

# **Opinion Article**

## **ADAPTATION OF INNOVATIVE INTERVENTIONS FOR ENHANCEMENT OF WATER USE EFFICIENCY: AN EXPERIENCE OF FARMERS' EMPOWERMENT IN SSPC**

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### **ABSTRACT**

Water is an elixir of life and it plays an important role in the economy of any country. Around 70% Approximately 70% of the freshwater is used in agriculture for irrigation; and therefore, Govt. of India has adopted an approach of 'more crops per drop' for Water Use water use. The impacts of irrigation relate to the changes in the quantity and quality of soil and water; specifically, in irrigation commands are crucial for the sustenance of irrigated agriculture. The problems of With respect to the deterioration of soil health and the environment, there by a reduction of in productivity is common in command area areas.

Infact, the agricultural sector has been slow and has much room for improvement to save water in irrigated agriculture. However, for enhancing WUE in command area, more important is areas, the involvement of the beneficiary farmers in crop and irrigation management is more important. Relay cropping is a complex suite of different resource-efficient technologies, which possesses the capability to that can improve soil quality, net return, and the land equivalent ratio, besides control of in addition to controlling weeds and pest infestation. A infestations. The recommended practice for the main crop of cotton-castor relay cropping that gave, which provides one and a half times higher greater income than the sole crop, has been evolved and been popularized. Cumin is a 2<sup>nd</sup> the second main crop grown after cotton. The improved practices of line showing on a raised bed instead of broadcasting, inter cropping intercropping with isabgul/ajwain, and practicing deficient irrigation that gave overall 43%, which resulted in an overall 43% higher yield, is were largely adopted. The concept of alternative furrow irrigation and applying irrigation at critical stages, which saves water to the extent of 30-35% 35%, is conceived and practiced by the farmers. The distinguish distinguished social engineering approach, articulation by which involves facilitating the farming community with the highest knowledge back-up and precision have, has been successful in sardar sarovar project command and have has a prime scope for enhancement of enhancing WUE in irrigation commands.

*Keywords: Social Engineering, Community Mobilization, Water Saving, Cropping Practices*

### **1. INTRODUCTION**

The Sardar Sarovar project comprises of a gravity dam on the Narmada River near Navagam, Gujarat. In terms of the The volume of concrete involved for in gravity dams, it ranks second largest in the world. It has an F.R.L. of 455 ft and a canal off taking on the right bank with its full supply level (at off take) at ht. 300 ft. A total utilizable flow of 28 MAF at 75.75% dependability is estimated and allocated as follows: Madhya Pradesh – 18.25 MAF; Gujarat – 9.0 MAF; Rajasthan – 0.5 MAF; and Maharashtra – 0.25 MAF. The

main canal after traversing 458.318 km through ~~middle~~central and ~~north~~northern Gujarat ~~cross~~crosses the boundary and runs 74 km in Rajasthan, with 598 different types of structures on it. The canal network consists of 44 branches, ~~and~~ 727 distributaries, ~~and~~ 4459 minors.

The project command of 18.45 ~~lakh~~ ~~halakhha~~ lies between ~~24°21'40" to 24°40' N~~ latitude and ~~of 69°33' to 73°50' E~~ ~~Longitudes~~longitude. The topography is characterized by flat alluvial plains, except ~~for~~ small parts ~~having that are~~ undulating and marked by small hillocks. In most of the parts, ~~the~~ drain density is good, and the soils are alluvial in nature ~~and~~ derived from ~~the~~ Deccan Traps. The command area covers 3177 villages of 77 talukas in 17 districts of Gujarat. With ~~a view of respect to the~~ efficient use of precious water, ~~the~~ 'Narmada Planning Group' ~~have has~~ worked for years and carried-out various studies. The whole command area is divided into 13 ~~Agro-Climatic Regions~~agro-climatic regions (ACRs) considering ~~the~~ parameters of topography and land forms, rainfall, groundwater features, ~~and~~ land irrigability class, including drainage patterns and canal alignments.

The irrigation water allowances for the different ~~Agro-Climatic Regions~~agroclimatic regions have been ~~worked-out keeping in view~~determined considering the soil classification, groundwater availability, ~~crops-grown~~crop growth and climatological factors. In poorly drained flat lands with relatively high water ~~table~~tables, limited water ~~allowance~~ ~~has~~allowances have been planned. A special allocation of 0.86 MAF of water ~~has been was~~ made to provide drinking water to 173 towns and 9490 villages (53% of ~~the~~ total 18676 villages of Gujarat) within and ~~out-side command in~~outside of Gujarat. The villages and urban centres of ~~the~~ arid region of Saurashtra and Kutch and all "no source" villages and the villages affected by salinity and fluoride in North Gujarat ~~are~~benefited.

The impacts of irrigation ~~relate~~related to ~~the~~ changes in ~~the~~ quantity and quality of soil and water ~~specifically, especially~~ in irrigation ~~commands~~, are crucial for ~~the~~ sustenance of irrigated agriculture. ~~The problems of~~With respect to the deterioration of soil health and ~~the~~ environment, ~~there by a~~ reduction ~~of in~~ productivity is common in command areas. Soil salinity is a prime problem in irrigation ~~commands which, as it~~ not only decreases ~~the~~ agricultural productivity but also, ~~reduce the~~ reduces economic returns and affects the physicochemical properties of the soil. Two ~~third~~thirds of the command ~~is having semi-arid~~has semiarid climatic ~~condition~~conditions, where inherent salinity exists. There are coastal areas called 'Bhal' and 'Bara Track' ~~having with~~ coastal salinity and ~~problem of~~drainage. ~~Vast problems.~~ ~~The vast~~ area in the vicinity of ~~the~~ little run of Kutch is ~~low a low-~~lying flat ~~having with~~ salt-affected soil.

~~It has been experienced that farmers' response is more aggressive towards~~Farmers are more likely to respond more aggressively to their problems in ~~practicing~~practising irrigated agriculture ~~rather in comparison of than to~~ many activities ~~under~~taken for their ~~benefits, with this consideration, solving the~~benefit; therefore, farmers' problems were ~~undertaken~~solved on ~~a~~priority basis.

## 2. methodology

## 2. Methodology

Appropriate strategic actions, viz. mitigation measures for land affected by excessive seepage, reclamation of 'Teliyo Khar' affected land, conjunctive use of water, ~~and~~ restricted use of pesticides ~~has that have~~ been successfully carried-out in ~~the~~ Sardar Sarovar Project Command are discussed ~~here under: below.~~

### **2.1 Rejuvenation of land affected by excessive seepage:**

~~The excessive~~Excessive seepage in the fill segment of ~~the~~ canal, i.e., ~~the~~ earthen embrace, is a ~~commonly occurring~~common problem ~~in commands. Such a.~~ This problem of soil degradation was faced by the farmers of three villages ~~having their~~whose fields ~~adjoining~~adjoined the Saurashtra Branch Canal. Located just ~~on~~upstream of each of the three fall structures of canal-based power houses. As the canal reaches ~~in banking~~having FSL quite above thea bank with an FSL above ground level, the excessive seepage on both ~~the~~sides ~~had caused~~causes water logging ~~condition~~conditions. Normal cropping was ~~under~~hindrance ~~due to~~hindered by soil degradation. The farmers were demanding to take suitable measures to mitigate the problem, such as ~~they can continue taking~~continuing to take crops.

## 2.2 Reclamation of “TeliyoKhar” affected land:

The tail-end area of ~~the~~ Bolera and Rajpura branch canals of ~~the~~ Sardar Sarovar Project is in the vicinity of the little run of Kutch, ~~have and has~~ inherent soil salinity, flat topography and inferior ground water at ~~a depth~~depths varying from 2.1 to 10.9 m. There is a soil layer with a calcium content ~~at a depth~~varying from 1.2 to 4.0 m, which acts as an impervious layer. This layer restricts ~~the~~downwardward movement of water, causing temporary water logging ~~condition in~~conditions throughout the entire area.

The soil of this area has high ~~concentration of Sodium (Na), Bicarbonate (HCO<sub>3</sub>) and Chloride (Cl) which makes~~concentrations of sodium (Na), bicarbonate (HCO<sub>3</sub>) and chloride (Cl), which make the soil sticky and salty. ~~Also, found that the soils is in the range of 'highly' to 'very highly saline' soils with more than 20 SAR that indicate that the area have~~Additionally, more than 20 SARs of highly to very highly saline soils were found, which indicates that the area has an alkali hazard. The presence of chloride makes the soil hard, and the presence of bicarbonate makes the soil sticky and soft. The combination of ~~this~~these two makes the soil of swelling in nature, sticky, and ~~itself~~it looks like “Teliyo Khar”. This problem ~~have made~~has created many limitations ~~on~~for normal agriculture, and, therefore, ~~the~~farmers have been ~~representing about~~experiencing this age-old problem.

## 2.3 Participatory Irrigation Management:

As envisaged in the 'Water Use Plan' of ~~the~~ SSP, the delta available at ~~the~~ head of ~~the~~ main canal is ~~about~~approximately 550 mm, which may ~~reduce to about~~decrease to approximately 320 mm at ~~the~~ field level. ~~It is~~is a great challenge to fulfil irrigation ~~requirement~~requirements with this available delta. Therefore, it is inevitable ~~to use that~~ this canal water will be used as efficiently as possible. In fact, the agricultural sector has been slow and has much room for improvement to save water through educational, economic, and policy incentives. However, the situation in ~~the~~ Sardar Sarovar Project is more critical in view of the envisaged allocated delta.

~~Creation~~The creation of physical infrastructure is only a part of the envisaged achievement of ~~the~~irrigation projects. The ultimate realization is ~~in the achievement of~~to achieve higher water use efficiency. In the case of irrigation projects, ~~thea~~ higher WUE is only possible if successful PIM ~~combines~~is combined with better crop and agricultural practices. The government has accepted the concept of ~~Participatory Irrigation Management which ensure~~participatory irrigation management, which ensures equitable and efficient distribution of irrigation water.

## 2.4 Farmer ~~Centered~~Centred Interventions:

It was felt ~~needed to create~~that there was a need to increase interest among the beneficiary farmers ~~for practicing~~in practising PIM ~~such as~~to achieve higher ~~Water Use Efficiency~~water use efficiency. Farmers are mainly interested in their income through agriculture. Specifically, providing support ~~infor~~ resolving agricultural problems;and enhancing their income may ~~win the~~increase individuals' confidence and faith ~~towards better~~in improving irrigation management. In view of this~~, several~~ such approaches made in the SSP command are discussed here~~under~~.

#### **2.4.1 Restricted use of ~~pesticide~~:pesticides:**

The use of pesticides increases with the intensification of agriculture, as ~~along with~~does the creation of irrigation ~~facility. The pesticides~~facilities. Pesticides are considered a vital component of modern farming, ~~playing and play~~a major role in maintaining high agricultural productivity. However, ~~its~~excessive use ~~of it~~could result in adverse ~~effect~~effects on the environment and human health in particular. It ~~causes threat to the~~threatens ground water contamination. ~~Presence~~The presence of pesticide residues in ~~ground water~~groundwater is especially serious because it is a source of drinking water. ~~Of course, the~~The use of ~~pesticide~~pesticides in the present-day agriculture seems to be unavoidable. ~~But~~However, ensuring their judicious use ~~by~~ina conservative manner ~~by~~adopting the recommended method is ~~enough~~sufficient to prevent ~~the~~this problem to ~~the~~a large extent.

~~With a view to take~~To implement strategic preventive measures, ~~the~~pesticide residue monitoring in the SSPC was initiated in ~~the year~~2009 in collaboration ~~of with the~~All India Network Program (AINP) on Pesticide Residue, ICAR, Unit-9, Anand. Strategic locations were selected ~~scientifically~~to collect the samples of surface runoff water ~~infrom~~ ponds and ~~sub-surface~~subsurface water from open wells. ~~Total~~A total of 176 pesticides were monitored by ~~determining multi-residue~~multiresidue analysis with ~~the~~a limit of 0.5 µg/L (ppb).

#### **2.4.2 Improved practices of cumin cultivation:**

India is the largest producer and consumer of cumin ~~seed~~seeds in the world. Gujarat is a leading state in cumin production, contributing more than ~~60 per cent~~60% of the production ~~of in~~ India. The area under this high-value cash crop ~~have~~increased ~~much~~greatly after the availability of Narmada water for irrigation, which ~~becomes~~became a strength of the SSP command.

~~Growing~~The simultaneous growth of two or more crops ~~simultaneously~~on the same land ~~which makes~~results in the efficient use of limited arable land. Efficient intercropping not only improves the productivity but also ~~sustains~~sustains soil fertility status (Singh ~~et al~~et al., 2013), ~~besides assured~~in addition to providing income from any crop against the collapse of anyone. Patel and Amin concluded that intercropping of cumin with ajwain in 1:4 row arrangements with cutting of ajwain at 45 DAS is better for realizing higher cumin equivalent yield, gross return and net return.

#### **2.4.3 ~~Cotton-Caster~~Cotton-Castor relay cropping:**

Cotton is the main crop ~~which is~~grown in ~~over 40 %~~more than 40% of the area of command. BT ~~Cotton~~cotton is a heavy feeder ~~which take~~that takes a short time to reach ~~in the~~the reproductive phase;and ultimately, it requires ~~shorta~~shorter period ~~as compare to~~than does hybrid cotton, and ~~also~~it is ~~space a~~space-planted crop, so ~~intra~~intra-row space can be utilized. Relay cropping is a complex suite of different resource-efficient technologies, ~~which possesses the capability to that can~~improve soil quality, ~~to~~increase net return, ~~to~~increase the land equivalent ratio, and ~~to~~control the weeds and pest ~~infestation~~infestations. The

furrow and drip methods of irrigation ~~gave higher~~ increased the WUE, ~~up~~ as observed by Shirahatti et al. (2007) and Choudhary et al. (2016).

Castor is ~~another~~ less water requiring long-duration cash ~~crop. Which can be~~ crops. The ~~plants were~~ grown ~~in~~ between two rows of BT cotton after ~~the~~ cotton crop ~~reaches at~~ reached the reproductive stage. ~~Castor~~ The castor crop ~~was~~ grown ~~in~~ between two ~~rows~~ rows of standing cotton during ~~rab~~ the Rabi season (relay cropping), which ~~provide~~ provided supplementary income. The ~~uniqueness~~ unique feature of the cotton-castor ~~copor~~ relay cropping system is the combination of two cash crops, which improves the economy of farmers through the cultivation of cotton and castor as an industrial commodity. Plant spacing in castor ~~crop~~ crops plays an important role in boosting ~~the~~ yield.

## 2.5 Development of ~~Model~~ the 'Village Service Area' ~~Model~~:

The Water Use Plan of ~~the~~ Sardar Sarovar Project command envisages the concept of ~~Village Service Area~~ village service area covering and ~~the~~ area of a minor canal. ~~The Participatory Irrigation Management~~ Participation irrigation management is primarily accepted for the successful operation and maintenance of irrigation systems ~~in commands. But, so far~~ successful precedencies. However, ~~successful studies on this topic~~ are rare. An agriculture-centred distinguished approach was adopted for the development of a modal VSA – a minor (Vegadvav) in Halvad Taluka.

Farmers were motivated, guided and facilitated ~~for adoption of to~~ adopt improved ~~agricultural~~ practices ~~of agriculture~~ aimed at increasing ~~the~~ farmers' income. ~~Farmers~~ The farmers were provided with ~~the~~ scientific ~~know~~ knowledge on how, from time to time, ~~as per to meet~~ their ~~need~~ needs as ~~and well as~~ when ~~to~~ arise. The implementation of ~~Participatory Irrigation Management~~ participatory irrigation management was an inclusive component of ~~the~~ ultimate goal of achieving integrated agricultural development. This farmer-centered bottom-up approach is time ~~taking-consuming~~ but, holistic and sustainable.

## 3. RESULTS AND DISCUSSION

### 3.1 Rejuvenation of land affected by excessive seepage:

~~As an effort, first~~ First, the problem was defined based on available earlier and current soil and crop data. Possible mitigation measures ~~comprised of activities to prevent~~ include ~~preventing~~ seepage, providing intercepting ~~drain~~ drains and on-farm soil reclamation measures, namely ~~suggestion, the use~~ of salt-tolerant/field/tree/crops and grasses, green manuring, crop rotation by ~~legume~~ legumes, restriction of inferior ground water use, frequent and lite irrigation, fertilizer selection and ~~its~~ application methods, tillage at specific soil moisture ~~content, enhance~~ contents, ~~enhanced~~ use of ~~farm yard~~ farmyard manure and ~~compose~~ composition and other location-specific measures, ~~where all of which have~~ evolved scientifically. This was followed by ~~the~~ finalization of an acceptable action plan on consultation among the stake holders. Which was then implemented, and, now the farmers are able to take their crops as earlier.

The farmers were provided with ~~the~~ possible mitigation measures ~~offer~~ for managing their land resources scientifically, as evolved from available ~~know how~~ knowledge/technologies, soil investigation ~~report~~ reports and interactive ~~discussion~~ discussions/brainstorming among farmers, field staff and experts.

### 3.2 Reclamation of "TeliyoKhar" affected land:



~~As a result of detail~~The detailed results of the soil investigation, analysis and interpretation ~~by reports were reported,~~ as well as several consultations/field visits/brain storming ~~visits~~ among the farmer, officers of ~~the~~ line department and experts. An integrated approach ~~ofto~~ implementation consisting ~~of~~ various activities for adoption by ~~the~~ farmers ~~besidesin addition~~ ~~to~~ providing sound surface drainage ~~systems~~ ~~systems~~ in place ~~have beenhas~~ evolved. A cluster of ~~the~~ 26 most affected villages ~~arewas~~ selected for ~~undertaken~~ reclamation measures on ~~a~~ pilot basis. ~~Farming~~The farming community is now fully involved in the process of development, such as ~~to reclaim thereclaiming~~ degraded land.

### 3.3 Participatory Irrigation Management:

~~For involving~~To involve beneficiaries and stakeholders in irrigation management, the ~~Government hasgovernment~~ enacted ~~the~~ PIM Act in 2007. Water Users' Associations (WUAs) ~~have beenwere~~ formed from ~~amongstamong~~ the beneficiary farmers in the SSP command area with ~~the~~ expectation ~~to takeof taking~~ over the operation and maintenance of the system from ~~the~~ minor head and below along with community-based agricultural and economic activities. ~~In spite ofDespite~~ all efforts to educate and involve ~~the~~ WUA members with the support of competent NGOs and extension activities, the farmers' response is sluggish, and the successful functioning of WUAs~~are very fewis~~ ~~limited~~. Hence, ~~a~~ distinguished approach ~~whichthat~~ can involve the farming community in managing ~~their~~ crops with the least ~~amount of~~ water is ~~felt~~ needed in the project.

### 3.4 Farmer-Centered-Centred Interventions:

~~Each location of pesticide residue monitoring has assessed area contributing runoff water~~The contributions of runoff water to each pesticide residue monitoring location ~~were assessed,~~ and the test results were ~~looked intoexamined~~ precisely ~~such as~~ to identify the need for strategic preventive measures to be undertaken based on the observations. The farmers of ~~the~~ identified clusters, namely, vegetable growers around Padara and cotton growers around Karjan talukas, were educated and convinced in person ~~forabout the~~ controlled use of pesticides by integrated pest management, which has reduced the cost as well. As a result, ~~sothus~~ far, the status of pesticide residue in the entire Sardar Sarovar Project command is 'Below Detectable Level'.

~~By under taking~~A large number of ~~demonstration on~~ ~~demonstrations of~~ recommended ~~improvedimprovement~~ practices, namely, line sowing instead of broad casting, raised bed sowing with irrigation through drip ~~system, practicing~~ ~~systems,~~ deficient irrigation ~~practices~~ and ~~inter-culturinginterculturing~~ using wheel ~~hoehoes,~~ ~~have been implemented.~~ This improved practice resulted in ~~on~~ an average ~~3333%%~~ increase in productivity ~~besides saving inin addition to saving~~ water and ~~an~~ increase in area from ~~about~~ ~~approximately~~ 0.5 lakh ha to 1 lakh ha during ~~the~~ last three years. ~~Further~~ ~~Furthermore,~~ farmers were motivated ~~for adoption ofto adopt~~ value addition ~~methods~~ such as shorting and cleaning, which ~~gave higherresulted in greater~~ economic ~~returnreturns.~~

~~Cotton~~The cotton-castor relay cropping technique was recommended earlier by the State Agricultural University. This recommendation was reassessed and modified appropriately by trial for three years on ~~the~~ Narmada Irrigation Research Project farm. ~~ByAt~~ this time, large-scale ~~demonstration on farmer's field~~ ~~demonstrations on farmers' fields~~ were also conducted. ~~Results have shown 27 % higher income to~~The results revealed a 27% increase in income ~~for~~ the farmers. This resource-efficient practice ~~giving higher return to the farmer, which provides greater returns to farmers,~~ has been adopted largely in Karjan, Thasra, ~~and~~ Harij talukas, and ~~the~~ majority of ~~the~~ farmers have realized the benefit of the new cropping system.

### 3.5 Development of ~~Model~~the 'Village Service Area': ~~Model~~

The community efforts of ~~construction of constructing~~ storage tanks, blending ground water ~~which that~~ is inferior ~~with to~~ canal water, ~~adoption of adopting~~ MIS, ~~Rotational Water Distribution, and diversification to high rotating water distribution, and diversifying high-value~~ crops and other improved agricultural practices, along with common economic activities ~~of such as the~~ purchase of inputs and ~~sell of the produce the sale of produce~~, have been ~~evident of success. After the initiation unsuccessful. Since the beginning of~~ the year 2010, ~~presently~~ more than half of the ~~land holdings landholdings currently~~ have their own tube well, a storage tank of ~~the~~ required capacity, ~~a~~ piped water distribution network and MIS adoption. The remaining farmers are quickly ~~joining in the adoption now adopting these practices~~.

## 4. CONCLUSION

~~For achieving To achieve~~ the objectives of the Sardar Sarovar Project, long-term sustained efforts both in terms of time bound completion of identified activities and ensuring the implementation of identified policies have been envisaged.

The command area development activities ~~were~~ carried out mainly for ~~the~~ enhancement of ~~Water Use Efficiency on water use efficiency on a~~ sustainable basis, ~~an The~~ effective utilization of water, as per ~~distinguish distinguished~~ water use policy envisaged under the project, is to empower ~~Water Users Associations water user associations~~ such that they can distribute the water ~~by Rotational Water Supply via a rotational water supply~~ and use it efficiently from ~~the~~ canal network, ~~at minor both minorly~~ and below. For this purpose, ~~the~~ farmers are trained ~~for in~~ participatory irrigation management and specific ~~practices of~~ crop management ~~practices~~. However, ~~the very few~~ successful achievements ~~are is very few have been reported~~.

Hence, a bottom-up approach of engaging ~~the~~ local farmers in the process of command area development, specifically crop and irrigation management, by creating willingness among them followed by need-based empowerment with facilitation ~~have has~~ been successfully adopted. This ~~farmer's centric farming~~ approach of mobilizing ~~community communities~~ is time ~~taking consuming~~ but holistic ~~to enhance for enhancing~~ water use efficiency on ~~a~~ sustainable basis.

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