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UNDERGROUND WATER BALANCING SYSTEM - AN INNOVATIVE AND NATURAL APPROACH FOR HILLY AREAS: A CASE STUDY IN THRISSUR DISTRICT, KERALA, INDIA

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ABSTRACT

The present study was conducted to simulate a design and construction of contour trench known as underground water balancing system (UWBS), which divides the water in both directions from the centre and recharge the groundwater. It restores groundwater on hilly areas and stop soil erosion and maintains the water content or moisture in soil strata. The irrigation strategies adopted at the Ayur Jack Farm; the continued integrity of land and water systems which is essential for all economic growth and to ensure food security. The model Jackfruit farm of five acres of land where the farmer has done Rain Water Harvesting Method (RWH) which he names underground water balancing system (UWBS) is at Kurumalkkunnu in Veloor Panchayat. The UWBS helps to hold water against the force of gravity, increases in the infiltration of rainwater, reduce runoff also causes increases soil, water storage and revegetate jack fruit saplings during dry seasons. The site is between North latitudes .10° 37' 34.3'' N and longitudes 76° 09' 16.2'' E. This is useful for increasing agriculture productivity and solving the problem of shortage of water in hilly areas and rubber plantation. By adopting UWBS the farmers are able to store 6.0728 crores litre of water /year in five acres of land. On the capacity storage, to cover irrigation needs the farmer is able to store 42 percentages of flooded water and in 2018 and also able to store a 20 percentage increase floodwater. Therefore, UWBS is proposed as a solution to address flood and water scarcity in hilly areas. The proposed design is economically feasible and in terms of volume, with a rainfall of 5 mm, every square metre of the field receives 0.05 m, or 5 litres, of rainwater stored as groundwater.

Keywords: *Underground Water Balancing System; Sustainable Water Management; Dryland; Rain Water Harvesting Method; Trenches; Water Conservation*

INTRODUCTION

Veloor is a village and Panchayat in Thalapilly Taluk, Thrissur District, Kerala State have low rainfall compared to another part of the district**.** The model Jackfruit plantation in hilly regions which was once a flourishing rubber plantation still 2016. In 2017 he cut down rubber trees on 5 acres and planted jackfruit instead. As rubber plantations consume a lot of groundwater and rainwater and also he finds it as one of the reasons for water scarcity. The uneven climatic conditions in the region were another motivation for the farmer to implement a Rain Water Harvesting Method.

The subsequent population growth, climate change and growing demand for water for irrigation purposes are increasing the pressure on water resources. Kerala Samuhya Jellashama Samithi [KSJS] started the project in 1995 digging a community bore well for thirty-five families which were 150 meters away from model 'Ayur Jackfruit Farm'. As rainfall is very scant in the area, the wells and hand pump around the farm become dry by the year 2012. In 2017 the farmer replaced the rubber plantation with Ayur jack Farm by digging shallow trenches across the hill slope for water conservation and planted jackfruit trees. After the implementation of projects in 2017 with a simple water harvesting technique in farmlands, the damages caused by the deluge could have been considerably reduced. All wells inside the farm and community bore well, having sufficient water throughout the year, which fulfils the need of thirty-five families and also nearby wells in and around 500 meters. His rainwater harvesting method on the five acres replenished the groundwater table in the area. The contour trenchspaced between 4.5m apart and depth 1.5m which he called the underground water balancing system (UWBS) divides the water in both directions from the centre and recharge the groundwater. In neighbouring Kuranchery, with the same geographical structure, reported 19 deaths in landslips during the deluge in the year 2018.

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Cost-effectiveness of innovation/ Technology.

Construction process of Underground Water Balancing System(UWBS) is pretty simple. First Layout the level of contour line, then mark the contour line. Then ridges are constructed along the contour line, usually spaced between 4.5m apart and depth 1.5m which intercepted flowing water before it attains the erosive velocity. The trench section is in Parallel shape which has the ideal following dimension

Space between two trenchs :4.5 m

Depth down side - 1.5 metre
Width of bed - 2 metre
At Elevation of hill 30°

Volume of soil excavated equivalent to volume of bermsoil
Volume of berm = area of berm × length horizontal
Area of berm = ½ (1.5+1.5) × 4.5
Equaivalent = 6.75meter square
Volume of berm = 6.75 m^2 ×L

There is growing concern about the depletion of groundwater levels, lack of water quality, the effects of climate change and the need to meet future water requirements, especially in Kurumalkkunnu in Veloor Panchayat drought-prone semi-arid regions.

WORK COST

The cost to conserve water is Rs Two lakh/Acres including fencing, trenching, 2 bore wells, 2 electrical connection, and drip irrigation.

Particulars	**Price (Rs)**
Net Fencing	5,0000
Trenching	5,0000
Bore Wells (2 Nos)	5,0000
Electrical Connection (2 Nos)	1,0000
Drip irrigation	4,0000
Total	**2,00000**

STUDY AREA

Veloor is a village and Panchayat in Thalapilly Taluk, Thrissur District, Kerala, India. Usually, Veloor is dry areas and having water scarcity throughout the year. This case study describes how at Ayur Jack, Thrissur, Kerala where the underground water balancing system method on farming practices at five acres plot. The farmer planted 1000 Jackfruit trees and one lakh sapling. The design process of the Underground Water Balancing System involves finding the following specifications: Spacing between two Contour Trenches, Cross Section of UWBS (Top Width, Bottom Width, and Depth)and Choice of Plantations. The design parameters used are Groundwater, PH of the water, Rainfall in that given area (High, Medium or Low, Soil Type and Tree planned and compared to other plantations in that region.

DATA USED

Soil Type

The laterite Soil

The predominant soil type observed is the lateritic soil, which covers almost the entire midland areas of the district.

These soils are in general well-drained, low in essential plantnutrients and organic matter. They exhibit very low cation exchange capacity and aregenerally acidic.

Source:
http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_thr.pdf

Relative Humidity

- The humidity is higher during the monsoon months from June to October and is around 93% during morning hours and 76% during evening hours.
- 4.3 Wind Velocity: The wind speed is more during December and January months and it is less during October.
- 4.4 Evaporation: It is high during the months of December to April because of more bright sunshine hours and less number of rainy days. It is less during the monsoon months from June to October. The maximum rate of 7.4 mm/day is recorded in January and the minimum rate of 2.9 mm/day is recorded in July.
- 4.5 Potential evapotranspiration
- The annual PET for Vellanikara is 1776.3 mm-based on Thornthwaite's method.
- 4.6 Aridity index The ratio of potential evapo transpiration to rainfall is known as the aridity index and it is around 0.6 for Vellanikara.

Source
http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_thr.pdf

Temperature:

April is the warmest month of the year. The temperature in April averages 29.8 °C | 85.6 °F. July is the coldest month, with temperatures averaging 25.6 °C | 78.1 °F.

Source: Reference :
https://en.climate-data.org/asia/india/kerala/velur-964943/

GROUNDWATER

Groundwater quality of groundwater monitoring wells									Reference
Near Location	PH	EC in µs/cm at 25 C	Total Hardness as Ca CO3	Ca	Mg	Cl	F	NO3	
				Concentration, mg/l					
Keecheri	8.02	391	66	16	6.3	61	0.24	63	http://cgwb.gov.in/District_Profile/Kerala/Thrissur.pdf

METHODOLOGY

The Rainwater harvesting model called 'Underground Water Balancing, where contour trench was dug and every drop of water percolates underground. Ridges are constructed along the contour line, usually spaced between 4.5 m apart and depth 1.5 m which intercepted flowing water before it attains the erosive velocity. The first 1 meter above the ridge is for planting a jackfruit tree with 4 m space whereas the rest is the catchment. The soil removed is used to create a berm just downhill from the trench. The trenches should be dug perpendicular to the slope (along the contours). Planting jackfruit trees decrease runoff, which enhances water infiltration and prevents soil erosion. The height of each ridge varies according to slopes, narrow down and runoff water is stored between two ridges. The key success of these systems is to locate the ridge as exactly as possible along the contour. Excess water from walking paths is transported to the trenches every time it rains heavily." Trenches break the sloppy ground and therefore reduce the velocity of water runoff. It carries excessive rainfall safely downstream and to let off stream flow in natural channels. As the speed of runoff is decreased, trenches filter runoff water from rainfall and hence reduce soil degradation, erosion and enhance infiltration of surface run-off and soil moisture. As a result, after 4-5 mm rainfalls water were stored underground, the bore wells and open wells and groundwater tables get recharged. With a rainfall of 1 mm, every square metre receives 1 litre of rainwater. Rainfall of 1 mm supplies 0.001 m^3 or 1 litre of water to each square metre of the field. Thus 1Acre receives 4048.58 litres.

The soil erosion checked by the contour trenches restores the soil fertility, particularly lost by water and wind force. Further, when the sun shines on the water, light and heat are reflected onto jackfruit saplings and trees on the trenches, this affects the increased humidity createsa microclimate's in the area. These microclimates can support plants to get soil PH, temperatures, sufficient light, humidity distribution and air circulation which are quite high in nutrients helps to grow healthy plants.

RESULT AND DISCUSSION

The Effect of Trenches on Soil-Water availability and Ground Water

Now a day's the main challenge to achieve food security goals is to improve the water-use the efficiency of crops. Kerala witnessed flood in 2018 and 2019 and shows a rise in temperature due to potential evapotranspiration is a clear indication of climate change. The study shows the storage capacity in one cent of land is 120000lt (CWRI, Kerala)/Year. With Underground Water Balancing System' the farmers are able to store 6.0728crores litres/Year in five acres of land. Each tree required eight litres of water for six months. Therefore 1000 trees required 14.4 lakh litres of water for six months and the remaining water was stored as groundwater by farmers through which water level in nearby wells increases and all wells around the farm have sufficient water during summer. The scientific part was in 2018 when Kerala was flooded where there was a rise of water level in rivers and other water bodies the farmers stored 42 percentages of flooded water and in 2019 when a similar situation arises he stored a 20 per cent increase floodwater using Underground Water Balancing System'.

He harvested each drop of the torrential rain to ensure water safety. Water from even walking paths is directed to the trenches. The underground water balancing system, method of farming by dividing the land into layers by digging trenches can be effectively replicated in the high ranges and other hill areas to prevent landslips. The main objective of this study was to define a general method for selecting suitable Rain Water Harvesting method which suits for dryland and also hilly areas.

Replicability of the Technology

The underground water balancing system method of farming by dividing the land into layers by digging trenches can be effectively replicated in the high ranges and other hill areas to prevent landslips. The studies confirm the crucial role of Jack fruit trees in preventing landslides. The deep-rooted trees observe water and help to avoid excessive soil water pressures.

Total benefits accrued (Tangible &Intangible)

- It helps to reduce water scarcity in the area.
- Groundwater level increased in and around 500 m and all well having sufficient water in the summer season.
- There is a paradigmatic shift from maximizing productivity per unit of land area to maximizing productivity per unit of water consumed.
- Maintain ideal temperature, humidity, and moisture inside the farm which helps to harvest 18% and 20%.more jack fruit every year.
- Economic value, for instance, of saving the population of a region from the potential effects of a drought, if the probability or severity of future drought events is not known.
- The practice improves resource efficiency, conserve water resources and reduce water pollution.
- Prevents soil degradation and erosion.
- Enhances surface water infiltration and soil moisture.
- Increase in percolation; stop the soil loss.
- Increase the green cover over the area and soil quality.
- Increase the availability of drinking water nearby farms.
- Reduce flood hazards and applicable to all soil and rainfall conditions.

CONCLUSIONS

This study has successfully investigated the level of water-saving which the farmer is doing through water

conservation practices. The existing rainwater harvesting system called 'Underground Water Balancing System' is an innovation which could help to solve the water shortage issue at Ayurjack farm and surrounding wells in and around five hundred meters. Close to the farm 35 wells that were once dried up, are now having enough water during summer. He saves about 6.0728 crores liters/Year of rainwater every year that are enough to water 1,000 odd jackfruit trees and one lack sapling in his farm round the year. When Kerala was hit by a destructive heavy flood in the year 2018, he saved every drop of water by capturing each drop of rainwater into trenches dug in the fields. When most of the farmers left farming due to insufficient water in case of a scanty rainfall or the farms would be destroyed due to torrential rains, the farmer finds the solution for both.

The ideal level of the PH of water at the Ayur Jack farm is 5.5 which is far below the Panchayath level. |The oxygen released per jack fruit tree was 13.16 tons/year and trees act as carbon sinks, alleviating the greenhouse effect. In addition, this pilot project gives a positive impact on society by promoting greater awareness of the importance of freshwater, as a valuable resource that needs to be conserved. New scientific knowledge on the concept of sustainability and rainwater harvesting system was given to students and the local community through campaigns and awareness camps at Jackfruit farm. The rainwater harvesting method in which the farmer practices promote significant water saving and also give technological solutions to improve water quantity and quality aspects that contribute significantly to sustainable water conservation practices. This is because the standardisation of the trenches would help capture the most amount of rainwater and run-off during the rainy season and reserve the water for crop use during the dry season. The total area under rubber plantation in Kerala is around 13 lakh acres, of which 93 per cent is smallholdings and now a day's farmers are facing torrential rain or drought-like situation. Farmers can easily and reasonably adopt 'Underground water Balancing System'. The system would help farmers to maintain the optimum level of water and subsequently ground water level increases. It also helps to avoid flooding and drought situation due to climate change.

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