TECHNOLOGICAL OPTIONS FOR POOR QUALITY SALINE WATER MANAGEMENT IN AGRICULTURE: *SCOPE & PROSPECTS*[1]

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ABSTRACT

Sustainability of irrigated agriculture in the arid and semi-arid regions of the country has faced the challenge because alkalinity/salinity problems associated with soils and irrigation waters. Many problems of the irrigated agriculture arise from inefficient management of irrigation water especially when it carries high salt concentrations. One of the major problems confronting present day agriculture is decreasing availability of good quality irrigation water. With increasing demand and decreasing availability of good quality waters, there is growing tendency among the farmers to use these poor quality waters for crop production. Indiscriminate use of poor quality waters in the absence of proper soil-water-crop management practices pose grave risks to soil health and environment. In India about 36 percent of irrigated lands have been damaged at different levels due to such type of practices. In arid zone, even a good quality water supply will add two tons of salt per hectare every year.

This disappointing picture caused due to faulty irrigation development has now resulted in the planners giving grater attention right at the planning stage to include irrigation improvement intervention as a preventive strategy. However failure of institutional aspects of implementing the improvement strategies, lack of provision of drainage coupled with social aspects relating to ineffective communication between farmers and the agencies have all contributed to failure of our efforts to prevent the growing problem of water logging and salinity. For example, increase in area under canal irrigation during the last three decades was only 19 percent; increase through tube wells has been of the order of 160 and 189 percent in Haryana and Punjab, respectively. Whereas, the scenario on ground water utilisation is not the same in several other states or they're specific areas disadvantaged either with poor quality aquifer yields or their quality. Surveys rate 32-84 per cent of the presently 'running' wells of different states to be of poor quality.

Technological options like vertical drainage where ground water quality is poor but water table is at a reasonable level, skimming well/ *doruvu* technology where shallow ground water management is needed and where water table is high and quality of ground water is poor, subsurface drainage (SSD) is suggested along with different management practices. Different strategically approaches were adopted of in different period. In the seventies and eighties the major emphasis was system (canal) improvement, on farm development (OFD) and farmers participation. But each of these prescribed strategies/ remedies enjoyed the status of a 'privileged solution' at one time or other. There was no effort to harness the synergetic benefits of those options, with the result that no progress was achieved in testing these strategies together. It does not stimulate testing and modification and does not promote a 'learning process' strategy. From 1990's onward the emphasis shifted on transfer of irrigation management, operation and maintenance from government to the water users through some short of institutional set-ups. Concern about the proper utilisation of poor quality waters for crop production in areas, where their use is inevitable, is not new. Efforts have been made for the development of management practices for using poor quality waters. Although it is widely acknowledged that preventive strategies like irrigation improvement intervention have only a limited scope for immediate benefits to the farmers and that curative measures like subsurface drainage (SSD) are needed to tackle the problem of water logging and salinity. Yet SSD development was neglected both at the national, state and at the farm. Since subsurface drainage technology is indivisible in nature, it needs collective action, which calls for new institutional set up to tackle the problem. Keeping the above in view, this paper will suggest the scope and prospects of different technological options and the form of institutional set up which is needed to promote equity among all stakeholders and devolves power and autonomy to local institutions with effective regulation backed by legislation and enforcement for sustainable development of agriculture in the saline environment.

Keywords: Privileged Solution, Learning Process, Synergetic Benefits, Preventive Strategies,

1 INTRODUCTION

In the seventies irrigation enjoyed a favoured status in terms of investment in agricultural sector. More than 75 percent World Bank assistant is on irrigation. The resultant outcome is the unprecedented rise in agricultural productivity. Afterwards there is a decline trend of investment on irrigation. One reason of such type of disillusionment is due to its economic performance. The poor performance is mainly due to poorly managed operations; inadequate supplies in the tail ends and untimely and unreliable water deliveries. In the fresh ground water zone there is a threat of serious water scarcity due to over use of ground water and consequent decline in water table. On the other hand farmers are generally disliked towards the use of saline ground water. Due to non-exploitation of poor quality ground water and mismanagement of surface canal water creates the problem of water logging and secondary Stalinization. As a result about 15-20 percent command area have become afflicted with the menace of water logging and salinity. These areas are mostly underlain with marginal and poor quality underground water. In the northwest states of India like Haryana, Punjab, Rajasthan and Gujarat are facing greater problems of water logging and salinity. In Gujarat about 9 percent of the total geographical area is affected by salinity and sodicity. About 20-30 percent of the area in the Chambal Command of Madhya Pradesh has gone out of cultivation because of water logging and salinity.

Acquifers surveyed in different states have been indicated that about 32-84 percent of the ground water is of poor quality in nature. Central Ground water Board (1994) reported that about 4 percent area in Haryana is under saline ground water whereas for Punjab it is about 3 percent for Rajasthan it is about 82 percent for Gujarat it is about 10 percent and for Uttar Pradesh it is about 1 percent area. The document of Eighth Five Year Plan has reported 17.61 million ha area affected by the problem of waterlogging (8.53 million ha), alkalinity (3.58 million ha), and salinity and sandy area (5.50 million ha) (GOI 1991). Recent estimate shows that the extent of salt affected soils in India was 8.6 mha and 4.5 mha is waterlogged (Singh 1994).

Keeping the above in view, this paper will suggest the scope and prospects of different technological options and the form of institutional set up which is needed to promote equity among all stakeholders and devolves power and autonomy to local institutions with effective regulation backed by legislation and enforcement for sustainable development of agriculture in the saline environment.

1.1 Technological Options:

Various remedial measure such as better water management, conjunctive use of canal and ground waters, improvement of surface drainage, on-farm development, introduction of forestry, amendment of soils and shallow ground water management were suggested. Out of those it has been suggested to adopt the technologies like vertical drainage where ground water quality is good and water table is at a reasonable level, skimming well/ *doruvu* technology where shallow ground water management is needed and where water table is high and quality of ground water is poor, subsurface drainage (SSD) is suggested along with different management practices. Similarly for reclamation or to make productive of alkali soils, gypsum base reclamation strategies were suggested where resource base of the farming community is sound. In the poor resource base-farming situation, adoption of salt resistant varieties like *CSR10* and *KLR1-4* for paddy-wheat cropping sequence is recommended in the first year of the reclamation programme. It was also suggested that for quick encasement small doses of gypsum along with salt resistant varieties fetched higher returns. Different strategically approaches were adopted in different period and it was observed that all the above-mentioned approach fetched good returns, which is financially and economically viable in the farmers' field.

1.2 Case studies of different technological adoptions:

1.2.1 Sub subsurface drainage at Haryana:

In Haryana, subsurface drainage was installed in 589 ha at thirteen different locations in order to prevent, or enable the reclamation of areas which were already affected by water logging and soil salinity and about 2000 ha in two different location has been selected for SSD under Indo-Dutch collaboration. in the Chambal Command area in Rajasthan where SSD were installed on 10 thousand under Canadian Funded Project. In collaboration with CSSRI, WALMI in Gujarat installed SSD in 200ha in four different location . The cost of installation of SSD mainly depends on soil type, depth and spacing of drains, location under drainage and the type of the drainage material used. At present (1994-95 prices) the cost of manually installed SSD varies from RS.22,310 to RS. 18,525 per ha in Haryana (Datta & de Jong,1998).

The installation of a subsurface drainage system enables the control of the watertable level and the desalinisation of the soils by leaching, either with irrigation water or with the monsoon rains. Operational research on Sampla Farm showed that salinity in the topsoil decreased rapidly after drainage, from about 50 dSm^{-1} in June 1984 to about 5 dSm^{-1} in November 1985, in spite of low rainfall in these years (Rao et al. 1991). In all small-scale pilot projects in Haryana , most of which are run by the farmers, the short-term effects of subsurface drainage were:

- A considerable increase in cropping intensity;
- A shift in the cropping pattern towards more remunerative crops;
- A remarkable increase in crop yields.
- An increase in the efficiency, or productivity of fertilizers.
- Increase in gainful employment
- Timeliness of planting and harvesting;
- Increase the land value.

The combined result of these changes was a substantial increase in farm incomes.

It is well documented that subsurface drainage sustains or restores the productivity of the agricultural land (Datta & de.Jong 1997). The cost of installation of SSD is about Rs 35,000 per ha at 1997-98 prices. It needs collective action for which institutional set up is needed. An attempt has already taken in Hiragana , Rajasthan and Gujarat. An positive co-ordination were observed in some of the small scale SSD area (Datta & Joshi, 1993, Datta,1998).

1.2.2 Doruvu technology in coastal Andhra Pradesh:

Due to lack of availability of canal water, poor recharging rate and occurrence of clayey soils in deeper layers are the major constraints for installation of tubewell. The source of irrigation are mainly from rain water and use of shallow depth of good quality ground water. Though the coastal area received high rainfall but with very high permeability of coastal sands, almost all the rainwater percolates in to the soil. The infiltrated rainwater having lesser density floats over the subsurface saline water itself is underlain by impervious soil layer. To tap and use the shallow ground water farmers forced to draw shallow ground water that collects in dug-out conical pits locally called " *Doruvus*" in Andhra Pradesh. Due to wastage of 20 percent productive land, unproductive evaporation and high maintenance costs, the ACRIP-Saline Water, Bapatla centre improved the traditional "Doruvus" into improved subsurface water harvesting system (SSWHS). The immediate impact of it:

- change the cropping sequence from rainfed ground nuts to paddy;
- fallow land due to lack of irrigation reduces;
- cropping intensity increases due to sufficient quantity of good quality water;
- it can irrigate 3 ha of area during rabi;
- it can irrigate 4-5 ha by using sprinklers or drip method irrigation system for plantation crops.

The cost of installation of SSWHS system at 1997-98 prices is about 48,000, which can irrigate about 3-4 ha of land. Consolidation of land holdings is essential to take the full advantage of above-mentioned technology. Individual farmers can install but due to poor resource base and poor economic condition of the coastal farmers it needs government intervention.

1.2.3 Management practices for saline water use in Uttar Pradesh:

The AICRIP-Agra center adopted Karanpur village in Uttar Pradesh under ORP programme since 1993-94. Recommended doses of gypsum (1.25 t/ha) along with 2 t/ha FYM were applied where alkali waters were used for irrigation. Conjunctive use of canal and saline waters, used gypsum, conservation of rain water and use of sprinkler and drip method of irrigation were suggested as the management strategies for saline water for irrigation. The effects of the above-mentioned strategies are:

- fallow lands during kharif season is drastically reduced;
- average yield both in kharif and rabi season increases;
- crop stability both the seasons increases;
- requirement of man days per ha increases;
- annual income of the farm families increases.

Economic studies for using saline drainage water for irrigation shows that if the share of good quality irrigation water is limited, it is possible to produce the wheat by using saline drainage water and the yield will be higher than the break even level of output (Datta et.al ,2000).

To promote the adoption of the technology, the effective supply price of the technology to the farmer will be reduced, which will increase the quantity demand (along with demand curve) as driven by private net returns. Such a demand shift increases the technology prices, *ceteris paribus*, and thus stimulates competition to provide new technologies. Subsidy is needed for encouraging encourage the comparatively dis-advantages farmers, subsidy is an essential component to make their production frontier stronger (Datta, 1998).

Policy intervention in the form of availability of canal water during the time of sowing is an essential component in the saline environment. The irrigation authority should take care, that canal water must be available in the saline ground water zone at least during sowing season, in time. If timely canal water is available it will encourage the farmers to bring more and more area for crop production and will use their saline ground water either through conjunctive use (if canal water is provide by the agency one or two) or subsequent irrigation afterwards as per the crop's requirement.

1.2.4 Technology for alkali soil:

Several management options have been advocated by the CSSRI for reclamation of alkali soils, such as (i) reclamation for crop production with rice based cropping system, (ii) afforestation activity singly and/or in conjunction with appropriate crops in between, and (iii) cultivation of forage and grasses without application of any soil amendment, etc. For the option of reclamation for crop production again management strategies could be adopted such as amelioration through soil amendment and appropriate cropping practices and in poor resource endowment situations, through biological amelioration-growing salt resistance varieties of paddy and wheat.

1.2.4.1 Chemical amendment technology in Haryana, Punjab & Uttar Pradesh:

Over the past few years, chemical amelioration of alkali soils in Punjab, Haryana and Uttar Pradesh has been fairly standardised. It involves land grading and bunding, assured irrigation, soil test based application of an amendment (mainly gypsum). Different technological options for reclamation of alkali soils demand different amount of capital investment during the initial stages in the form of land leveling, land shaping, application of water, installation of tubewells, applications of gypsum. The success of the programme on a wider scale depends upon the amount of reclamation cost, the performance of the crops grown in the first year as well as during subsequent year along with their cost of cultivation and the length of gestation period.

Economic studies of chemical amendment technology (with subsidy) for reclamation of salt affected alkali soils were highlighted by several scholars. Operational Research Project at Kapurthala in the Punjab showed that the benefit cost (B-C) ratio was as high as 2.25 (Kahlon and Singh 1980). In different set of situations in Punjab the benefit-cost ratio varied from 1.15 to 1.20 (Bajwa *et al* 1983). The benefit-cost ratio in different situations under farmers' resource constraints in Haryana ranged from 1.34 to 1.42 (Joshi,1985). The pay-back period was about 2 and 3 years in Haryana and Punjab. Few studies in Uttar Pradesh showed that the performance of technology is encouraging and paying (Singh and Bajaj 1988).The benefit cost-ratio was about 1.21 in Rai Barailly under a government sponsored program in Uttar Pradesh (Government of U.P., 1989). Most of the studies under ORP adopted farmers and those in periphery and also at several distantly located situations showed that there exists a wide gap between the level of package of practices recommended by the CSSRI and its actual adoption level by the farmers. If the yield gap between recommended and farmers' level of technology could be narrowed, the alkali soils after reclamation have great potential in increasing the much-needed production of rice and wheat in the country. It is, therefore, necessary that potential of the land reclamation technology must be exploited to bridge the untapped yield reservoir. The gap can be minimize if proper network for gypsum base infrastructure can be evolved and it may be link with easy rural credit facilities at the village level.

1.2.4.2 Adoption of biological base technology in Uttar Pradesh:

The scope of alternative technological option like growing salt resistant paddy-wheat varieties. It has been observed, from the demonstration plots in the farmers fields at Mandanpur (in Aligarh) during 1991-92 under adoptive research trials of CSSRI, that without putting gypsum, the productivity of CSR 10 and KRL 1-4 in the marginally affected land (A-class) is about 34 qt/ha for paddy and 8.23 qt/ha for wheat. In moderately (B-class land) affected land, it was 28 and 7.71 qt/ha and for severely (C-class) affected land it was 20 and 5 qt/ha respectively. Financial analysis shows that those salt resistant paddy-wheat varieties fetched higher B-C ratio (5.56) in the marginally affected. In the moderately affected area (B-class) the internal rate of returns is about 68 percent and for severely affected it is about 24 percent, which are much higher than the opportunity cost of capital. It indicates, that even if the amount of subsidy which is given at present on gypsum (Rs 9900/ha on an average level) can be withdrawn in the context of our new economic policy, the biological amelioration technology, i.e., salt resistance paddy-wheat varieties (CSR 10 & KRL 1-4) will be financially and economically feasible for producing the food grain in soils with different level of degradation (Datta et. al ,1996). In order to induce the farmers to adopt the reclamation technology at a fast rate, it may be suggested to use 25 percent gypsum (instead of 50 percent on GR as a recommended dose) along with salt resistant paddy (CSR 10) and wheat (KRL1-4) varieties. It will not only reduce the investment cost but also help to increase the productivity of salt affected soils. However to judge the technical viability of the above alternative, it calls for further research. If it is technically feasible, then may be salt resistant varieties along with 25 percent gypsum amendment is the appropriate low cost technology for resource constraint farmers located in Uttar Pradesh. It has been observed that the adoption of chemical amendment technology for reclamation is more where productivity in normal soils are high i.e. resource rich environment. Whereas dissemination of gypsum base technology has been slow in the resource poor areas (Datta & Joshi 1992).

2 CONSTRAINTS & POLICY NEEDS

In the institutional aspects, the poor performance of irrigation arises mainly due to larger systems, lack of reliable and responsive management, no management in terms of deliberate water allocation in response to actual circumstance The inherent lacuna of the institutional set-up in irrigation systems is promoting irregularity, uncertainty, favoritism, exploitation and corruption. To overcome some of the problems, during seventies and eighties major emphasis was shifted towards improvement of irrigation performance through on-farm development (OFD), participation in the form of involving water users and strengthening of irrigation agencies. But there was no effort to harness the synergetic benefits of those options, with the result that no progress was achieved in testing these strategies together. From 90’s onward rethinking is going on to transfer of responsibility and authority for irrigation management from government to non-governmental authority. Keeping in mind, such transfer will help the water users to maintain transparency, accountability and supporting incentives to the users by managing, operating and maintaining of irrigation system. In the approach paper of the Ninth Five Year plan (1997-2001), it is proposed to improve the efficiency of end-use of water through adoption of water-efficient devices and promote conjunctive use of surface and ground water. The entire attempt, which was mentioned, was present and initiative was taken for a long time, but all of a sudden calls for an organised solution by means of public intervention. Those solutions are not thought to require testing and modification for sustainability in long term. And attempt is always in terms of diverting fund from one specific scheme to another alternative options. Where the surface layers are not too saline; dry drainage where the management system allowed, indeed encouraged, salt to be leached from intensively cultivated land and to accumulate on the surface of abandoned fallow land; and further development of salt tolerant varieties. However as a preventive measure for short run, those solutions may be effective but for long term, subsurface drainage (SSD) has been proved to be the only option to reclaim the waterlogged saline lands, where salts are accumulated both in soil and ground water.

The main draw back in the system that it assumes free market mechanism will work implicitly i.e., well-capitalised and market-oriented farmers will take care the operation and maintenance. But in reality it is difficult because the inherent drawback of unsatisfactory performance of irrigation system is due to non-fulfillment of the target, incompatible rational action with collective rationality and finally quantity-constrained behaviour compelled the individual to adjust his or her own private decisions. It is not easy to see a system of subdividing the benefits into purchasable units that can be competitively sold separately to different individuals. In other words, property rights, the basis of all markets cannot be easily be established at regional scale. Even if the market fully reflected the values for individual goods and services, the market would still allocate less than a socially optimum amount because farms are unable to fully appropriate the gains from R&D. Without internalisation of environmental externality and holistic approach, only shifting the power will not improve the system.

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