Water harvesting through some remarkable projects, like Spreading Channels, Open Mines & Step Wells in the Gujarat State

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ABSTRACT

Agriculture is by far the largest user of the world's water, soil and biodiversity. It accounts for about 65 to 70 % of the total water withdrawal of the world. The requirement of water is due to increase in the population and hence the increase in requirement of food. In addition, there is a tremendous pressure to meet water requirement for other purpose such as drinking water, industrial use etc. this leads to competition between various water users and thus agricultural sector have to adjust for water which is available at its end.

There are various familiar irrigation schemes which are very useful for agricultural and drinking purpose, but these are not enough against the huge requirement of water in every field of life. Considering the facts and looking to the figures of rain fall in various districts of Gujarat, the technocrats, engineers, planners, administrators and politicians decided to implement some innovative techniques for rain water harvesting in this region. After careful study of various aspects, two remarkable schemes came into mind and thus the development of rain water harvesting through filling the unused stone quarries in the district of Porbandor and to restore the forgotten Step Well-Vaav-in the Gujarat state and fill them by rain water started few years back. These ideas were developed and justified by the Government of Gujarat, and as such many Step Wells were searched, which were either completely blocked or partially blocked and restoration works for such Step Wells were planned. At present about 40 Step Wells are restored and thus rain water harvesting took place in various districts.

Most of the Southern and Western coast of Saurashtra & Kutchh comprises of Lime stone which is cavernous in nature. Due to cavernous nature of the geological formation near the coast and excessive withdrawal of ground water by farmers for irrigation, the intrusion of saline water in the ground water aquifers took place. This ultimately resulted into the salinity ingress. Looking to the magnitude and gravity of Salinity problem, the concept of construction of spreading channels was suggested by the high level committees made by the Government of Gujarat in the year 1976 & 1978, headed by the then Chief Secretaries.

Hence the construction of spreading channels-linking two nearby reservoirs at convenient places considering the condition of the strata of underground soil and requirement of the local people to minimise salinity ingress in the Saurashtra coastal region of Gujarat started few years ago.

These above mentioned remarkable and innovative approaches, taken by the Government of Gujarat are beneficiary and due to this irrigation potential created, the storage of sweet water is made possible.The water quality in terms of TDS shows improvement. Also the quality and yield of the agriculture produce has improved.
An improvement in the ground water level is observed and the prices of agricultural land have also improved considerably.

This paper aims to make suggestions about the usefulness of such innovative projects which can give a direction to solve the problems of water storage even in other states and regions having similar structures like open mines and step wells and connecting two nearby reservoirs through spreading channels for the betterment of the people of India.

1-INTRODUCTION:-

The source of all water is rain, a most beautiful gift of God. Natural supply of usable water for different purpose for all mankind and for all walks of life, hence we should preserve/conserve and harvest it by adopting different traditional and contemporary methods and techniques which are available at our end at present for the betterment of our own. Main objectives of rain water harvesting are to conserve and augment both ground water and surface water resources to reduce water level depletion, to improve the quality of ground water and to prevent see water intrusion in coastal areas.

Since time immemorial man has been trying to device more and more infallible methods for locating ground water. Exploitation of ground water by adopting esoteric method is carried where necessity is felt and resources are compromised. Water is a vital resource for agriculture, domestic use and industries.

Although, about three fourth of earth is water, the estimate volume of fresh water is about only 2.5 %, the rest being sea /salt water. As per the WHO estimate only 0.007 % of all water on earth is readily available for human world consumption. The study made by IWMI-Global Water Scarcity study program, scenario of availability of water is not good and it reveals that by 2025 more than 1.8 billion people will live with absolute water scarcity.

Now considering the facts about the availability of water source for Gujarat, we can found that Gujarat mainly depends on surface water and the state has 185 River Basins and the available quota of water in state is 50100 MCM, out of which, 38100 MCM is surface water with unequal distribution all over the state.

Out of the total 125 lakhs hector of cultivatable land in the Gujarat state, 18 lakhs hector is under the surface water irrigation, 18 lakhs hector is under Sardar Sarovar yojna, 9 lakhs hector is under the Sujlam Suflam project and check dams, 20 lakhs hector is under the underground water irrigation and about 60 lakhs hector land depends on rain fall.

Now let us go through some details about some remarkable kind of Water Harvesting projects, which are recently taken on hand to Store the “sweet” water of rain for the betterment of the people residing near about such projects.

2-SPREADING CHANNELS:-

Before we go in the details of spreading channels, let us now understand the base and necessity for the construction of spreading channels in the Saurashtra Reigion of the Gujarat state. Most of the Southern and Western Coast of Saurashtra & Kutchh comprises of Lime stones which is cavernous in nature. Due to cavernous nature of the geological formation near the coast and excessive withdrawal of ground water by farmers for irrigation the intrusion of saline water in the ground water aquifers took place, which ultimately resulted into the salinity ingress.

Looking to the magnitude and gravity of Salinity problem, the Government of Gujarat appointed two High Level Committees (HLC) to study the Salinity Ingress Problem and suggest solution, which includes HLC – I, Headed by the then Chief Secretary SHRI. H.K.L.Kapoor- in 1976 and HLC – II, Headed by the then Chief Secretary SHRI. K. Shivraj-in 1978.

2.1 Suggestions made by HLC-I & II

(A) Salinity Control Techniques:-
- (1) Tidal Regulators and Bandharas
- (2) Fresh Water barriers
- (3) Extraction barriers
- (4) Static barriers

(B) Recharge Techniques:-
- (1) Check dam
- (2) Recharge Tanks
- (3) Recharge Wells
- (4) Spreading Channels
- (5) Aforestation & Nala plugging

(C) Management Techniques :-
- (1)Change in cropping pattern
- (2) Regulation of ground water extraction and

(D) In addition to above all HLC-I recommended Coastal Land Reclamation

Spreading channels are unlined canals which are connecting two nearby reservoir and facilitating availability of water to nearby areas. Spreading channels form a useful recharge device when recharge is desired along a narrow but long area. If the artificial recharge is attempted near the junction of Miliolite limestone and Gaj limestone, the induced recharge will result in ground water movement towards the sea.

It will help to control movement of saline water from sea side, in addition to providing additional ground water. The Spreading channel will also feed surplus floodwater from one reservoir basin to another where rainfall is scanty. A channel of considerable length would definitely be advantageous but, the dimensions would have to be restricted depending upon availability of quantum of fresh water.

By connecting two reservoirs excess water from one reservoir can be diverted to another, this helps in times of unequal and less rainfall. Water stored in spreading channels can be utilized by farmers of nearby area for irrigation purpose which results in improved yield of crops. Due to increased output in farming, agricultural income is enhanced which reduces migration from this area and improving ground water quality. These channels allow water to percolate into deep grounds, thus raising ground water table and improving ground water quality also.

A channel of considerable length would definitely be advantageous but, the dimensions would have to be restricted depending upon availability of quantum of fresh water. The channel should be constructed in small length at different locations in the reach- area depending upon availability of water from proposed recharge reservoir. It is extremely important that both recharge and salinity control works are taken up intensively in a particular reach, basin wise, in the shortest possible time so that the results are as per expectation.

To avail maximum benefit of available storage of water of all schemes which are under construction and schemes which are in pipeline may be planned as follow:-

- The water of the reservoirs of schemes which are in progress at present in the area can be considered as available for first 5 years for the work of salinity prevention as canal distribution system may only develop fully after 5 years from completion of the canal system.
- In order to get maximum recharge benefit, the reservoir of Medium and Minor capacities may be constructed on all big and small rivers depending upon condition and feasibility of sites.

Special Recommendation:-

- When these existing canals and distributaries are proposed to be used for feeding the spreading channel the storing capacity of spreading channel will be limited to the carrying capacity of the tail distributory.
- If required the spreading channels can also be fed from the tail distribution of existing projects on the upstream side, when there is overflow from the dams.

2.2 Benefits of spreading channels:-

- At present @18000 Ha. land is getting direct & indirect benefit from about 130 kms. of completed length of total 18 Nos. of Spreading Channel, and much more works are under progress and planning for the betterment of the people of Gujarat.
- As per the recommendation made to construct 360 kms. of spreading channel more than @36450 Ha. of land will get direct and indirect benefit of irrigation.
- Storage of sweet water is available for recharge into lower aquifers resulting in raising of ground water table and improvement of quality of water.
- By connecting two reservoirs excess water from one reservoir can be diverted to another, this helps in times of unequal and less rainfall.
- Water stored in spreading channels can be utilized by farmers of nearby area for irrigation purpose which results in improved yield of crops.
- Due to increased output in farming, agricultural income is enhanced which reduces migration from this area.
- Spreading channels are unlined canals which are connecting two nearby reservoir and facilitating availability of water to nearby areas.
- These channels are not meant for flow water for irrigation, but water stored in this facilitates lift irrigation for surrounding areas, thus raising agricultural production and improving ground water quality.
- Construction of spreading channels is very easy as it involves excavation and C.D. works only, which can be taken up faster as compared to lined canals.
- These channels allow water to percolate into deep grounds, thus raising ground water table and improving ground water quality also.

2.3 Benefits accrued from various salinity schemes:-

- Various salinity control and recharge works under the salinity control and recharge techniques are taken up by the Govt. according to the recommendations of the HLC-I & II.
- Due to completion of different salinity prevention works in HLC-I & II reaches, irrigation potential more than 70480 Ha. is created.
- In addition to this beneficiaries (local farmers/villagers) have lifted water for irrigation from radial canals through their own means.
- The quality and yield of the agriculture produce has improved.
- The water quality in terms of TDS shows improvement.
- Improvement of ground water level.
- The prices of agriculture land have also improved considerably.

This has direct bearing on the improvement of economic prosperity of the region. In most of the areas where migration has taken place due to effects of salinity the migrated families have returned after constructions of salinity control schemes.

Due to arrest of salinity ingress the quality of water in the area has improved which resulted in substantial improvement in quality and yield of agriculture produce of the area. After successful implementation of salinity control programmed especially in HLC-I area an overall improvement in environmental and socio-economic conditions of the area has been recorded. Substantial increase in the market prices of land to tune of 300 to 1000% and more are observed in these areas.

2.4 Socio Economic Impact of various Salinity Control Schemes :-
The socio economic assessment study of salinity prevention schemes shows a good sign of the development of coastal area of Saurashtra region.

2.4.1 Livelihood:-
As the main occupation of the villagers is agriculture and animal husbandry, the benefit of various salinity schemes occurred as availability of water increases for agricultural purpose and also for drinking water. This helped for the betterment of their livelihood and lifestyle changed.

2.4.2 Gender sensitization:-
As the availability of drinking water increased the women of villages gets more time to spend in other social activities, like child carrying, to take part in agricultural activities of their own family and to attend gram sabhas. Some women who are keen in stitching work and embroidery work, they also get more time and start such works for earning purpose for their family.

2.4.3 Animal Husbandry:-
More fodder is available for animals and thus milk production increased, which helps villagers to earn more. Also as the marketing opportunities increased due to the development of dairies in nearby town, more and more villagers go for this another beneficial business and gets good earning.

2.4.5 Health:-
As the people gets pure drinkable water, the health status of villagers increased. Also many water born diseases reduced due to availability of fresh and good quality water. Ultimately good health helps the people in doing their day to day work with more energy and strength.

2.4.6 Migration
In early days villagers have very little choice for their earning, but due to the availability of good water resources in every village, the opportunities of job increases and they gets jobs in village itself for their earning and the migration of villagers for earning reduces.

3-NIR-SAMPATI-SANGRAH PROJECTS:-

Filling Stone Quarry-(Open Mines) by sweet water-in the Saurashtra Region of Gujarat.

In the district of Porbanadar there are some existiting un used Stone Quarries (Open Mines) on coastal belt of village Miyami to Madhavapur, which at low level from nearby sweet water resources at the depth of 4 to 15 meter, due to this, and as such some un used stone quarries are at the same level or lower level which quarries can be joined by nearby sweet water resources.

Considering this concept the then District Collector had suggested “NIR-SAMPATI-SANGRAH PROJECT” to fill up these unused stone quarries from nearby sweet water source in “Chintan Shibir” of Hon’ble Chief Minister and accordingly 5 works of @ 310 Lakhs are suggested by the department. At Present work for construction of approach channel from one Tidal Regulator to unused stone quarry to store sweet water, which passes away in Arabian Sea in monsoon period at a cost of @ 40 Lacs, due to this @244 lakhs of gallon sweet water was stored and 314 hector of land get benefits by recharging and saline intrusion in ground water also improved at some extent. At present few projects are at hand and more will take place in near future and as such the rain water harvesting in a non-typical and through new idea will be stored for various purposes.

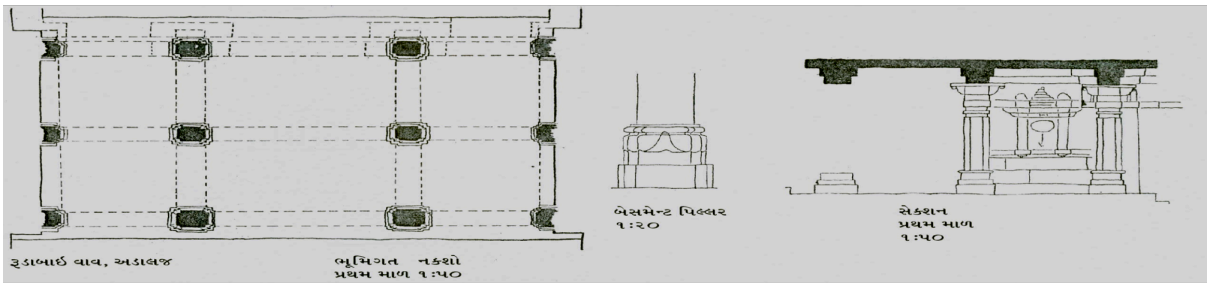
By making humps by dumping loose excavated materials of aforesaid approach channels, which is generated as naturally attractive beautiful place and this plase also be developed as a tourist place. Another benefit of such attempts is revenue generation from the excavated stuff. i.e. lime stone etc. was made by the concern department through auction process.

So these are new projects to store the sweet water in unused Stone Quarry has been developed and more works are also under progress in the Saurashtra Region of Gujarat state.

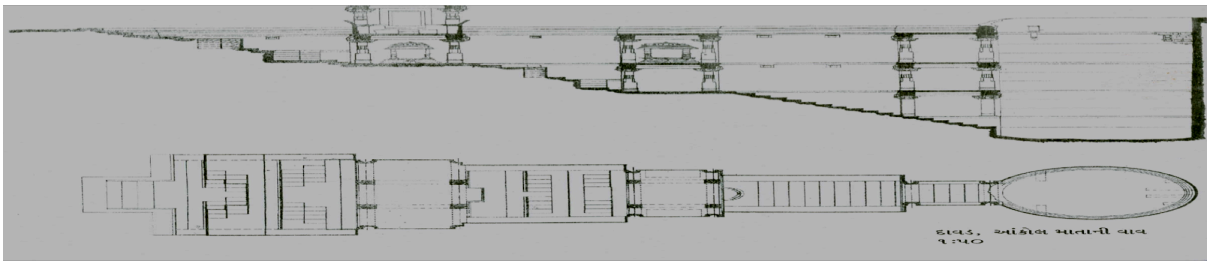
4- RESTORATION WORK OF STEP WELLS – “JAL-MANDIR” FOR WATER HARVESTING :-

Step wells, also called Kalyani or Pushkarni (Kannada), Bawdi (Hindi), Barav (Marathi), Vaav (Gujarati) are wells or ponds in which the water may be reached by descending a set of steps. They may be covered and protected and are often of architectural significance. They also may be multi storied having bullock which turns the water wheels to raise the water in the well to the first or second floor.

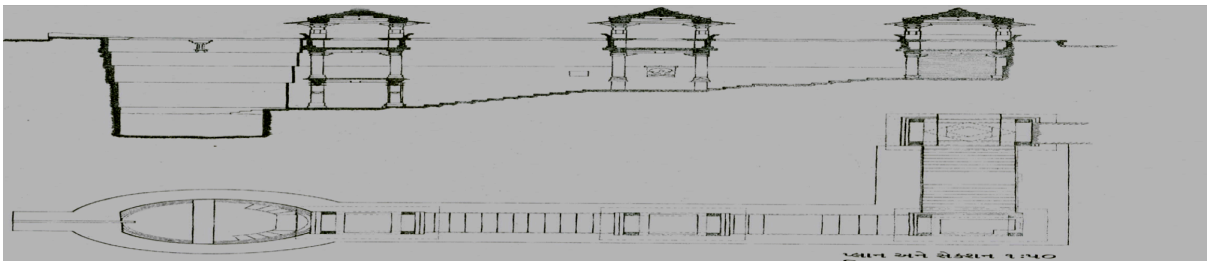
Rudabai Vaav – Adalaj (Nr. Gandhinagar)



Akol Mata ni Vaav - Davad



Gyan Vaav - Visavadar



A typical well is made up of the Mandapa-the entrance pavilion- which forms the main approach at the ground level. The Kuta-the flight of steps-leads down to the water-or Kund-at the bottom. The above diagrammatical sketches of Step Wells, help to understand the basic concept and guidelines of construction of them.

Water in the architecture of India could be found since the earliest times and had played an important role in the culture. Step wells were first used as an art form by the Hindus and then popularized under Muslim rule. Step well construction is known to have gone on from at least 600 AD in the south western region of Gujarat, India. The practical idea even spread north to the state of Rajasthan, along the western border of India where several thousands of these wells were built. The construction of these step wells hit its peak from the 11th to 16th century. Most existing step wells date from the last 800 years. There are suggestions that they may have originated much earlier, and there are some suggestions that precursors to them can be seen in the Indus Valley civilisation.

The first rock-cut step wells in India date from 200-400 AD. Subsequently, the wells at Dhank (550-625 AD) and construction of stepped ponds at Bhinmal (850-950 AD) takes place. The city of Mohenjo-daro has wells which may be the predecessors of the step well; as many as 700 wells have been discovered in just one section of the city leading scholars to believe that 'cylindrical brick lined wells' were invented by the people of the Indus Valley Civilisation. One of the earliest existing stepwells was built in the 11th century in Gujarat and is known as the Mata Bhavani's vav. A long flight of steps leads to the water below a sequence of multi-story open pavilions positioned along the east/west axis. The elaborate ornamentation of the columns, brackets and beams are a prime example of how step wells were used as a form of art.

The British rule of the Indian subcontinent of that time was not satisfied with the quality of hygiene that existed in these step wells and instead installed pipes and pumps to replace their purpose. In fact, even the invasion by Mughal rulers did disrupt in the culture practiced in these step wells. As a matter of fact, they encouraged the building of many step wells. It was strictly the British that forced abandonment of the wells. Consequentially, the social and religious activity taken place in these places were lost to the authority of the British.

The most important purpose of a Vaav is to store water and distribute it when needed. In a state like Gujarat, which has scanty rainfalls, it is believed that the Vaavs would have been constructed to serve this purpose. It is also been found that some of them were built in the 8th century and thus they are of high historic importance. An important fact about Vaavs is that, since the direct sunlight cannot penetrate too deep into them, the evaporation of water is less and also as the water gets filtered from the earth, it remains pure and fresh. Another important fact about Vaavs is that as the minerals and other natural substances get mixed with the water, it is very helpful in development of physical and spiritual health of the people who consume it and also improve the yield of crops when used in agriculture.

The importance of water to the locations in which they were found have been realized in the past decade now that many communities in the area are scarcity of rain and water. The construction of these wells encouraged the incorporation of water into the culture where they were popular. These step wells were even proven to be well built after withstanding earthquakes in the range of 7.6 on the Richter scale.

With the passage of time old Step wells (Vaavs) were either filled or forgotten. History reveals that lot of Vaavs may be in a damaged condition, so the state Government thought to conduct a research work to find out these historically important Vaavs and thus revive them in all respects. In view of this, Government of Gujarat started to find step wells in Gujarat and developed a data base of all the step wells and found many step wells which were forgotten in the history and they were found in some remote areas in many villages and forest areas. At present @ 669 Step wells are there in Gujarat and out of this 518 are water filled and 73 are under the Archie logical Survey of India as a protected Monument.

From 133 Partial blocked Step wells Government started restoration works of such step wells and at least 40 step wells in various districts of Gujarat were reconstructed/restored and planned to storage of water and the people residing nearby have been benefitted. These districts are (1) Amreli-3 Nos.(2) Ahmedabad-3 Nos.(3) Bhavnagar-3 Nos. (4) Bharuch-2 Nos.(5) Banaskantha-2 Nos.(6) Kutchch-2

Nos. (7) Mehsana-4 Nos. (8) Porbandar-6 Nos. (9) Rajkot-4 Nos.(10) Surendranagar-3 Nos.(11) Surat-1 No.(12) Sabarkanth-3 Nos.(13) Valsad-4 Nos.

This is a remarkable project and Government has done a very good job to implement it. After the research work was carried out, the Government found out that they all were very rich from the point of view of sculpture and heritage, so they might be a possible tourist attraction.

These above mentioned remarkable and innovative approaches, taken by the Government of Gujarat can also be helpful and can give a direction to solve the problems of water storage even in other states and regions having similar structures like open mines and step wells.

I hope that the paper will enlighten the details regarding steps taken by the Government of Gujarat for Water conservation and some innovative projects to store the rain water in the Saurashtra region as well as a path given guidelines for others to follow for the betterment of their people in general and Nation at large.

Here are some photographs related to the schemes discussed in the paper:

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 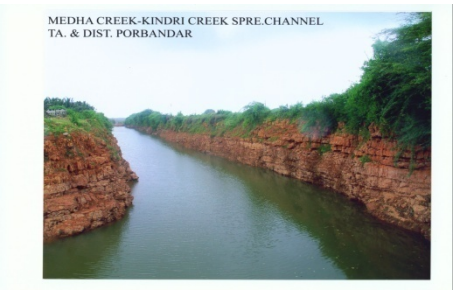
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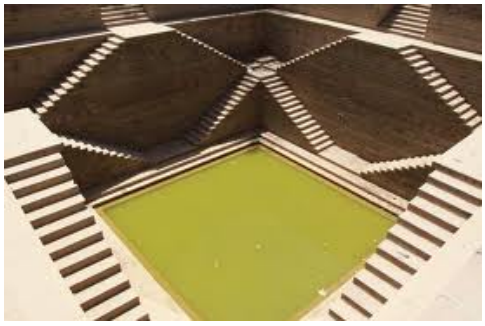
PHOTOGRAPH OF TYPICAL STEP WELL 	**PHOTOGRAPH OF TYPICAL STEP WELL** 
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STORAGE OF SWEET WATER IN UNUSED OPEN QUARRY-MINES 	**STORAGE OF SWEET WATER IN UNUSED OPEN QUARRY-MINES** 

UNUSED STONE QUARRY FILLED WITH WATER 	**Hon'ble Minister's visit at site** 
Hon'ble Minister's visit at site 	**UNUSED STONE QUARRY FILLED WITH WATER** 

Paper by:- Er. Kirit B. Trivedi, 55, graduated in Mechanical Engineering Branch from the L.D. College of Engineering of Gujarat University, Ahmedabad. He joined as an Assistant Engineer (Mech.) in the Government of Gujarat after he was selected for the post of Assistant Engineer (Mech.) by the GPSC in the year 1981 & carried out various tasks as a Mechanical Engineer during his tenure of 29 years. He was than promoted as a Deputy Executive Engineer (Mech.) in the year-2010 and posted in the Narmada, Water Resources, Water Supply & Kalpsar Department at Gandhinagar. He has done Master of Business Administration-(MBA) in Marketing and a Post Graduate Diploma in Disaster Management from IGNOU-New Delhi. He has presented Technical Papers at the Vigyan Bhavan- New Delhi during the "International Conference on Habitat" in the year-1997 & "World Congress on Natural Disaster Mitigation" in the year -2004, conferences which were organized by the Institution of Engineers-India & WFEO. He also has presented Three papers during the India Water Week-2012 held at New Delhi during the Month of April-2012, at Vigyan Bhavan. He was also invited to deliver talks on various subjects by All India Radio-Rajkot. He also presented papers on Disaster Management at various conferences. He is life member in Mechanical Division of the Institution of Engineers-India and also worked as an Executive committee member at its Saurashtra Local Branch-Rajkot for 14 years. He is a **Fellow** of the Institution of Valuers-New Delhi also. At present he is working as a Deputy Executive Engineer (Mech.) at Gandhinagar-Gujarat.

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The website: www.gswan.gov.in and inputs given by Salinity Ingress Prevention Circle, Rajkot, Gujarat.