SSRG International Journal of Economics and Management Studies
ISSN: 2393 – 9125 / https://doi.org/10.14445/23939125/IJEMS-V7I5P107

Volume 7 Issue 5, 40-45, May, 2020

Review Article

Water Management in Agriculture: Issues and Strategies in India

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Received Date: 22 March 2020
Revised Date: 27 April 2020
Accepted Date: 15 May 2020

Abstract *- India has 16% of the world's population and only 4% of the world's water resources, which are depleting rapidly. The demand for water is expected to grow from 40 billion cubic meters (bcm) currently to around 220 bcm in 2025. Water is one of the most important inputs essential for crops. Both its shortage and excess affect the growth and development of the plants, yields, and quality of produce. There are numerous methods to reduce such losses and to improve soil moisture. These are mulching, cropping, planting of trees, utilization of fog or dew by net-surfacing traps or polythene sheets, contour farming, transfer of water from surplus areas to deficit areas by inter-linking water systems through canals, desalination technologies such as distillation, electro-dialysis, and reverse osmosis, use of efficient watering systems such as drip irrigation, and sprinklers will reduce the water consumption by plants. The most important step in the direction of finding solutions to issues of water and environmental conservation is to change people's attitudes and habits; this includes each one of us. Water, the critical resource of agriculture, has not been well managed in India, despite the country being an agricultural powerhouse. It has some 195 MH of land under cultivation, of which some 62 percent is rain-fed and 37 percent irrigated. Agriculture uses 85 percent of the water resources with low efficiency. The rain-fed area is the critical area of cultivation with the largest concentration of rural poverty spanning several agro-ecological regions. Water management is related to three important challenges in the agricultural front today, namely raising productivity per unit of land, reducing poverty, and responding to food security needs. In the light of the new call to achieve "more crop per drop", this paper discusses pertinent issues related to irrigation in India and the strategies and arrangements to address water scarcity for irrigation. The study finds that problems are largely institutional, structural, and administrative. Overcoming them is crucial for agricultural development in general and water management in particular.*

Keywords *- Water Agriculture; India; Management; PaniPanchayats.*

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I. INTRODUCTION

"Irrigation is everything in India; water is even more valuable than the land", remarked Sir Charles Trevelyan decades ago. "If the monsoon fails, there will be a lockout in the agricultural industry," remarked Wolff. Today the general acceptance is that the problem is not a shortage of water but one of its poor management, i.e., utilization, augmentation, and conservation. The country is endowed with 183 million hectares of cultivable land, 115.6 million farming families, 400 million of annual precipitation, and a conducive agro-climate for cultivating a variety of crops. About two-thirds of the country's population work in agriculture and feed over 1000 million people every day. Yet, the majority of farmers are under the clutches of poverty, debt, and hunger. Micro studies on poverty in rural areas cannot keep out irrigation as an explanatory factor. For instance, Gurunathan, applying linear regression technique for estimating the strength of irrigation in determining rural poverty in the state of Tamil Nadu (for 37 years from 1964 to 2000), found that rural poverty can be reduced by 1.54 percent through an increase of one hectare of groundwater irrigation for very thousand rural population. A study by Hans in Belthangadi and Mangalore taluks of Dakshina Kannada District, Karnataka, using the chi-square method, revealed that as households move up from below the poverty line to higher income levels, they are in a better position to availability and accessibility of irrigation infrastructure. In many cases, the average income per household almost doubled when irrigation was utilized.

Indian agriculture, even now, is heavily dependent on the monsoons. Nearly 70 percent of the net sown area is rain-dependent. Problems of Indian agriculture are intricately linked to the per-capita availability of water in a cost-effective manner. This fact has to be viewed in the context of 2007 that was earmarked as "Water Year" by the Government, as also the general crisis and contemporary challenges in the agricultural sector. Even a non-farm activity like insurance is penetrating the irrigation sector, and we now have rainfall insurance and re-insurance in India. Demand for food is increasing, but the vast majority of lands remain fallow during the dry season. This is so in more than half of the arable land. The

water problem is a triple problem – problem from the supply side, from the side, and from the quality angle.

By the year 2030, India needs to produce 60 percent more rice with much fewer resources. To keep up the momentum of growth, a careful economic valuation of inputs, including irrigation, is of considerable importance. The use of major resources of the earth like water has to be guided by the principles of optimum and scientific utilization, both as individual commitment and international agreement. Despite rapid strides in high-tech agriculture and commercial/corporate farming, sustainable agriculture and livelihood security will largely be decided on the natural resource – base, use, and conservation. With this in mind, the objectives of this paper are:

- to present the problems and challenges in the waterfront for Indian agriculture;
- to highlight areas that need to be addressed for better water management; and
- to examine some initiatives in India to save water,

II. EXTENT AND EFFECTS

Irrigated agriculture is limited only to 46 percent of the cropped area in India, but it contributes nearly 56 percent of the agricultural output, and about 60 percent of food grains production comes from irrigated area. Efficiency or deficiency in farming is largely related to water – rainfall or irrigation. It is true for productivity improvements through area expansion as well as through combined inputs (irrigation, fertilizers, plant protection measures, etc.). Even the entrepreneurial ability in farm operations is water-linked. No doubt, under modern farming, irrigation is one of the inputs in integrated farm management. Total Factor Productivity criterion of farm efficiency places adequate importance on irrigation to explain variations in yields and technical efficiencies across crops and across farms. For instance, a study of paddy farmers in the state of Andhra Pradesh by Raju revealed that the non-availability of assured irrigation leads to low-level usage of fertilizers too and, in turn, low yields.

III. IRRIGATION SCENARIO

India has an irrigation potential of 139.89 hectares, of which 108.3 m ha (i.e., about 77 percent) has already been utilized (see Table 1). The average annual per-capita availability of water is estimated to be about 1,829 cubic meters at the national level. This is expected to decline to about 1,341 CUM by the year 2025 and 1.140 CUM. by the year 2050, owing to the increase in population. The per-capita storage capacity in India is only about 207 CUM. as compared to 1,111 CUM in China. Out of the total water supply, the share of irrigation at present is about 80 percent. This is likely to go down to 73 percent by 2025

Table 1. Water Resources of India

Geographical Area	328 m ha
Culturable Area	185 m ha
Rainfall	4000 cubic km
Utilizable Water Resources	1122 cubic km (including Resources 432 cubic km from Groundwater)
Ultimate irrigation potential	139.9 m ha

Source:S. M. Mendhekar and M. L. Chalakh, Technical Digest, issue 6

As water is vital not only for increasing the output of varied crops but also for sustainable employment and income in the agricultural sector, proper planning and management of this resource is essential. Creating appropriate infrastructures and adopting suitable management practices will help augment the utilizable water resources and improve the efficiency of the facilities.

IV. STRATEGIC ISSUES

There is a global threat to water resources, not just in terms of climate change but also the model of valuation and distribution. For instance, in Chile, water is no longer a public good; it has become a capital good, left to the discretion of speculators, and is separated from the land. The result? Water is sold as a market good at highprices. The small farmers are now almost a species in extinction, replaced by seasonal workers. These are some of the visible effects of the crisis in rural Chile, 50 years after a land reform that postulated that “the land is for those who work it.” Now, in order to tackle the crisis, the grandchildren of the land reform – environmental and social activists – are proposing an alternative, i.e., new land reform to reclaim water as a public good, at a time when a persistent drought is affecting much of Chile.

The situation is so acute, making it necessary to use tanker trucks to distribute water in some low-income neighborhoods in cities around the country. Commoditisation and privatization of water led to the imbalance between human rights, environmental integrity, and corporate profits. Now the people are thirsting for structural reforms to bring new market rules and uphold human rights, including water access and sanitization. Such a situation has already arrived in India.

Water scarcity is rampant, often resulting in crop failure, poverty, social conflicts, and farmers’ suicides (an average of 15,000 annually). India, being a signatory to the World Trade Organisation (WTO), is under pressure to open its market to the globalized economy. So, the impoverished farmers will certainly need assistance which is much more than financial. Across the dry land states of Gujarat and Rajasthan, social workers from the SadguruFoundation created several village-level cooperatives that in turn setup a number of SHGs, lift

irrigation groups, horticulture groups, mil vendors groups, etc. These productive groups are asset and job-creating and, at the same time, work as social networks of civic associations known to confront poverty, resolve social disputes and provide opportunities for community development.

Keeping in mind both utilization and conservation aspects of water 'efficiency' parameter is the key strategic factor. Inefficiency limits capability and reliability. While this is a physical issue, we have some economic issues too. The financial manifestations of current investment and water pricing policies have their deleterious economic consequences on the production front. A shortage of water, which may be seasonal, multi-annual, or secular, is a threat to a wide range of economic activities – municipal water supply and water-based sewerage, water-intensive industries and agriculture, hospitals, mines, power stations, shale-gas production, hotels, etc. It is possible to make the Irrigation Departments autonomous and self-financing through increased water charges, improving collection rates, and developing instruments to capture private sector investments in development and management.

Subsidized water rates sap farmers' interest to opt for the tenets of water use efficiency and conservation. Millions of dollars spent on irrigation subsidies have led to more water use, not less. This has led to a fall in water tables – ranging from 15 percent to 75 percent, say the scientists. Further, we have institutional issues like a weak organization base and delivery mechanisms for water, allied inputs, and extension services.

India has been experiencing successive droughts in the past several years. Nine states – Andhra Pradesh, Telangana, Karnataka, Maharashtra, Madhya Pradesh, Chhattisgarh, Odisha, Jharkhand, and Uttar Pradesh – have declared a drought in the year 2015-16. All these points to the need for strategies in the short and long term to prevent droughts, mitigate the adverse effects of droughts, and ensure better and more efficient management of water resources. Building climate-resilient agriculture is the need of the hour.

V. CHALLENGES AND OPPORTUNITIES

One of the most important challenges both in the waterfront and food front is that of climate change. The term "global climate change" refers to the rising temperature of the earth due to an increased amount of carbon dioxide (CO2) and other greenhouse gases (GHGs). The phenomenon and presence of climate change have created more intensity in the uncertainty of water availability, making it difficult to optimize actions and their timings.

Natural resources have become vulnerable. Agriculture in India is in a peculiar situation of growth with vulnerability. A significant part of the annual variation in India's GDP growth over the past century is attributable to yearly variations in rainfall. Rise in the sea level and depletion of potable water as well irrigation potential are serious concerns. Estimates predict that with an increase in temperature by 2080-2100, the probable loss in crop production is 10-40 percent. Green House Effect is a challenge to the green revolution today.

In several coastal areas of the country, a new problem is rising. Sand mining is causing the water table has gone down, and due to this, farmers have been increasing the horse-power of their motors, again with repercussions on cost and economic performance of irrigation and cultivation.

Substantial progress in irrigation has been made through programs and policies such as Command Area Development Programme (1974-75), Accelerated Irrigation Benefits Programme (1996-97), National Water Policy (2002), and so on. Yet, the major problem in irrigation continues to be the under-utilization of potential, particularly of major and medium irrigation projects.

The outlays on major and medium irrigation rose from Rs376 crore in the First Five Year Plan to more than Rs1,65,000crore in the Eleventh Plan, which was cumulatively Rs3,51,000 crore (GoI 2012). A study of 210 major and medium irrigation projects by a Delhi non-governmental organization (NGO) that used data from the Ministry of Agriculture showed that after investing Rs1,30,000 crore, between 1990-91 and 2006-07, these projects were irrigating 2.4 million hectares (ha) less than before.

The Twelfth Plan working group indicated that there had been massive time and cost overruns (Dev, 2016). Added to this is the sensitive issue of user charges. Lack of thorough knowledge of the scarcity-value of water to its user is an obstacle in its efficient use. Political interferences, shortages of electricity, etc., are also affecting the working of Water (*pani*) *Panchayats.*

VI. LESSONS, SUGGESTIONS, AND CONCLUSION

Apathy and administrative constraints are making agriculture weary. A multi-pronged strategy is needed to improve the water-management system and practice in India.1 Every farmer and farm-based organization should implement this. Central Government, as well as the state governments, should ensure and enhance.

Incentives to invest in the adaptation of new methods of water-saving, harvesting, etc., particularly to meet uncertainties of weather and global climate changes. Even the innovative "participatory public delivery system" should be encouraged for water management in general and underground water in particular. The underlying principle should be one of "least cost" according to the objectives of effectiveness, economic efficiency, and equity. As stated by the then President of India, His Excellency ShriPranab Mukherjee, "Strategic partnerships for the adoption of best practices and to maximize benefits through technology transfer have become more important today.

India, which had witnessed a Green Revolution in the Sixties, is now moving towards an "Evergreen Revolution", recognizing the positive role that information technology can play as a powerful catalyst for sustainable agricultural development. India's strategy centers on the Action Plan for Information and Communication Technology (ICT) for Agriculture, which has been operational since 1995."1

People associated with agriculture and allied activities should be recognized as resource management communities with awareness and a positive attitude towards an "integrated approach to the utilization of natural resources" – soil, water, and bio-diversity. This approach should not be an adhoc one but a strategic collaboration for sustainable ecosystems, rural livelihoods, and food security (Bunning, n.d.). Moreover, it has to be strong in its quantitative and qualitative dimensions. Irrigation has to be developed in terms of area coverage as well as conservation.

Dissemination of time-tested technical know-how regarding water use, reuse, and replenishment, as well as drought and disaster management, should be made available eve to small and marginal farmers. Research in labs should be dovetailed with field experiments to cater to the feltneeds of farmers and to enrich the experiences.

Knowledge sharing is going to be another important sub-sector in this scheme of things in the coming days. The Central Water Ministry has – in this connection – called for the active participation of all stakeholders.

Participatory Irrigation Management (PIM) – along with the Water Users Associations (WUAs) – has been conceived as the thrust area ineffective irrigation management by involving and associating the farmers in planning, operation, and maintenance of the irrigation system in India. So too are the Irrigation Management Transfers (IMT) Programmes which states are keen about. The progressive involvement of farmers in water management has yielded desirable results in terms of equity, efficiency, and economy.

It has already sounded on a research program of farmers' participatory action in 5000 villages to promote "more crop and income per drop" of water, training of water-masters in each *Pani Panchayat*2, and wider dissemination of know-how to the user-level through electronic and print media. *PaniPanchayats*that in 1972 came to save many farmers during the severe drought in Maharashtra and also became very popular.

Orissa should be revitalized in all states of India. Similarly, Karnataka's programs such as *JalNirmala*(clean water), *Jalarakshana*(water protection) and *NammaBhumiNammaThota*(our land, our garden), Gujarat's aquifer mapping exercise (under MGNREGA), Rajasthan's *JalChitra*(water map), and other initiatives must bring in harmony between people and the environment.

There should not be any clash of interests here. Huge and largely successful programs like MGNREGA and the National Rural Livelihood Mission (NRLM) can be linked with many small yet locally viable and sustainable water management programs. Such efforts will also strengthen local governance and participatory management. More and more collaboration of related ministries with the civil society can, thus, initiate a paradigm shift in rural development in general and water management in particular, i.e., a shift away from narrow engineering construction approach to demand-driven participatory approach.

VII.CONCLUSION

Study b conducted Karnataka some distorts and Rajasthan in Bhilwara district during the year 2011-2013 to assess the economic feasibility of refinement renovation of a traditional water harvesting structure under *RastriyaKrishiVikasYojana*(National Agriculture Development) project revealed that the average number of irrigations in one ha increased from 1.8 to 3.86 after renovation of existing and crop diversification index increased from 0.432 to 0.782 and 0.432 to 0.659 during and seasons, respectively.

Increased water resources and improved technologies increased productivity by 28 to 48.5 percent in both seasons. On average, 54,499 annum was obtained after one year of renovation with an average B: C ratio of 2.52 against a total expenditure of 35,859. Besides, about 251 to 403 man-days employment was generated as an indirect benefit due to water resource development and implementation of improved crop production technologies.

The average cost of water storage in the renovated was found to be 6 m, whereas a net return of 19 m was realized by utilizing the stored water for irrigation to crops and fish during the first year of study. Renovation of existing *nadies*(rivers) increased groundwater recharge by 15-41 percent (Jat et al., 2016). Lessons such as these are inspiring, no doubt but emulation in more and more districts of the country is what we are eager about.

Strict enforcement of laws to prevent indiscriminate sand mining, injudicious use of electricity, etc., can save a lot of water without adversely affecting crop production and productivity. Damage control exercises should be taken up for implementation without wasting any time. This is in the interest of all resources, including labour. For instance, enhanced land and labour productivity due to better water management can lead to higher real wages too. YogindraAlagh has estimated that if land augmentation emerges with the success of the interrelated issues of water management, cropping intensity can rise by 0.5 percent annually, and in the decade 2010/2020, real wages would rise by 7 percent additional or 27 percent in total and rural-urban inequality would go down.

Educating the farmers has to be at the top of the agenda of agricultural development in general and water management in particular. While IT and BT need to be

promoted on a large scale, they should be made 'farmer-friendly. In the light of the recurring drinking water scarcity also in several parts of the country, water management for both irrigation and drinking purposes would receive urgent attention. The choice of techniques for the optimization of resources should be crystal clear to all concerned. Public and private investments will have to be stepped up for this national cause. Therefore, policies and programs for irrigation development in the future have to be 'focused' on increasing per-capita availability of water, costand time reductions of irrigation projects; rationalization of rates; better maintenance of works, and sound management of natural resources coupled with HRD of farm-managers.

Water-saving and water-use efficiency schemes and strategies such as Awareness campaigns on Water, Sanitation, and Hygiene (WASH), Training programs on Sustainable Agriculture (SA) and Water Use Efficiency (WUE), and rainwater harvesting, water recycling, etc. which are already functional must be become "best practices" of all water users. It is heartening to note that citizens' initiates are also forthcoming in a positive way. For instance, the "Next drop" started by AnuSridharan as a platform between citizens and the government has helped solve the water problems of the residents in Hubli, a town in Karnataka.1 Similar case is that of UddhavKedkar of Shivni village (Maharashtra). These eco-saviors, fighting like warriors, are the change-makers, the Global Indians who have acted locally.

In the tsunami-hit lands of Andaman, Several NGOs (e.g., Voluntary Health Association of India, Nehru Yuva Kendra, Nandi Foundation, Tata Institute of Social Sciences, etc.) actively participated in enhancing livelihood security of the affected people. They took up the 'cash for work' program and did desolation of water bodies, clearing of fields from damaged crops, strengthening of river bunds, and so on. The rescue, rehabilitation, and reassuring measures helped agriculture to revive.

Rational management of water needs strong pro-democratic and environment-friendly systems in place. Further, they need to be integrated with best farm practices. No doubt, this is going to be a daunting task given the fact that climate change will heighten the need to anticipate water shortages worldwide (Jaeger, 2017). There are clear challenges with definite choices. The most difficult challenge is to make the best choice. Water can save us. We can also save water. Preaching is good, but practice makes us perfect.

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