plants were being transferred into the pits, whereas during the 4 months (March, April and November 2021, and April 2022), there was no rainfall inception at all. The data from the weather station Churu indicated a highest mean evaporation of 9.1mm/24 hours, whereas the minimum value of 1.1 mm/24 hours for this parameter was recorded during January 2022 (Table 1).

6.2. Soil conditions at the experiment sites

The analysis conducted at the start of the experiment (October 2021) revealed that the experimental soil was light in texture (sandy soil) and slightly alkaline in respect of pH (Table 2). The Measuring Electrical Conductivity (EC) of the soil tells us how much nutrients there is in the water. For most plants, ideal EC measurement is between 1.2-1.6 during the vegetative stage and 1.6-2.4 during flowering, but this can also depend on the type of plants that are grown. Salt content measured as Electrical Conductivity (EC) in our plantation site soil was on the lower end, but well within the normal range. Thus, proving that the soil is unproblematic and viable. Most of the soil fertility parameters (Phosphorus, Sulphur, Zinc, Iron, Copper, and Manganese) were in medium or sufficient range. However, organic matter of this soil was still low, requiring the application of manure whereas Potassium was assessed as high.

6.3 Some physical and social milestones for monitoring:

a. The sustainability of plants must be monitored, and dead plants must be replaced.
b. Plants should be monitored and protected from the spread of any kind of pest or disease. Immediate steps should be taken in case of any appearance of infection or infestation.
c. The beneficiaries should take due care of nurturing and protecting the plants by means of social fencing.
d. From time to time, feedback should be collected from Agricultural research institutions, non-governmental organizations, and other such institutes for further improvement of the technique over a period.

6.4 Matrix for measuring the intended performance:

A. Number of trees surviving at the end of every season.
B. Climatic changes during experimentation.
C. Comparison of the soil conditions before and after planting the trees.
D. The increase in the number of branches, and the height and girth of the plants every six months.

Table 1: Climatic data of experimental sites during the experimentation period

Month	Weather Station-Sikar			Weather Station-Churu
	Mean Maximum Temperature ^{0}C	Mean Minimum Temperature ^{0}C	Rainfall in mm	Evaporation in mm per 24 hours
March-2021	33.3	16.0	000.0	06.0
April-2021	36.9	17.8	000.0	07.5
May-2021	37.7	22.7	106.0	07.6
June-2021	37.7	24.7	048.0	07.6
July-2021	36.1	25.1	175.0	06.0
August-2021	34.1	23.2	153.0	06.3
September-2021	32.1	22.4	208.8	03.8
October-2021	32.6	17.3	033.0	04.1
November-2021	28.9	09.7	000.0	02.7
December-2021	22.9	07.3	002.0	01.6
January-2022	18.8	06.2	042.0	01.1
February-2022	25.6	09.6	005.0	03.0
March-2022	26.3	12.5	004.0	06.2
April-2022	34.7	19.2	000.0	09.1

Table 2: Soil Analysis of different experimental sites at the time of starting the experiment (October 2021)

Parameter	Units	Experimental sites for various plants						Rating
		Kabriyawas Dantaramgarh	Banathala	Bawari	Sikar		Lamiya, Palsana	
Soil Textures	-	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Light soil
pH		7.90	7.70	7.80	7.30	8.10	7.90	Slightly Alkaline
Electrical Conductivity (EC)	ds/m	0.09	0.16	0.12	0.07	0.32	0.10	Normal (Non-saline)
Organic Carbon	%	0.40	0.30	0.28	0.30	0.34	036	Low
Available Phosphorus (P)	Kg/ha	24.0	36.0	28.0	24.0	24.0	36.0	Medium
Available Potassium (K)	Kg/ha	290.0	295.0	310.00	290.00	244.00	310.00	High
Available Sulphur (S)	Ppm	21.0	20.00	16.00	18.00	16.00	18.00	Sufficient
Available Zinc (Zn)	Ppm	0.48	0.51	0.45	0.33	0.96	0.38	Sufficient
Available Iron (Fe)	Ppm	4.67	5.05	1.69	160	4.60	1.69	Sufficient
Available Manganese (Mn)	Ppm	3.10	4.12	432	3.23	2.16	3.89	Sufficient
Available Copper (Cu)	Ppm	0.36	0.31	0.36	0.38	0.38	0.36	Sufficient

7. Results and Discussion

The results of the experiment were observed at various stages of the study, tabulated, and the means for different parameters were calculated to present the data and information in an understandable form. The outcomes of it are presented and discussed subsequently under different sub-headings.

7.1 Sustainability of plants under One-litrewater technique

Most of the transplanted plants sustained when grown using the One-litrewater technique. However, a few plants died due to harsh weather conditions like cold fronts and harsh winds. The dead plants were replaced by fresh plants, the details of which are present in the Appendix 4. The recorded data on sustainability percentages indicated that there was no mortality of the Ardu plant when grown in Govt. Upper Primary School Kabriyawas and Govt. Sen. Sec. School Banathala, but the survival rates recorded at Shree Gopal Goshala Danta, Govt. Primary School Bawari, and Govt. Sen. Sec. School Lamiya were 97.42%, 93.2%, and 93.75% respectively (Table 3). The survival rate of these plants was quite high indicating a very low rate of mortality.

No mortality was observed in the case of Shisham (Dalbergia sissoo), Rohida (Tecomellaundulata), Ber (Ziziphus mauritiana), and Khejri (Prosopis cineraria)plants at any experimental site (Table 4, 6, 8 & 9). This revealed that these plants are hardier in comparison to other plants grown in the experiment site. Neem plants indicated 96.49%, 90%, and 88% sustainability respectively at Shree Gopal Goshala Danta, Govt. Primary School Bawari, and Govt. Sen. Sec. School Lamiya (Table 5). These sustainability values were quite high. The respective survival percentages of Moringa plant were found as 90%, 91. 66, 100%, 93.15%, and 84.61% at Shree Gopal Goshala Danta, Govt. Primary School Bawari, Govt. Sen. Sec. School Banathala, Gramin Mahila Shikshan Sansthan, and Govt. Sen. Sec. School Lamiya (Table 7) respectively. As the survival rates of these different plants were mostly above 90%, the survival rate of plants was not a significant problem in this experiment (Figure14).

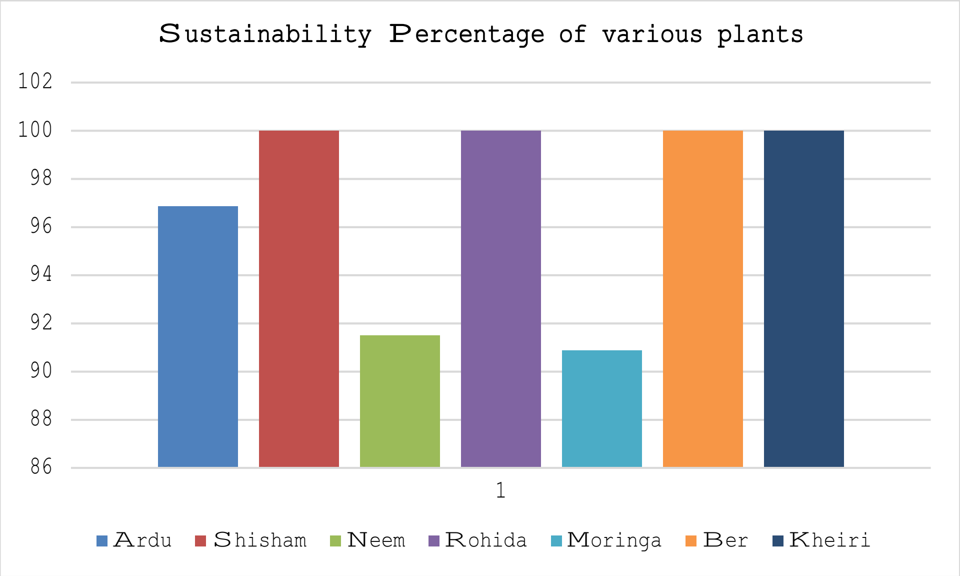


Figure 14: Sustainability (%) of different plants tested in the experiment

Table 3: Impact of One-litre Irrigation Technique on survival of the Arduplant in Sikar Rajasthan

Sr. No.	Locations	Number of plants planted	The number of plants that survived	Survival Rate (%)
1	Shree Gopal Goshala Danta	350	341	97.42%
2	Govt. Upper Primary School Kabriyawas	17	17	100%
3	Govt. Primary School Bawari	103	96	93.20%
4	Govt. Sen. Sec. School Banathala	70	70	100%
5	Govt. Sen. Sec. School Lamiya	32	30	93.75 %

Table 4: Impact of One-litre Irrigation Technique on survival of the Shishamplant in Sikar Rajasthan

Sr. No.	Locations	The number of saplings planted	The number of plants that survived	Survival Rate (%)
1	Shree Gopal Goshala Danta	60	60	100%
2	Govt. Upper Primary School Kabriyawas (Sikar) Rajasthan	14	14	100%
3	Govt. Primary School Bawari	32	32	100%
4	Govt. Sen. Sec. School Banathala	5	5	100%
5	Govt. Sen. Sec. School Lamiya	5	5	100%

Table 5: Impact of One-litre Irrigation Technique on survival of the Neem plant in Sikar Rajasthan

Sr. No.	Locations	Number of saplings planted	The number of plants that survived	Survival Rate (%)
1	Shree Gopal Goshala Danta	627	605	96.49%
2	Govt. Primary School Bawari	60	54	90%
3	Govt. Sen.Sec. School Lamiya	50	44	88%

Table 6: Impact of One-litre Irrigation technique on survival of the Rohidaplant in Sikar Rajasthan

Sr. No.	Location	Number Of Trees Planted	The number of plants that survived	Survival Rate (%)
1	Shree Gopal Goshala Danta	130	130	100%
2	Govt. Upper Primary School Kabriyawas	14	14	100%
3	Govt. Primary School Bawari	16	16	100%
4	Govt. Sen.Sec. School Banathala	05	05	100%
5	Govt. Sen.Sec. School Lamiya	20	20	100%

Table 7: Impact of One-litre Irrigation Technique on survival of the Moringa plant inSikar Rajasthan

Sr. No.	Location	Number of saplings planted	Number of plants that survived	Survival Rate (%)
1	Shree Gopal Goshala Danta	90	87	90%
2	Govt. Primary School Bawari	19	17	91.66%
3	Govt. Sen. Sec. School Banathala	5	5	100%
4	GraminMahilaShikshanSansthan	73	68	93.15%
5	Govt. Sen.Sec. School Lamiya	13	11	84.61%

Table 8: Impact of One-litre Irrigation technique on the survival of Ber plant in Sikar Rajasthan

Sr. N0.	Location	Number of saplings planted	The number of plants that survived	Survival Rate (%)
1	Shree Gopal Goshala Danta	108	108	100%
2	Govt. Primary School Bawari	20	20	100%

Table 9: Impact of One-litre Irrigation technique on survival of the Khejriplant in Sikar Rajasthan

Sr. No.	Location	Number of saplings planted	Number of plants that survived	Survival Rate (%)
1	Shree Gopal Goshala Danta	135	135	100%

7.2 Growth of plants

The success of the plantation depends on its growth rate. The plantation/afforestation project is considered successful only when the growth of the plants is not hampered due to problems arising from soil, climate, disease, insect, or sudden shock. Different parameters like the number of branches (in case of branching trees only), and the height and girth of plants are measured to assess their growth. Depending on the growth rate of trees (plants might be slow, medium, or fast growing), a significant increase in these parameters during a given time, will indicate successful growth. However, if the values of these parameters are not increasing at all or the increase is minimal, the plants cannot be regarded as growing successfully.

Luckily, these three parameters have been increasing during the 8-9 months of the experimentation at all sites, despite the increases being lesser in the beginning, indicating a slow initial growth. The reasons for slow initial growth are the time taken for the establishment of plants and root growth, harsh climatic conditions during winter months, and the non-application of water after completion of the transplantation procedure (because it is a requirement of the one-litretechnique). However, the roots established after the initial development phase and were able to absorb water from deeper depths of the soil. Later, the development of the plants reached a balance, resting at a normal growth rate. The possible reason behind this scenario is discussed in Tables 10 to 16. Therefore, it can be concluded that the One-litretechnique can support the growing of various local forest plants with only one litreof water applied once at the time of transplantation. Later, as the roots of these plants are established, they absorb the water from the soil that was conserved earlier. Thus, making the plants self-sustaining until they become trees.

Table 10: Impact of One-litre Irrigation technique on the plant characters of Arduin Sikar, Rajasthan

Location	**Average Number of branches**		**Average Plant height (cm)**		**Average plant girth (cm), just at the ground level**	
	December 2021	**April 2022**	**December 2021**	**April 2022**	**December 2021**	**April 2022**
Shree Gopal Goshala Danta	1.0	1.1	42.0	46.2	1.40	1.99
Govt. Upper Primary School Kabriyawas	1.0	1.1	40.1	49.0	1.32	1.88
Govt. Primary School Bawari	1.0	2.0	46.2	52.1	1.43	1.97
Govt. Sen.Sec. School Banathala	1.0	1.1	40.8	45.3	1.35	1.87
Govt. Sen.Sec. School Lamiya	1.0	1.4	37.3	43.3	1.38	1.96

Note: Averages have been calculated by adding all the values of a plant character at any location and dividing by the total number of Ardu plants

Table 11: Impact of One-litre Irrigation technique on the plant characters of Moringa in Sikar, Rajasthan

Location	Average Number of branches		Average Plant height (cm)		Average plant girth (cm), just at the ground level	
	December 2021	April 2022	December 2021	April 2022	December 2021	April 2022
Shree Gopal Goshala Danta	1.0	1.4	32.0	37.1	1.41	1.96
Govt. Primary School Bawari	1.0	2.0	27.5	31.3	1.00	1.76
Govt. Sen.Sec. School Banathala	1.0	1.3	28.2	31.8	0.95	1.21
GraminMahilaShikshanSansthan	1.0	1.9	28.5	32.1	1.87	2.31

Note: Averages have been calculated by adding all the values of a plant character at any location and dividing by the total number of Moringa plants

Table 12: Impact of One-litre Irrigation technique on the plant characters of Shishamin Sikar, Rajasthan

Location	Average Number of branches		Average Plant height (cm)		Average plant girth (cm), just at the ground level	
	December 2021	April 2022	December 2021	April 2022	December 2021	April 2022
Shree Gopal GoshalaDanta	1.0	6.9	35.5	38.2	1.45	1.65
Govt. Upper Primary School Kabriyawas	1.0	7.5	32.4	40.1	1.80	2.37
Govt. Primary School Bawari	1.0	3.9	33.4	40.4	2.13	2.67
Govt. Sen.Sec. School Banathala	1.0	3.8	35.0	43.5	1.54	1.91
Govt. Sen.Sec. School Lamiya	1.0	3.2	36.6	43.6	1.05	1.33

Note: Averages have been calculated by adding all the values of a plant character at any location and dividing by the total number of Shisham plants

Table 13: Impact of One-litre Irrigation technique on the plant characters of Rohidain Sikar, Rajasthan

Location	Average Number of branches		Average Plant height (cm)		Average plant girth (cm), just at the ground level	
	December 2021	April 2022	December 2021	April 2022	December 2021	April 2022
Shree Gopal Goshala Danta	2.53	4.59	28.5	22.0	0.95	1.20
Govt. Upper Primary School Kabriyawas	3.20	7.94	30.20	37.0	1.22	1.83
Govt. Primary School Bawari	1.00	2.42	30.50	29.0	1.02	1.11
Govt. Sen.Sec. School Banathala	1.15	2.0	29.80	33.0	0.92	1.0
Govt. Sen.Sec. School Lamiya	1.82	2.9	26.77	22.0	0.90	1.0
GraminMahilaShikshanSansthan	1.33	2.85	30.00	26.46	0.83	1.0

Note: Averages have been calculated by adding all the values of a plant character at any location and dividing by the total number of Rohida plants

Table 14: Impact of One-litre Irrigation technique on the plant characters of Neem in Sikar, Rajasthan

Location	Average Number of branches		Average Plant height (cm)		Average plant girth (cm), just at the ground level	
	December 2021	April 2022	December 2021	April 2022	December 2021	April 2022
Shree Gopal Goshala Danta	1.0	1.10	30.50	32.0	1.32	1.63
Govt. Primary School Kabriyawas	1.0	2.0	27.30	29.0	1.37	1.40
Govt. Sen. Sec. School Lamiya	1.0	1.16	28.50	31.0	1.41	1.57

Note: Averages have been calculated by adding all the values of a plant character at any location and dividing by the total number of Neem plants

Table 15: Impact of One-litre Irrigation technique on the plant characters of Ber in Sikar, Rajasthan

Location	Average Number of branches		Average Plant height (cm)		Average plant girth (cm), just at the ground level	
	December 2021	April 2022	December 2021	April 2022	December 2021	April 2022
Shree Gopal Goshala Danta	2.20	4.46	30.12	29	1.21	1.32
Govt. Primary School Bawari	2.16	4.68	30.01	31	1.86	2.03

Note: Averages have been calculated by adding all the values of a plant character at any location and dividing by the total number of Ber plants

Table 16: Impact of One-litre Irrigation technique on the plant characters of Khejriin Sikar, Rajasthan

Location	Average Number of branches		Average Plant height (cm)		Average plant girth (cm), just at the ground level	
	December 2021	April 2022	December 2021	April 2022	December 2021	April 2022
Shree Gopal Goshala Danta	2.14	4.27	30.30	34.0	0.84	1.04
Govt. Sen. Sec. School Banathala	1.98	2.38	28.25	37.0	0.80	1.0

Note: Averages have been calculated by adding all the values of a plant character at any location and dividing by the total number of Khejri plants

7.3 Impact of litrewater technique on soil parameters

Plant growth does not impact the soil negatively. It rather adds organic matter to the soil (falling of leaves and subsequent decay), increasing its fertility parameters, and leaching down the salts that are present in excessive amounts. All conceivable effects of growing plants are positive.

This fact was also proven from the soil analysis performed at the end of the experiment. It was observed that there were no negative effects of our plantation on the soil. Though the pH of the soil increased slightly due to irrigation with groundwater, it is still within the normal range (Moderately alkaline). This could be since the groundwater in arid regions contain more Na than Ca + Mg + K. The Na-dominated groundwater replaces Ca and Mg from the soil, thereby forming more quantities of Sodium Carbonate (Na_2CO^3) and Sodium bicarbonate ($NaHCO^3$) which are highly alkaline, increasing the pH of the soil. There was increase in Phosphorus content of the soil (Table 1 &17).

An interesting phenomenon presents itself when the moisture percentage of the soil beneath the plants and the soil that was 150 cm (5 feet) away, were compared (Table 18). Significantly higher values of soil moisture were recorded underneath the growing plants in comparison to the bare soil nearby (Figure 15&Appendix 5, 6, &7). This indicates that plant roots absorbed the moisture from deeper layers of the soilup to 18-36 inches (45 – 90cm) depth. This shows the clear success of the One-litretechnique that can be adopted for afforestation.

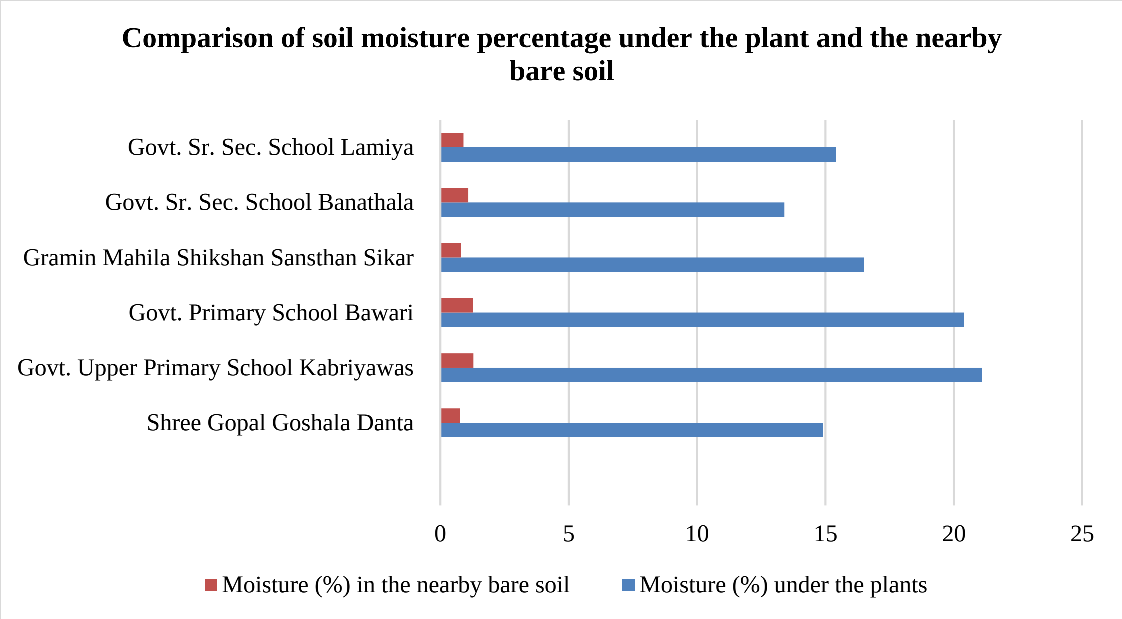


Figure 15: Comparison of moisture percentage (%) under the plants and nearby bare soil at different experimental sites

Table 17: Soil Analysis of different experimental sites at the time of closing the experiment

Parameter	Units	Experimental sites for growing various plants						Rating
		Kabriyawas	Dantaramgarh	Banathala	Bawari	Sikar	Lamiya	
Soil Texture	-	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Light soil
pH	-	8.0	7.9	8.2	7.7	8.3	8.4	Moderately alkaline
EC	ds/m	0.33	0.32	0.34	0.28	0.29	0.16	Normal (Non-saline)
Soil moisture	%	6.84	1.42	3.62	7.30	6.04	7.87	Medium
Organic Carbon	%	0.30	0.34	0.33	0.36	0.35	0.30	Low
Available Phosphorus (P)	Kg/ha	25.0	32.0	36.0	31.0	28.0	39.0	Medium

Available Potassium (K)	Kg/ha	268.0	218.0	270.0	216.0	350.0	480.0	High
Available Sulphur (S)	Ppm	24.0	22.0	18.0	18.0	22.0	19.0	Sufficient
Available Zinc (Zn)	Ppm	0.84	0.92	0.74	0.74	0.75	0.98	Sufficient
Available Iron (Fe)	ppm	4.16	4.10	4.52	3.94	4.68	4.61	Sufficient
Available Manganese (Mn)	ppm	2.30	3.18	3.10	2.91	3.67	4.91	Sufficient
Available Copper (Cu)	ppm	0.40	0.36	0.48	0.42	0.42	0.38	Sufficient

Table 18: A Comparison of Soil Moisture (%) of the experimental sites at different time intervals

Location	**Soil Depth (Inches)**	**Soil moisture Percentage (%)**		
		Under the growing plants		**Neargrowing plants(5 feet away)**
1	**2**	**April 2022**	**May 2022**	**May 2022**
Shree Gopal Goshala Danta (a)	0-9 9-18 18-36	2.35 19.93 34.05	1.42 14.42 28.86	0.0 0.50 1.78
Shree Gopal Goshala Danta (b)	0-9 9-18 18-36	10.13 37.55 42.45	6.61 23.00 33.69	0.0 0.30 1.94
Govt. Upper Primary School Kabriyawas	0-9 9-18 18-36	10.62 27.23 37.17	6.61 21.21 33.51	0.0 0.60 2.35
Govt. Primary School Bawari	0-9 9-18 18-36	7.76 24.69 28.87	7.30 18.76 23.46	0.0 0.60 3.27
GraminMahilaShikshanSansthan Sikar	0-9 9-18 18-36	8.58 22.85 26.05	6.04 16.69 25.94	0.0 0.40 2.04
Govt. Sr. Sec. School Banathala	0-9 9-18 18-36	6.95 18.34 28.53	3.63 12.74 23.76	0.0 0.40 2.88
Govt. Sr. Sec. School Lamiya	0-9 9-18 18-36	14.94 24.69 28.21	7.87 14.24 24.22	0.0 0.40 2.46

8. Scientific basis and supporting theories of the One-litretechnique

The moisture from the rain is lost due to the following reasons:

a) Runoff,
b) Evapotranspiration by weeds, and
c) Through capillary action that causes the upward movement of water in the soil.

If this water is harvested and locked underneath the soil within the rooting zones of plants (Yosef and Asmamaw, 2015), it can later be used for growing plants using only a limited volume of water applied just at the transplantation time of the saplings.

If the saplings are planted in the last week of September or the first week of October when the temperature is low and the upper soil is comparatively old, the roots of these saplings can penetrate deeply to reach the conserved water. The plants can grow and become hardy till February-March before the onset of the next summer season beginning in April when the temperature and evaporation will go very high. The topsoil begins to dry at that time, letting the moisture content move deeper into the soil. Thus, the conditions will make the growth of plants difficult. However, the plants can combat this situation by moving the roots further down towards the moisture in the deeper layers of the soil. This in turn, habituates the plants to absorbing water from deeper parts of the soil and surviving even when there is less water available on the topsoil.

The removal of weeds after every three months, also provides an opportunity to check the evapotranspiration rate. The One-litretechnique has thus been built on a scientific footing as it has been clearly proven in the present project. It is best suited to the conditions of Rajasthan and can be adopted for afforestation in the arid lands, transforming the ecology of the desert.

The basic principle behind this theory is the conservation of percolated rainwater and its protection from evaporation using the practice of removing weeds and breaking capillaries. These measures are successful to check the loss of water and helps the soil to retain the adequate moisture quantity that's necessary for trees to survive in dry and arid areas. Hence, applying only one litreof water during a plant's entire life can become possible because the rest of water requirements will be met by water absorption from the soil.

However, one should consider that the monsoon should bring more than 40 cm of rains per annum. Saplings planted using this one-litretechnique survive on the natural water by absorbing moisture from the water-heavy soil underground during the winter and summer seasons until the next monsoon arrives during the months of June/July after the plantation.

Trees may absorb nutrients from the depths of the earth and bring them to the upper surface of the soil,thus protecting the land from desertification. Adoption of agroforestry, raising legumes, recycling of nutrients, nurturing soil with organic fertilizers, expanding the biodiversity base of agriculture, proper management of soil water, and afforestation and reforestation on larger areas of the land would prove vital for preventing the processes contributing to desertification of the land in dry areas like Rajasthan.

9. The limitation of the study and one-litrewater technique and the mitigating measures

The plantation done with this technique will always be open to very extreme climates whether cold (-1C normal is normal for this area, but it reached -5C this year) or hot (55 degrees) or areas which do not get optimum rainfall of 35-40 cm (350-400 mm). However, this limitation applies to even plants that are planted using normal quantities of water. Therefore, measures like covering it with sacks and protecting it from the cold waves are necessary requirements for all plantations. Logically, if the protected plants do not survive, only then can the one-litretechnique be regarded as a failed technique. Nevertheless, the survival rate (90-100%) of saplings planted using the one-litretechnique was higher than the conventional techniques (almost 50%).

The districts of East Rajasthan receive more rainfall than West Rajasthan. The mean annual rainfall in East and West Rajasthan is about 64.9 cm and 32.7 cm respectively. The maximum rainfall in the state is received in the Southern or South-Eastern districts of the state. This experiment was conducted in comparatively low rainfall areas so that it faces the worst water deficit conditions. The success under such conditions is highly appreciable.

The basis of this technique is conserving water by ploughing the field before and after the onset of the monsoon, and once again towards the end. one must wait for the rains from July to September before one should start the plantation. Even if the rainfall was low (lower than 35-40 cm) during the middle month, it won't be a problem. It should however, rain within the above parameter towards the end of September. This is because the initial rains bring moisture to the deep soil layers after ploughing, while the September rain will moisten the topsoil which is very important for the plants in the absence of water. If proper rainfall isn't received by September, the topsoil will dry and harden, and could pose problems for normal plant growth.

10. Conclusion

The following conclusions are drawn from the data and information collected in experimental project of the present research study (Tables 1 to 18).

- The One-litretechnique proved successful to grow local plants Ardu (Ailanthus excelsaRoxb.), Shisham (Dalbergia sissoo), Neem (Azadirachta indica), Rohida (Tecomellaundulata), Moringa (Moringa oleifera), Ber (Ziziphus mauritiana), and Khejri (Prosopis cineraria) using just one litre of water applied only once at the time of the transplantation of saplings.
- The sustainability of plants was 100% in the case of Shisham, Rohida, Ber, and Khejri while it was more than 90% in the rest of the three plants (Ardu, Neem & Moringa). No sustainability problem was thus observed.
- The growth of plants was good, with no significant constraint recorded in this regard.
- No negative effect on the soil was observed. It had rather improved in certain characteristics like soil moisture, organic matter, and phosphorus.
- Plants were able to increase soil moisture underneath the soil, the values of which were significantly higher in comparison to nearby bare soil (Table 18).

- All the planned aims and objectives of the project were successfully met.
- The technique can be broadly adopted all over the world under situations that have similar conditions to Rajasthan, especially drylands and hot arid zones, however at micro ecological factors may require further study before adoption of this technique which may or may not give desirable result but over all it seems this technique might be very useful for arid zone.

11. Overall Impact of the project

In this project arond 2200 trees was planted on 522,720 sq feet area of land effectively saving 725,000 litres of water that is enough to support 10,357 households for a day. It directly impacted the lives of more than 27000 villagers,3500 children, and 500 abandoned cattle of 5 villages and the city of Sikar in Rajasthan, India. It also provided 100 extra days of employment to more than 150 members of rural communities and this included 75 women and 50 men.

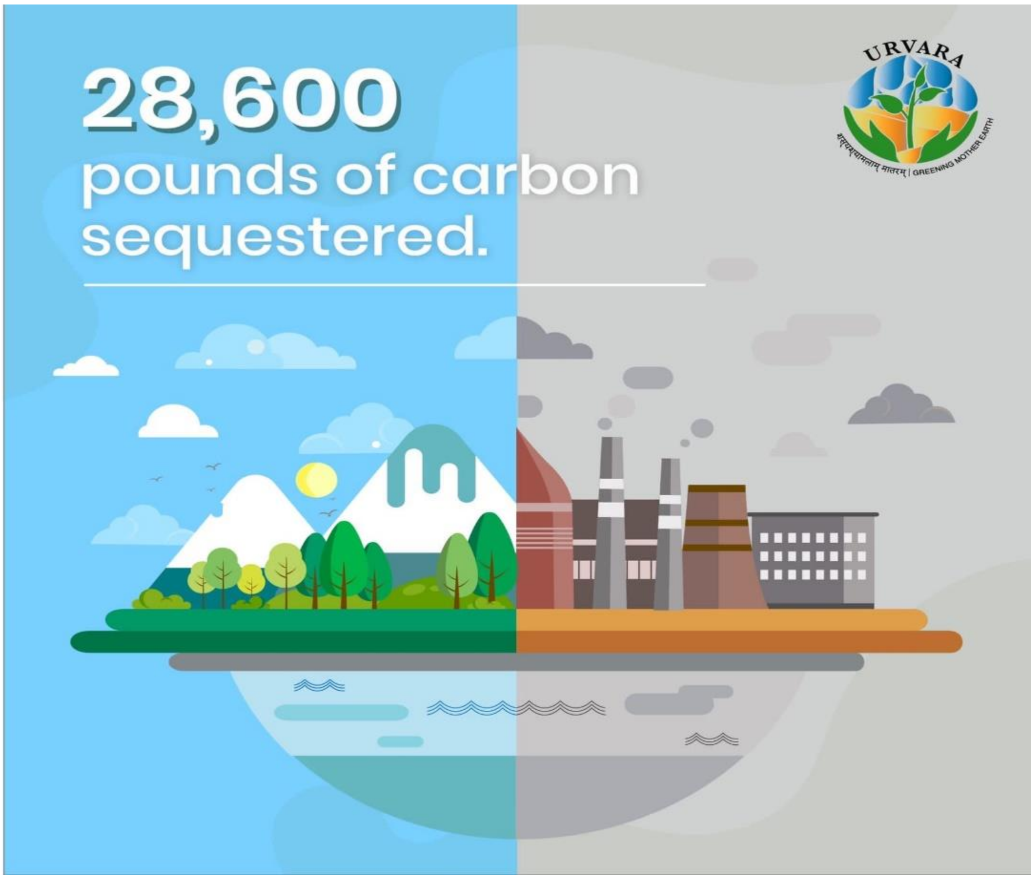
The saplings planted by us will generate 572,000 pounds of oxygen annually once they attain maturity which is sufficient to support 1200 families of four members each. Some more details are depicted through the following pictures/diagrams(Diagram 14).

Diagram 16: The overall impact of the project on various parameters (No. of trees planted, water saved, Number of children impacted, carbon sequestering, and area greened)


URVARA
725,000 +
liters of
water saved


URVARA
3,500 +
Children
directly
impacted


572,000
pounds of oxygen
generated annually.
URVARA
GREENING MOTHER EARTH


28,600
pounds of carbon
sequestered.
URVARA
GREENING MOTHER EARTH

12. Recommendations

It is recommended that the One-litretechnique for the growing of local forest trees must be extended to the farmers through extension workers and awareness programs. The policymakers should put in full support to this innovative technique for the greening/ afforestation of degraded/ desertified lands in Rajasthan. Resultantly, the associated problems of the scarcity of water, unemployment depleting food and feed supplies, and low community income can also be rectified.

There are many stakeholders who benefit from the results and outcomes of this study. The major ones are policy makers for the area of Rajasthan, the government departments (Agriculture, Forestry, Livestock, and Community and Social Development), The Community Leaders, Managers of Afforestation activities, and The Researchers. Following are the specified recommendations for each of them to follow and implement.

I. The policy makers should frame policies and programs to help the poor farmers who want to practice agroforestry or afforestation on their lands, especially supporting them to install drip Irrigation (which is often too costly and unaffordable for the poor farmers). The Drip Irrigation is a basic requirement to implement the One-litrewater technique of plantation.

II. The government departments should chalk out programs for making the communities aware of this technique. Their representatives can meet the farmers, hold demonstrations, make presentations, and involve them in demonstrative trials. The target they should achieve is the strengthening of afforestation activity for the adaptation of the one-litretechnique.

III. The community leaders can hold meetings, get in touch with the researcher (Adhi Daiv) to elucidate the technique, as well as representatives of the departments to raise awareness about the one-litretechnique in the affected communities.

IV. The researchers should continue their research to unfold corners left uncovered in this study because of time and resource constraints. The researchable items are the performance of the technique on other plants – especially on those having higher water requirements, and involving other variables (climate, water quality, and soil characteristics etc).

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APPENDIX 1

PLANT REPLACEMENT REPORT

Location	Plant Name	Number of saplings planted on 02 October 2021	Number of the cold wave affected plants in December 2021	Number of plants that survived after the coldwave January 2022 and Survival Percentage (%)		Number of replaced plants in March 2022	Number of Plants after replacement on 01 April 2022
Shree Gopal Goshala Danta	NEEM	627	192	435	69.37 %	150 Rohida + 42 Khejri	627
	ARDU	350	63	287	82%	44 Rohida + 19 Kherrii	350
	ROHIDA	130	00	130	100%	00	130
	KHEJRI	135	00	135	100%	00	135
	MORINGA	90	60	30	33.33 %	22 Rohida+ 19Ber + 19 Khejri	90
	SHISHAM	60	00	60	100%	00	60
	BER	108	00	108	100%	00	108
	Total	1500	315	1185	79%	315	1500

Location	Plant Name	Number of saplings planted on 02 October 2021	Number of the cold wave affected plants in December 2021	Number of plants that survived after the cold wave January 2022 and Survival Percentage (%)		Number of replaced plants in March 2022	Number of Plants after replacement on 01 April 2022
Govt. U. P. School Kabriyawas	ARDU	17	01	16	94.11 %	01	17
	ROHIDA	14	00	14	100 %	00	14
	SHISHAM	14	00	14	100 %	00	14
	Total	45	01	44	97.77%	01	45

Location	Plant Name	Number of saplings planted on 02 October 2021	Number of the cold wave affected plants in December 2021	Number of plants that survived after the coldwave January 2022 and Survival Percentage (%)		Number of replaced plants in March 2022	Number of Plants after replacement on 01 April 2022
Govt. Primary School Bawari	ARDU	103	018	85	82.52%	18 Rohida	103
	ROHIDA	16	00	16	100%	00	16
	SHISHAM	32	00	32	100%	00	32

	NEEM	60	22	38	63.33 %	03 Ber + 19Rohida	60
	MORINGA	19	07	12	63.15%	07 Ber	19
	BER	20	00	20	100%	00	20
	Total	250	47	203	81.20 %	47	250

Location	**Plant Name**	**Number of saplings planted on 02 October 2021**	**Number of the cold wave affected plants in December 2021**	**Number of plants that survived after the coldwave January 2022 and Survival Percentage (%)**		**Number of replaced plants in March 2022**	**Number of Plants after replacement on 01 April 2022**
Govt. Se. Sec. School Banathala	ARDU	70	55	15	21.42%	34 Rohida + 21Khejri	70
	ROHIDA	05	00	05	100%	00	05
	SHISHAM	05	00	05	100%	00	05
	MORINGA	05	00	05	100%	00	05
	Total	85	55	30	35.29%	55	85

Location	**Plant Name**	**Number of saplings planted on 02 October 2021**	**Number of the cold wave affected plants in December 2021**	**Number of plants that survived after the coldwave January 2022 and Survival Percentage (%)**		**Number and types of replaced plants in March 2022**	**Number of Plants after replacement on 01 April 2022**
Govt. Se. Sec. School Lamiya	ARDU	32	00	32	100%	00	32
	ROHIDA	20	00	20	100%	00	20
	SHISHAM	05	00	05	100%	00	05
	NEEM	50	00	50	100%	00	50
	MORINGA	13	13	00	00%	02 Ardu + 01Shisham + 10Rohida	13
	Total	120	13	107	89.16%	13	120

Location	**Plant Name**	**Number of saplings planted on 02 October 2021**	**Number of the cold wave affected plants in December 2021**	**Number of plants that survived after the coldwave January 2022 and Survival Percentage (%)**		**Number and types of replaced plants in March 2022**	**Number of Plants after replacement on 01 April 2022**
MahilaShikshan Sansthan Sikar	MORINGA	73	07	66	90.41%	07 Rohida	73
	Total	73	07	66	90.41%	07	73

Appendix 2: Soil Moisture Report (April-2022) for the plantation sites

Location 1	Soil Depth (Inches) 2	Fresh Soil Weight (Kg) 3	Dried Soil Weight (Kg) 4	Moisture weight (Kg) 5 = (3-4)	Soil moisture Percentage (%) 6 = (5/4) X 100
Shree Gopal Goshala Danta (a)	0-9 9-18 18-36	1 1 1	0.977 0.834 0.746	0.023 0.166 0.254	2.35 19.93 34.05
Shree Gopal Goshala Danta (b)	0-9 9-18 18-36	1 1 1	0.908 0.727 0.702	0.092 0.273 0.298	10.13 37.55 42.45
Govt. Upper Primary School Kabriyawas	0-9 9-18 18-36	1 1 1	0.904 0.786 0.729	0.096 0.214 0.271	10.62 27.23 37.17
Govt. Primary School Bawari	0-9 9-18 18-36	1 1 1	0.928 0.802 0.776	0.072 0.198 0.224	7.76 24.69 28.87
GraminMahilaShikshanSansthan Sikar	0-9 9-18 18-36	1 1 1	0.921 0.814 0.952	0.079 0.186 0.248	8.58 22.85 26.05
Govt. Sr. Sec. School Banathala	0-9 9-18 18-36	1 1 1	0.935 0.845 0.778	0.065 0.155 0.222	6.95 18.34 28.53
Govt. Sr. Sec. School Lamiya	0-9 9-18 18-36	1 1 1	0.870 0.802 0.780	0.130 0.198 0.220	14.94 24.69 28.21

Appendix 3: Soil Moisture Report-2 (May 2022) for the Plantation Areas

Location 1	Soil Depth (Inches) 2	Fresh Soil Weight (Kg) 3	Dried Soil Weight (Kg) 4	Moisture weight (Kg) 5 = (3-4)	Soil moisture Percentage (%) 6 = (5/4) X 100
Shree Gopal Goshala Danta (a)	0-9 9-18 18-36	1 1 1	0.986 0.874 0.776	0.014 0.126 0.224	1.42 14.42 28.86
Shree Gopal Goshala Danta (b)	0-9 9-18 18-36	1 1 1	0.938 0.813 0.748	0.062 0.187 0.252	6.61 23.00 33.69
Govt. Upper Primary School Kabriyawas	0-9 9-18 18-36	1 1 1	0.936 0.825 0.749	0.064 0.175 0.251	6.61 21.21 33.51
Govt. Primary School Bawari	0-9 9-18 18-36	1 1 1	0.932 0.842 0.810	0.068 0.158 0.190	7.30 18.76 23.46
GraminMahilaShikshanSansthan, Sikar	0-9 9-18 18-36	1 1 1	0.943 0.857 0.794	0.057 0.143 0.206	6.04 16.69 25.94
Govt. Sr. Sec. School Banathala	0-9 9-18 18-36	1 1 1	0.965 0.887 0.808	0.035 0.113 0.192	3.63 12.74 23.76
Govt. Sr. Sec. School Lamiya	0-9 9-18 18-36	1 1 1	0.927 0.868 0.805	0.073 0.132 0.195	7.87 14.24 24.22

Appendix 4: Soil Moisture Report (May-2022) Out Plantation (5 feet away from plants)

Location 1	Soil Depth (Inches) 2	Fresh Soil Weight (Kg) 3	Dried Soil Weight (Kg) 4	Moisture weight (Kg) 5 = (3-4)	Soil moisture Percentage (%) 6 = (5/4) X 100
Shree Gopal Goshala Danta (a)	0-9 9-18 18-36	1 1 1	1 0.995 0.983	0.000 0.005 0.017	0.0 0.50 1.78
Shree Gopal Goshala Danta (b)	0-9 9-18 18-36	1 1 1	1 0.997 0.981	0.000 0.003 0.019	0.0 0.30 1.94
Govt. Upper Primary School Kabriyawas	0-9 9-18 18-36	1 1 1	1 0.994 0.977	0.00 0.006 0.023	0.0 0.60 2.35
Govt. Primary School Bawari	0-9 9-18 18-36	1 1 1	1 0.994 0.978	0.000 0.006 0.032	0.0 0.60 3.27
GraminMahilaShikshanSansthan Sikar	0-9 9-18 18-36	1 1 1	1 0.996 0.980	0.000 0.004 0.020	0.0 0.40 2.04
Govt. Sr. Sec. School Banathala	0-9 9-18 18-36	1 1 1	1 0.996 0.972	0.000 0.004 0.028	0.0 0.40 2.88
Govt. Sr. Sec. School Lamiya	0-9 9-18 18-36	1 1 1	1 0.996 0.976	0.000 0.004 0.024	0.0 0.40 2.46

Appendix 5: Timetable detailing employed and volunteer people along with the hours they spent for various activities

S. N.	Date	Location	Activity	Number of days	Number of people employed	Number of volunteers	Number of hours	Total Hours
1	Jun2021	Govt. Higher Secondary School Lamiya	Site Selection	1	2	0	8	16
2	Jun2021	Govt. Primary School Bawari	Site Selection	1	2	0	8	16
3	Jun2021	Shree Gopal Goshala Danta	Site Selection	2	2	0	8	32
4	Jun2021	Govt. Upper Primary School Kabriyawas	Site Selection	1	2	0	8	16
5	Jun2021	Govt. Higher Secondary School Banathala	Site Selection	1	2	0	8	16
6	Jun2021	GraminMahilaShikshan Sansthan Sikar	Site Selection	1	2	0	8	16
1	1July2021	Govt. Higher Secondary School Lamiya	Removing unnecessary small plants and preparing the land	1	1	1	8	16

2	1July2021	Govt. Primary School Bawari	Removing unnecessary small plants and preparing the land	1	1	1	8	16
3	1July2021	Shree Gopal Goshala Danta	Removing unnecessary small plants and preparing the land	2	1	1	8	32
4	1July2021	Govt. Upper Primary School Kabriyawas	Removing unnecessary small plants and preparing the land	1	1	1	8	16
5	1July2021	Govt. Higher Secondary School,Banathala	Removing unnecessary small plants and preparing the land	1	1	1	8	16
6	1July2021	GraminMahilaShikshan Sansthan Sikar	Removing unnecessary small plants and preparing the land	1	1	1	1	16
1	11 July 2021	Govt. Higher Secondary School, Lamiya	First Ploughing	1	1	2	8	24
2	11 July 2021	Govt. Primary School Bawari	First Ploughing	1	1	2	8	24
3	11 July 2021	Shree Gopal Goshala Danta	First Ploughing	2	1	2	8	48
4	11 July 2021	Govt. Upper Primary School Kabriyawas	First Ploughing	1	1	2	8	24
5	11 July 2021	Govt. Higher Secondary School Banathala	First Ploughing	1	1	2	8	24
6	11 July 2021	GraminMahilaShikshan Sansthan Sikar	First Ploughing	1	1	2	8	24
1	September 2021	Govt. Higher Secondary School Lamiya	Second Ploughing	1	2	2	8	32
2	September 2021	Govt. Primary School Bawari	Second Ploughing	1	2	2	8	32
3	September 2021	Shree Gopal Goshala Danta	Second Ploughing	2	2	2	8	64
4	September 2021	Govt. Upper Primary School Kabriyawas	Second Ploughing	1	2	2	8	32
5	September 2021	Govt. Higher Secondary School Banathala	Second Ploughing	1	2	2	8	32
6	September 2021	GraminMahilaShikshan Sansthan Sikar	Second Ploughing	1	2	2	8	32
1	September and October 2021	Govt. Higher Secondary School Lamiya	Plantation	2	4	9	8	208

2	September and October 2021	Govt. Primary School Bawari	Plantation	2	4	9	8	208
3	September and October 2021	Shree Gopal Goshala Danta	Plantation	5	4	9	8	520
4	September and October 2021	Govt. Upper Primary School Kabriyawas	Plantation	2	3	10	8	208
5	September and October 2021	Govt. Higher Secondary School Banathala	Plantation	2	4	9	8	208
6	September and October 2021	GraminMahilaShikshan ,Sansthan Sikar	Plantation	2	3	10	8	208
1	Five days after plantation	Govt. Higher Secondary School,Lamiya	Weeding after five days	1	2	3	8	40
2	Five days after plantation	Govt. Primary School Bawari	Weeding after five days	1	2	3	8	40
3	Five days after plantation	Shree Gopal Goshala Danta	Weeding after five days	2	2	3	8	80
4	Five days after plantation	Govt. Upper Primary School Kabriyawas	Weeding after five days	1	2	3	8	40
5	Five days after plantation	Govt. Higher Secondary School Banathala	Weeding after five days	1	2	3	8	40
6	Five days after plantation	GraminMahilaShikshan Sansthan Sikar	Weeding after five days	1	1	3	8	32
1	15 December 2021	Govt. Higher Secondary School Lamiya	Cold Protection	1	1	1	8	16
2	15 December 2021	Govt. Primary School Bawari	Cold Protection	1	1	1	8	16
3	15 December 2021	Shree Gopal Goshala Danta	Cold Protection	2	1	1	8	32
4	15 December 2021	Govt. Upper Primary School Kabriyawas	Cold Protection	1	1	1	8	16
5	15 December 2021	Govt. Higher Secondary School Banathala	Cold Protection	1	1	1	8	16
6	15 December 2021	GraminMahilaShikshan Sansthan Sikar	Cold Protection	1	1	1	8	16
1	21 to 31 December 2021	Govt. Higher Secondary School Lamiya	Ploughing and re-ploughing	1	1	3	8	32
2	21 to 31 December 2021	Govt. Primary School Bawari	Ploughing and re-ploughing	1	1	3	8	32
3	21 to 31 December 2021	Shree Gopal Goshala Danta	Ploughing and re-ploughing	2	1	3	8	64
4	21 to 31 December 2021	Govt. Upper Primary School Kabriyawas	Ploughing and re-ploughing	1	1	3	8	32
5	21 to 31 December 2021	Govt. Higher Secondary School Banathala	Ploughing and re-ploughing	1	1	3	8	32

6	21 to 31 December 2021	GraminMahilaShikshan Sansthan Sikar	Ploughing and re-ploughing	1	1	4	8	40
1	15 February to 24 March 2022	Govt. Higher Secondary School Lamiya	Plant Replacement	3	1	2	8	72
2	15 February to 24 March 2022	Govt. Primary School Bawari	Plant Replacement	3	1	2	8	72
3	15 February to 24 March 2022	Govt. Upper Primary School Kabriyawas	Plant Replacement					
4	15 February to 24 March 2022	Govt. Higher Secondary School Banathala	Plant Replacement	3	1	2	8	72
5	15 February to 24 March 2022	GraminMahilaShikshan Sansthan Sikar	Plant Replacement	3	1	2	8	72
6	15 February to 24 March 2022	Shree Gopal Goshala Danta	Plant Replacement	5	1	2	8	120
1	25 March to 31 March 2022	Govt. Higher Secondary School Lamiya	Weeding and Hoeing	2	1	2	8	48
2	25 March to 31 March 2022	Govt. Primary School Bawari	Weeding and Hoeing	2	1	2	8	48
3	25 March to 31 March 2022	Govt. Upper Primary School Kabriyawas	Weeding and Hoeing	2	1	2	8	48
4	25 March to 31 March 2022	Govt. Higher Secondary School Banathala	Weeding and Hoeing	2	1	2	8	48
5	25 March to 31 March 2022	GraminMahilaShikshan Sansthan Sikar	Weeding and Hoeing	2	1	2	8	48
6	25 March to 31 March 2022	Shree Gopal Goshala Danta	Weeding and Hoeing	6	1	2	8	144
		Total		100	161	296		3656

Data collection of Plants

S.N.	Date	Location	Activity	Number of days	Number of people employed	Number of volunteers	Number of Hours	Total Hours
1	2 April, 2022	Govt. Higher Secondary School Lamiya	Plant data collection	1	0	1	3	3
2	3 April, 2022	Govt. Primary School Bawari	Plant data collection	1	0	1	6	6
3	4 to 6 April, 2022	Shree Gopal Goshala Danta	Plant data collection	3	0	1	8	24
4	7 April, 2022	Govt. Upper Primary School Kabriyawas	Plant data collection	1	0	1	1	1
5	8 April, 2022	Govt. Higher Secondary School,Banathala	Plant data collection	1	0	1	2	2
6	9 April, 2022	GraminMahilaShikshanSansthan Sikar	Plant data collection	1	0	1	2	2

First time soil sampling

S.N.	Date	Location	Activity	Number of days	Number of people employed	Number of Volunteers	Number of Hours	Total Hours
1	16 April, 2022	Govt. Higher Secondary School Lamiya	Soil sampling and Moisture data (Report - 1)	2	0	1	1	2
2	17 April, 2022	Govt. Primary School Bawari	Soil sampling and Moisture data (Report - 1	2	0	1	1	2
3	18 April, 2022	Shree Gopal Goshala Danta	Soil sampling and Moisture data (Report - 1	2	0	1	1	2
4	19 April, 2022	Govt. Upper Primary School Kabriyawas	Soil sampling and Moisture data (Report - 1	2	0	1	1	2
5	20 April, 2022	Govt. Higher Secondary School,Banathala	Soil sampling and Moisture data (Report - 1	2	0	1	1	2
6	21 April, 2022	GraminMahilaShikshanSansthan, Sikar	Soil sampling and Moisture data (Report - 1	2	0	1	1	2

Second time soil sampling

S.N.	Date	Location	Activity	Number of days	Number of people employed	Number of Volunteers	Number of Hours	Total Hours
1	16 May, 2022	Govt. Higher Secondary School Lamiya	Soil sampling and Moisture Data (Report – 2)	2	0	1	1	2

2	17 May, 2022	Govt. Primary School Bawari	Soil Collection and Moisture Data (Report – 2)	2	0	1	1	2
3	18 May, 2022	Shree Gopal Goshala Danta	Soil sampling and Moisture Data (Report – 2)	2	0	1	1	2
4	19 May, 2022	Govt. Upper Primary School Kabriyawas	Soil sampling and Moisture Data (Report – 2)	2	0	1	1	2
5	20 May, 2022	Govt. Higher Secondary School,Banathala	Soil sampling and Moisture Data (Report – 2))	2	0	1	1	2
6	21 May, 2022	GraminMahilaShikshanSansthan Sikar	Soil sampling and Moisture Data (Report – 2)	2	0	1	1	2

Totals

-	**Number of Days**	**Number of People Employed**	**Number of Volunteers**	**Number of Hours Total Hours**
Total for all activities	100 + 32 = 132	161 + 0 = 161	296 + 18 = 314	3656 + 62 ------------- 3718