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Traditional Rain Water Harvesting in the State of Rajasthan

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Abstract

Water has been harvested in Rajasthan since antiquity, by our ancestors perfecting the art of water management. Many water harvesting structures and water conveyance systems, specific to the eco-regions and culture have been developed. Water conservation is a practice needed for daily uses of man, animals, vegetation and agriculture. In Rajasthan, various techniques are used to save water, which are practical and nature friendly. Even from before the age of Kalibangan civilization, till today many practices are seen in different parts of Rajasthan.

There are many traditional practices used for conserving rain water; e.g.forts surrounded by water canals for protection from enemies (ikjs[k nqxZ). The civilians of state continue to build structures to collect and store the monsoon rain. Some unique water conservation techniques are still practiced in state and are efficient. These are sometimes better than the present-day water-saving techniques. The paper summarizes the transformation over the years in the construction and advancements of water conservation practices in Rajasthan. In dry regions, these practices have helped people survive tough times.Traditional methods may have a few challenges to overcome, but they have proven to be sustainable over a long period of time. In order to fight environmental degradation of the present and future, it is important to develop holistic and sustainable strategies, especially in vulnerable regions.

Introduction

About 71% of the Earth's surface is water covered and oceans hold about 96.5% of all Earth's water. About 1% is salty water in the ground and 2.5% is fresh water (1.2% is locked up in ice and 1.3% is surficial fresh water; mostly in lakes). Lake superior is about 10% of Earth's surficial fresh water. 69% of this 2.5% fresh water is found in ground ice and permafrost, 20.9% in lakes, 3.8% in soil moisture, 2.6% in swamp and marsh, 0.49% in rivers, 0.26% in living things and 3.0% in atmosphere.Table-1 is showing the distribution of water on and above the Earth.

Table -1. Distribution of water on and above Earth

S.No.		Source of water	% of total water
1		Oceans	96.5 %
2		Ice, Glaciers & Permafrost	1.76 %
	i	Ice caps, Glaciers & Permanent snow	1.74 %
	ii	Ground ice & Permafrost	0.022 %
3		Groundwater	1.7 %
	i	Saline groundwater	0.94 %

	ii	Fresh groundwater	0.76 %
4		Soil moisture	0.001 %
5	i	Lakes, Ponds etc.	0.013 %
		Saline lakes	0.0062 %
	ii	Fresh water lakes	0.0066 %
6		Atmosphere	0.0001 %
7		Swamps	0.00083 %
8		Rivers	0.00015 %
9		Biological water	0.0001 %

Distribution of precipitation is not equal on Earth. There are so many places which are fighting with drought hazard. The Atacama desert in Chile is known to be the driest place on the Earth. The average rainfall is 1.5 cm/year. Some weather stations have never received rainfall at all.As well as Rajasthan is also a subtropical dry region whose western part is a sandy desert. The average annual rainfall of this state is 57.3cm while eastern part gets 65cm and western part gets 32 cm only. So rain water harvesting (RWH) is very useful and mandatory in Rajasthan.

Water harvesting is the accumulation and storage of rain, rather than allowing it to runoff. In present days rain water is collected from a roof like surface and redirected to a tank, cistern, deep pit, aquifer or a reservoir with percolation; so that it could seep down and restore the ground water.But in Rajasthan there are so many traditional methods of RWH witch are different to present day harvesting system but the purpose of these are same to save rain water. In this research here are some rain water harvesting methods which are being practice in Rajasthan.

Study Area

Rajasthan is situated in North-West part of India among 23º3'N to 30º12'N and 69º30'E to 78º17'E in shape of irregular rhomboid and 10.41% of the country. It is five times larger than shri Lanka, three times of Czechoslovakia, seventeen times of Israel, more than two times of England and little bit smaller to Japan.

Rajasthan can be divided into four physical divisions like Western desert, Aravali mountains, Eastern plains and South-eastern plateau, five climatic zones like wet, humid sub humid, semi arid and arid, nine soil zones like Sandy soil, Brown sandy soil, Alluvial soil, Red-yellow soil, Medium black soil, Red-black soil, Red-loamy soil and Brown sandy alluvial soil and into ten Agro-climatic zones.

Aravali mountain chain is dilated from south west to north east in the state. Ever flowing Chambal and Mahi and Luni, Banas, Kothari, Kali sindh, Jakham, Som, Ahu, Parvati, Banh ganga, Ghagghar, Western banas, Sukadi, Jojadi, Parvan, Khari, Rupangarh, Mendha etc. are seasonal rivers in the state. Lunkaransar, Sambhar, Pachbhadra, Degana, Parbatsar are saline and Jaysamand, Rajsamand, Talabsahi, Gebsagar, Annasagar, Kaylana, Kolayat, Foysagar, Narayansagar, Silisedh etc. are sweet water lakes scattered in the state. Only 1% underground water of the nation is found in Rajasthan.

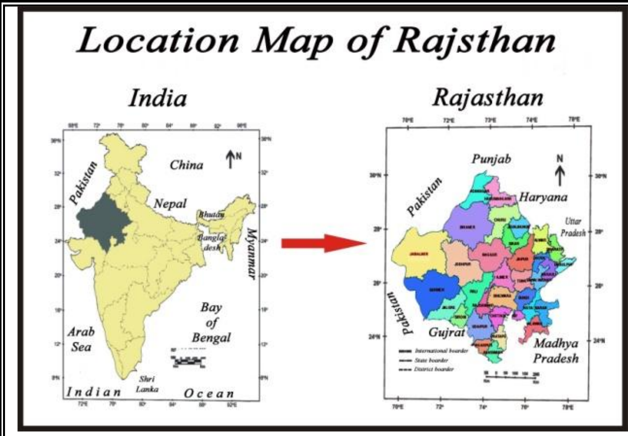

Fig.-1. Location of Rajasthan

Maximum average temperature of western Rajasthan is 36.1ºC and 33.3ºC in eastern part. Minimum average temperature is generally found between 17.7ºC to 21.1ºC. Average annual rainfall of the state is 57 cm. It lays in BWhw and BShw type climatic zones according to Koppen's climate classification. Land use of the state is as follows- net cultivated area is 51%, gross irrigated area is 43%out of which 67%area is irrigated by wells and tubewells. 17%land is uncultivated and 11.36%is fallow land. Average holding size in the state is 3.38 hactare and per capita available agriculture land is 0.49 hactare.

According to administration point of view there are 7 zones, 33 districts, 33 district councils, 352 panchayat samities, 343 tehsils, 10 Municipal corporations, 34 Municipal councils, 169 Municipal boardsand 11307 Gram panchayats in the state.

3.- <u>Traditional rain water harvesting systems</u>:- In Rajasthan,there are so many water harvesting methods in practice. Some of those are described here-

(i) Lake(>hy)/ Pond (rkykc)/ Nadi(ukMh) :-The relation among these in area and volume of water is Lake > Pond > Nadi. These may either natural or manmade.'*Sudarshan Lake*' in Gujarat is the oldest manmade lake in India which belongs to the time period of the Mourya dynasty in 300 BC and is situated in Girnar area of Saurashtra. '*Govind Vallabh Pant Sagar'* is the largest lake in India. While, Jaisamand lake (<+scj >hy) is the largest manmade lake of Rajasthan. In this state there is atleast one Nadi/Talab/Lake situated in every village to harvest the rain water. The lakes generally have a large catchment area while nadis have very small '*agor'*. The first pavemented nadi recorded in history ofRajasthan was built near Jodhpur in 1520 A.D. by Rao Jodha. In actual term nadis are natural pots on earth surface in which rain water is being collected. The water collected in nadis is called '*Palar Pani*' and catchment area is called '*Madar*' while excess water drainage is called '*Nehta*'. According to CAZRI, Jodhpur; the 37.01% of total demand of water of Nagour, Barmer &Jaisalmer is fulfilled by nadis.

(ii) Toba (Vksck) :- Toba is an important water harvesting system in western Rajasthan similar to nadi. But it is made in dense structured land in which leaching cannot be occurred more or is made pavemented and it is more deep than nadi. Due to soil humidity grasses grow near tobawhich are very useful for live-stock. Tobas provide water year around to villagers and one toba is generally sufficient to 20 families.

Fig.- 2. Nadi

Fig.- 3. Toba

(iii) Bawadi (ckoM+h) :- Stepwells are drinking water aquifers getting a regular recharge through rain water. To conserve the rain water stepwells were set up in large towns to provide water supply to the community. These were built byMillionaire businessmen (lsB), queens of famous kings (jkfu;ka) in famine. Each stepwell helps reaching the water to the ground level and maintains it properly. The well's massive open surface served as a rain catching funnel, collecting water and transporting it to the well's bottom. Chand bawadi of Abhaneri (Dausa), Hadi rani bawadi of Todaraisingh (Tonk), Rani ji ki bawadi (Bundi) and so many other bawadis are situated in Rajasthan. Bundi is known as 'City of stepwells.'

Fig.-4. Bawadi

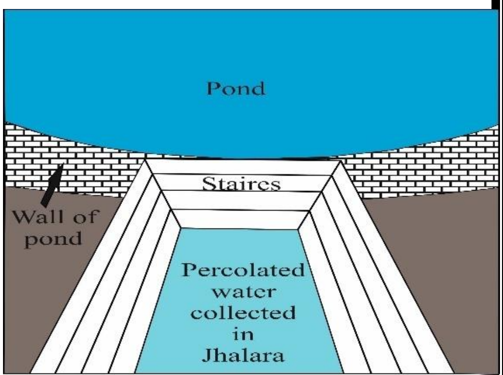

Fig.-5. Jhalra

(iv) Jhalara (>kyjk):-Jhalaras do not have their own catchment area rather these collect subterranean seepage of a *talab* or a lake located upstream. There are eight jhalaras in Jodhpur city, two of which are inside the town and six are found outside the city. The oldest jhalara is Mahamandir jhalara which dates back to 1660 A.D.

(v) Paar (ikj):- In the western part of Rajasthan paar is a common water harvesting practice. This region gets 25 cm per annum average rainfall. Paar maximizes the catchment of water percolating into the sandy soil. The rain water flows from catchment area and in that process percolates into the soil. To access the percolated water 15[l] to 40[l] deep small wells are dug in the catchment area using traditional masonry technology. Approx 5 to 10 or at some places 20 small wells are constructed in an average paar.

This is the most pre-dominant form of rain water harvesting in the Jaisalmer and adjoining districts. Rain water harvested through paar technique is known as '*Patali Paani'*. The water received from monsoon rains can be stored for next 6 to 8 months.

Fig.-6. Paar

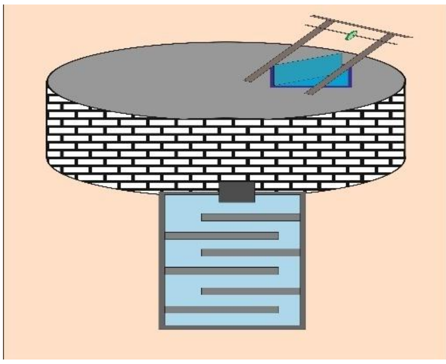

Fig.-7. Jhalra

(vi)Tanka (Vkadk) :- A tanka is a compound of a covered, underground, impermeable cistern on shallow ground for the collection of rainwater. The cistern is generally constructed out of stone or brick masonry or concrete with lime mortar or cement plaster. Rain water or surface run-off from roof tops, courtyards or artificially prepared catchments flow into the tank through netted inlets in the wall of the pit.

The water in a tanka is usually used for drinking only. If due to less rainfall tanka do not get filled, water would instead be obtained from nearby wells and tanks to fill the tanka. Tankas are usually constructed in villages for community usage due to the belief in the sanctity of water. This preservation technique is an ancient practice dating back to at least 1607 A.D.near Jodhpur.

Generally tankas are 20^{l} deep, 14^{l} long and 8^{l} wide and have a capacity of around 21000 litters but larger ones can be constructed where resources are available commonly.The catchment area, known as an agor, is a concave cemented funnel-like slope directing water into a collection pit that reduces the sediment load of water before it enters the underground cistern via a suitable mesh supported by bars in an angle iron frame to filter out other large debris. The micro catchment avoids seepage and prevents erosion and is fenced to restrict animal entry. The bottom of the cistern is also concave facilitating extraction of the maximum amount of water from the tanka. The cistern has a top cover to prevent evaporation and pollution of stored water by the foreign matter. A galvanised iron cover is built to facilitate withdrawal of water.

(vii)Kundi (dq.Mh) :-A kundi looks like an upturned cup nestling in a saucer. Essentially a circular underground well, kundi have a saucer shaped catchment area that gently slope towards the centre where the well is situated. A wire mesh across water inlets prevents debris from falling into the well pit. The sides of the well-pit are covered with line and ash. Most pits have a dome shaped cover or at least a lid to protect the water from evaporation and pollution. Water can be drawn out with a bucket.

Kundis are usually constructed with local materials or cement. These are owned by communities or privately. The first known construction of a kundi was during 1607 A.D. by Raja Sur Singh in village *Vadi ka Melan.*

Before the onset of rains every year, meticulous care is taken to clean up the catchment area of the kundis. Inlets for water to go in to the tank are usually guarded by a wire mesh to prevent the entry of floating debris, birds and reptiles. The top is usually covered with a lid from where water can be drawn out.

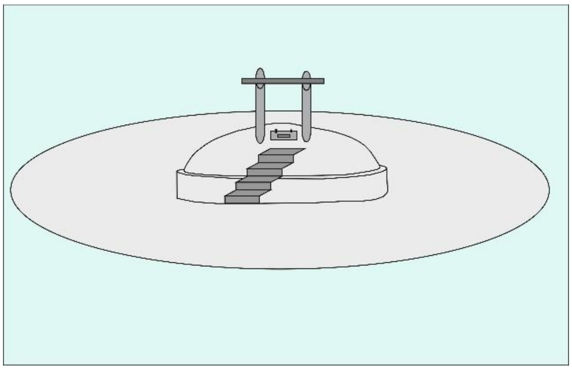

Fig.- 8. Kundi

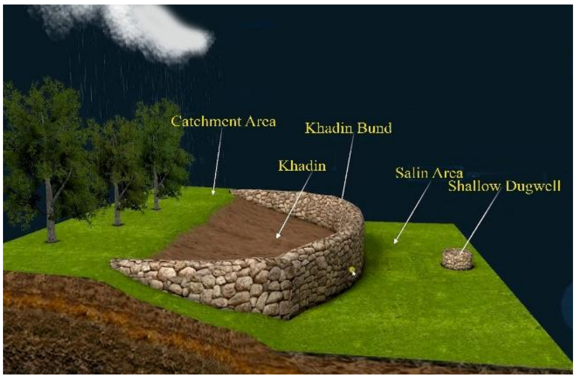

Fig.-9. Khadin

(viii) Khadin ([kM+hu) :- A khadin is a land-use system developed as early as in the 15th century by Paliwal brahmins of Jaisalmer to harvest surface runoff water for agriculture. It is practiced where rocky catchments and valley plains occur in proximity. The runoff from the catchment is stored in the lower valley floor enclosed by an earthen 'bund', which is across the edges of sloping farmlands.The rain water in monsoon flows down the slope and is stopped by it. This stored rain water may disappear below the soil by the first week of November, leaving thesurface moist. The crop sown in khadins mature without irrigation. The soils in the khadins are extremely fertile because of the frequent deposition of fine sediment, while the water that seeps away removes salts. If this reservoir overflows, the water goes into the shallow dug well. This water from the reservoir and shallow dug well seeps down the land and refills the ground water table. The area over which water spread;is called the 'Khadin area' or alternatively the 'Command area'.

(ix) Diggi (fMXxh) :- Farmers living in the lower command area of Indira Gandhi canal have constructed micro-farm water storage structures in their fields, called diggi. They store allocated canal water in diggi to utilize it as per irrigation requirements and can solve the problem of lack of water and irregular canal water supply. The government also has recognised the importance of diggi in these areas and came out with a standard design of diggi (110'X110'X10') size with 18' side slope to store about 25 lakh liters of water.

(x) Saza Kua (lk>k dqvk) :-Saza kua is the most important source of irrigation in the Aravalli hills in Mewar and eastern Rajasthan. It is an open well with multiple owners. The soil dug out to make the well pit is used to construct a huge circular foundation or an elevated plateform sloping away from the well. The first is built to accommodate the *rehat* (a traditional water lifting device) the sloping platform is for the *chada*, in which bulls are used to lift water. Saza kua construction is generally taken up by a group of farmers with adjacent land holding.

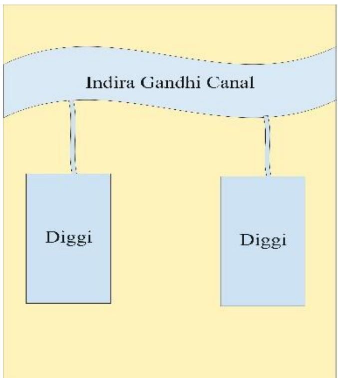

Fig.- 10. Diggi

(xi) Johad (tksgM+) :- Johad is a small earthen dam that captures and conserve rainwater. It promotes downward percolation of stored water and recharges ground water. It is commonly community owned traditional harvested storage wetland primarily used for storage of water resources for future use. The stored water is available yearround.Thishelps to recharge ground water in the nearby wells. These are useful for live-stocks, migrant birds, wildlife, fisheries as well as for drinking and irrigation water for human beings. Rajendra Prasad of Alwar is known as '*Johad wale Baba'*. The central goverbment with a view to solving future water scarcity in 2019 gave due importance to Atal Bhujal Yojana (Atal ground water scheme). It is a 5 years (2020-21 to 2024-25) water project.

The building of a simple mud and rubble barrier check dam is a good bet and cost effective. It can be built on a sloping terrain with a high embankment on the three sides while the fourth side left open for the rain water to enter. Such small catchment areas can trap and conserve rain water to a considerable extent, improving percolation and ground water recharge.

Fig.- 11. Johad

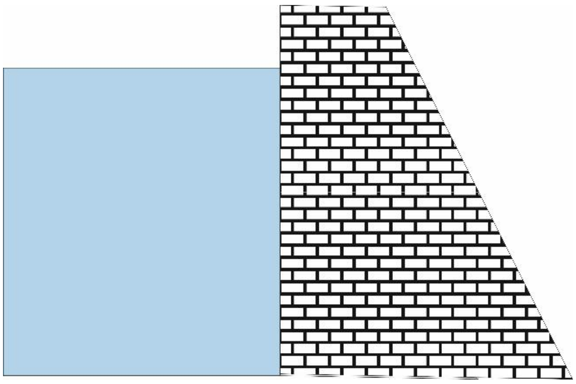

Fig.- 12. Rapat

(xii) Nada/Bandha (ukMk@ca/kk):- Nada/Bandha are found in Udaipur, Chittoregarh, Bhilwara, Rajsamand etc. districts of southern Rajasthan. It is a stone check dam constructed across stream to capture monsoon runoff water on a stretch of land. Submerged in water, the land becomes fertile as silt deposits on it and the soil retains substantial amount of water.

(xiii) Rapat (jiV) :- A rapat is a percolation tank with a bund to impound rain water flowing through a watershed and a waste weir to dispose of the surplus flow. It is either built of masonry, or earth is used. It doesn't directly irrigate land but recharges wells within a radius of 3 to 5 kilometres downstream. Silting is a serious problem with small rapats and estimated life of it varies from 5 to 20 years.

(xiv) Beri/Kui (csjh@dqbZ) :- Sustainable traditional source of water beri also known as 'Rejani' in Jaisalmer, 'Seje' in Barmar and 'Jhaare' in Aravallis. These are pitcher shaped shallow percolation wells that store rain water. A beri is about half a metre wide at the top and three to four metres wide at the bottom. Beris can hold up to 5,00,000 litres of water. Rainwater absorbed by the surface and mountainous rocks flows through the geological routes and gets collected in the areas comprised of sedimentary rocks. This seepage of water is known as 'Reza', 'Seza' and 'Jhar' in the local language based on which the water source has been named.

The construction of these wells calls for intense human labour and mastery. It takes several days to months to reach a minimum depth of 100^{l} to a maximum of 300^{l} to find water for one well. The most difficult part is digging through the hard layers. Even after a day's intense hard work, only about one and a half feet of land is excavated. Villagers also participate in the task by helping well-diggers in taking out the excavated soil. The benefits of these wells are several; it is people-centric, economical, sustainable and environment friendly. Interestingly, the beris are named after the person who constructed them.

(xv) Polymer Kundis (iksyhej dq.Mh) :-The kundi consists of a circular catchment area sloping towards the centrally located storage structure. The quality of water from kundi is good and if maintained properly no serious water contamination occurs. Its maintenance is easy. Local materials such as clay, silt, lime, ash and gravel are traditionally used to construct the catchment area of a kundi. They do not make completely impermeable layer. As a result some part of rain water is lost due to uncontrolled seepage. Nowadays in Churu district villages are using new technique of polymer science. Water based non-toxic polymer solutionthat permeate the highly porous sandy soil are used to increase runoff to kundis. These polymers act as binders and reduce permeability and infiltration rate of sandy soils. Use of water repelling chemicals in combination to some binding agents result in better runoff.

(xvi) Chauka (pkSdk) :- Semi arid Dudu block of Jaipur district is known for the origin of chauka system of monsoon rain water harvesting. The system consists of square shaped embankments. On three sides there are nine inch walls and one side is left open to allow rain water to fill the structure. As one structure fills then the over flow fills the next chauka and so on. Retaining the rain water in this way helps in preventing soil erosion and recharges the surface water enabling various grasses to thrive. This has the effect of holding the soil together and as the chauka system is used mostly on common land, provides grazing areas for cow and goat herds. It is quite effective in planting of grass seeds and trees. The ideal size of chauka is 100^{l}long X70^{l}wide X 1^{l} deep and this is to hold a 9^{ll}water level spread over a field. Once the level is full we can drain and recycle the moisture across the fields which helps in agriculture and afforestation.

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(xvii) Bhungroo (Hkwax#) :-Bhungroo means straw; a Gujarati technique of monsoon water harvesting is being popular in adjoining districts of Rajsthan with Gujarat border. By this life changing technology poor farmers are now converting crises into opportunities. This system injects and store excess rainfall underground and lifts it out for use in dry spells. Adoption of this technology has decreased salt deposits on soil and increased fresh water supply and under ground water table too. The massive underground reservoir can hold as much as 40 million litres of rain water. It harvests water for about 10 days per year and can supply for as long as 7-8 months. Artificially recharging aquifers by adding rain water to underground water reservoirs enables the communities to continue farming for more than half of the year. The non-saline rainwater when mixed with the underground saline water brings down the salinity of the ground water, making fit for agriculture use. By curtailing desertification, the technology helps to build resilience to climate change and to rejuvenate local bio-diversity. This in turn benefits the local community as it allows growing of local more nutritious food.

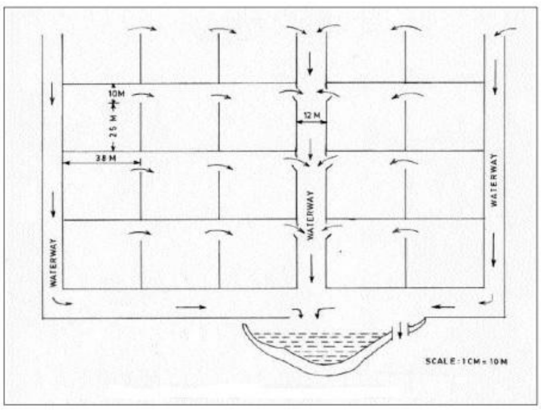

Fig.- 13. Chauka

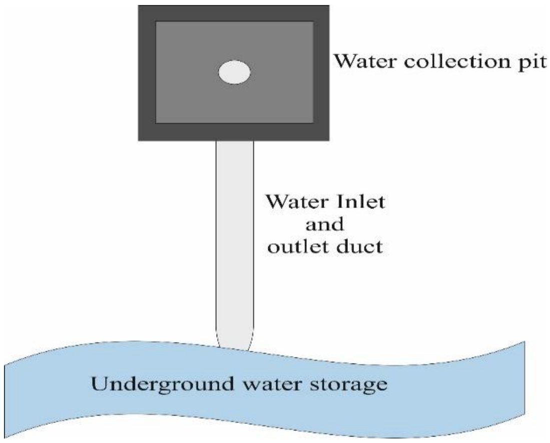

Fig.- 14. Bhungroo

Conclusion:

Rajasthan has 13.88% of India’s cultivable area, 5.67% of population and about 11% of country’s livestock but only 1.16% of surface water and 1.7% of ground water. Thus Rajasthan is a state with 10.4% of land area which has around 1% of country’s water resource. In this way this state is known as drought prone area for many centuries. Water has more importance than *Ghee* here. Rainfall variability is more than 30% in the state and in western part it is more than 60%.

This state is permanent home of drought. A proverb is famous in Rajasthan “rhtks dwfj;ks vkBoks dkG". So the traditional water harvesting systems described above have been in existence for many centuries. They have evolved using the age-old wisdom and knowledge of the terrain developed over hundreds of years. They serve the essential water requirements of the people, especially in the water deficient areas of the desert. Nowadays due to urbanisation and industrialisation these water harvesting systems are not in more practice. But we should regenerate and reform these so good ancient systems, which are especially suitable to the needs of folks. These systems also have crucial sociological, religious, cultural, historical and architectural importance.

Suggestions:

The people of Rajasthan are very religious and nature friendly. They always protect trees, wildlife, livestock, birds and human beings. Every Rajasthani know the value of water. To conserve more and more rain water we ought to reform these water harvesting techniques mentioned above with modern techniques. To regenerate these systems there is a strong need to aware people about these ancient techniques. These ancient techniques should be taught to students from school to university curriculums with present day new methods. Government also should spend more budget on it, So that under ground water table can be raised to fulfil the requirement of folks.

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