Water Management in Agriculture

Dr. Jagdeep Saxena

Demand of freshwater in agriculture sector is rapidly increasing while its supply is constant. Rainwater harvesting is limited due to low water storage capacity and lack of awareness. Due to unsustainable extraction of groundwater, water table is receding at an alarming rate of 0.3 meter per year. In agricultural water management, irrigation is a major component but it also includes water conservation practices and micro-irrigation techniques. Rice and sugarcane consume almost 60 percent of the country's irrigation water. New technologies and improved agronomic techniques can save irrigation water in significant quantities. Micro-irrigation techniques, such as drip and sprinkler, increase water use efficiency, save water and also lead to higher yields. Participatory Irrigation Management has emerged as a very effective tool for irrigation water management in villages.

'The earth, the land and the water are not an inheritance from our forefathers but on loan from our children. So, we have to handover to them at least as it were handed over to us.'

- Mahatma Gandhi

Water is the most critical input for agricultural productivity having a determining effect on the eventual yield. All other inputs/investments (quality seeds, fertilizers, high-end technologies, etc.) fail to achieve their full potential if crops are not optimally watered. Being a predominantly agricultural country, India needs huge amount of water for farming and allied activities. But, the country has only four percent share of global freshwater resources which is managed to support nearly 18 percent of world population. Increasing population coupled with food and nutritional security has created additional pressure on

water resources. Demand of water from various sectors of economy (urban, industry, and agriculture) is rapidly increasing while the supply of freshwater is constant. As a regular source of fresh water, India receives nearly 4,000 BCM (Billion Cubic Metre) of precipitation (rainwater, snow, hails etc.) per year, but approximately 80 percent of this is received during monsoon season (June-September) only. This results in huge run-off losses during monsoon and calls for irrigation investments for rest of the year. Due to limited water harvesting infrastructure, only less than one-third of this precipitation can be utilised. The per-capita storage capacity is India is low as compared to other countries. Annual utilisable surface and groundwater resources are estimated to be 690 BCM and 431 BCM respectively. Average flow of rivers is estimated to be 1869 BCM. Groundwater is a replenishable source which gets nearly 74 percent recharge from rainfall and the rest is contributed by canals, ponds, reservoirs and other water conservation practices. Agriculture sector uses 89 percent of the groundwater for irrigation, while 11 percent is consumed in the domestic and industrial uses. Overall, the agriculture sector is the largest freshwater user in the country accounting for almost 85 percent of the total water usage. This is mainly due to cultivation of water intensive crops such as rice, wheat, sugarcane and cotton, and very low irrigation efficiency. The common pool nature of groundwater and the difficulty of observing it directly make the resource challenging to monitor and regulate. Hence, unsustainable extraction levels that exceed natural recharge rates are depleting groundwater resources rapidly. Water table is receding at an alarming rate of 0.3 meter per year. The Central Groundwater Board has categorised 16.2 percent of the total assessment units *(Blocks, Mandals* or *Talukas*) numbering 6,607 as 'over-exploited'. Additional 14 percent units have been categorised at 'critical' or 'semi-critical' stage. However, if rainfall is collected and managed properly with the help of rainwater harvesting and artificial recharge structures for augmentation of ground and surface water, this can reduce dependence on groundwater to the tune of about 500 BCM out of the total annual water requirement of 1200 BCM for all sectors. The unsustainable groundwater use necessitates demand management and supply augmentation measures for increased water use efficiency in agriculture sector. In this context, agricultural water management is an imperative in the country. Although irrigation is a major component in agricultural water management, it also includes soil, land, and water conservation practices; improving the efficiency of water use in irrigation; and technologies for lifting, storing and conveying water. Further, the National Water Policy 2012 recommends conservation of existing water bodies, rivers, river corridors, etc.

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) is the most comprehensive scheme launched in 2015 to increase irrigation facilities, promote micro-irrigation and support development of water conservation and recharge structures. State Governments have also implemented their own specific irrigation schemes. In addition to Ministry of Jal Shakti, Central Ground Water Board is also working towards aquifer rejuvenation, water conservation and artificial recharge. Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is also significantly contributing in water conservation efforts across rural India.

Managing Water at Source

Soon after independence, Government of India pushed 'Creation and Expansion of Irrigation Facilities' into its top agenda to mitigate recurrent famines and hunger. During initial years, development of canal irrigation remained a priority area in which Government of India invested profusely through various irrigation projects across the country. As a result, the area irrigated by canals increased from 71 lakh hectares during 1950-51 to 144 lakh hectares during 1980-81; and further reached a peak level of 173 lakh hectares by the year 1991-92. However, during 1980s groundwater irrigation expanded at a much faster rate than canal irrigation. Consequently, area under canal irrigation not only stagnated but declined and hovered around 160 lakh hectares during 2011-12 to 2014-15, which is 10 lakh hectares less than what was achieved 20 years back. As a result, the share of canal irrigation in the total irrigated area has declined from 37.5 percent in 1984-85 to 23.43 percent in 2014-15. There are some specific reasons for making canal irrigation out of favour : low reliability and reduced flow of water at source; poor maintenance of canal and tributaries; poor utilisation of the irrigation

potential created; and an increase in cultivation of water intensive crops; and adoption of water intensive practices. Presently, canals are irrigating those lands, which have large plains, fertile soils and perennial rivers. The plains of north India are mostly canal irrigated.

Meanwhile, many major (Cultivation Command Area, CCA, more than 10,000 hectare), medium (CCA 2,000 – 10,000 hectare) and minor (CCA less than 2,000 hectare) irrigation schemes were launched to improve status of irrigation in India. Water resources development and management are planned, funded, executed and maintained by the State Governments as per their own state-specific priorities and resources, while Government of India supplements /supports the efforts of State Governments by providing financial and technical assistance through various schemes and programmes. With collective and concerted efforts at various levels, utilised irrigation potential (surface and groundwater combined) has reached to 87 million hectare, while ultimate irrigation potential touched 140 million hectare. As per latest estimates (2018-19), against total agricultural land of 1,80,888 thousand hectares, the cultivated land in the country was 1,53,888 thousand hectares, out of which net 71,554 thousand hectares was irrigated. Rest of the cultivated area, nearly 54 percent, is rainfed; that is, depends on rainfall for irrigation. Even if ultimate irrigation potential is achieved, nearly 31 percent of cultivable area will remain under rainfed condition. There has been substantial disparity in rainfall, it varies from less than 100 mm in western Rajasthan to

more than 2500 mm in north-eastern part of the country. Such condition necessitates formulation of different set of strategies to manage irrigation for whole year.

It is generally observed and well recognised that Indian farmers use 2 to 4 times more water to produce a unit major food crop than in China or Brazil. Hence, wise and efficient use of water is a must for sustainable development of agriculture sector and national food security. In this context, two crops–rice and sugarcane–deserve special attention as only these two crops consume almost 60 percent of the country's irrigation water. Technologies are available which can produce the same output with nearly half the irrigation water in these two crops. For instance, around 3,000 litres of water is used to produce one kilogram of paddy grain under the traditional flood irrigation. Whereas, under drip system of irrigation the requirement can be slashed to just 842 litres. New technologies, such as Direct Seeded Rice (DSR) and System of Rice Intensification (SRI) can also save 25 to 30 percent of water compared to traditional flood irrigation. In sugarcane, trench farming has been found very effective in saving water. About 300 farmers in Uttar Pradesh have been able to reduce water usage using trench farming and they have saved an estimated 60 million litres of water during 2019-2021. State Governments need to motivate farmers for adoption of scientifically designed cropping patterns to ensure optimum utilisation of water. Scheduling of irrigation is another simple and effective methodology to save water and energy. In the process, the correct frequency and duration of watering is determined on the basis of moisture in the soil and stage of the crop growth. About 35-40 percent water can be saved by scheduling of irrigation along with significant reduction in fertilizer use. Moisture sensors and automated irrigation systems which can be controlled by a farmer using smart phone, will help in deciding the time and amount of irrigation to be carried out.

The traditional methods of irrigation, mainly flood irrigation, have low irrigation efficiency (38 percent) due to excessive seepage loss and inequitable and untimely supplies. Adoption of water saving technologies such as sprinkler and drip irrigation systems have proven extremely effective in not just water conservation but also lead to higher yields. It has been observed that among various methods of irrigation, drip irrigation has achieved highest application efficiency of 90 percent with over-all efficiency ranging between 80-90 percent. New agronomic practices such as raised bed planting, ridge-furrow method of sowing, sub-surface irrigation and precision farming are also helpful in increasing irrigation efficiency. In this context, Government of India has launched new policies and schemes to increase area under irrigation and enhance water use efficiency.

Pushing Irrigation to New Heights

Among various schemes launched by Central Government, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) is the most comprehensive one aiming at protective irrigation for all agricultural farms in the country. Launched in 2015-16, it has the following 4 major components.

- Accelerated Irrigation Benefit Programme (AIBP),
- Har Khet Ko Pani (HKKP),
- Per Drop More Crop (PDMC), and
- Integrated Watershed Management Programme.

AIBP covers major to medium irrigation projects that involve an area of more than 2,000 hectare. During 2016-17, 99 on-going major/medium irrigation projects have been prioritised in consultation with States for completion in phases. Out of this, 44 projects have been reported to be completed/almost completed and an additional irrigation potential of 21.45 lakh hectare has been reported to be created by these projects. HKKP-Command Area Development and Water Management (CADWM) programme aims to utilise created irrigation potential as soon as project is completed. Further, its objectives include improving water use efficiency; increasing agricultural productivity and production; and bring sustainability in the irrigated agriculture in a participatory environment. So far, about 14.85 lakh hectare cultural command area has been developed. Under HKKP-Surface Minor Irrigation scheme, the total number of sanctioned projects are 6,213 and 3,098 schemes have been completed

upto March, 2020. During 2017-20, Surface Minor Irrigation (SMI) scheme could achieve irrigation potential of 1.20 lakh hectare. HKKP also runs a specific program for repair, renovation and restoration of water bodies. Out of 2,319 water bodies approved, 1,359 have been renovated as of March, 2020 with net irrigation potential of 0.5283 lakh hectare. Watershed Development Programme, running across the country, has successfully and significantly improved the availability of surface and groundwater in project areas. Since 2014-15, 7.09 lakh water harvesting structures have been created/rejuvenated and an additional area of 15.17 lakh hectare was brought under protective irrigation up to third quarter of 2020-21. The programme has also led to increase in productivity, vegetative cover, livelihood opportunities and household incomes causing socio-economic transformation. 'Per Drop More Crop' component of PMKSY focuses on enhancing water use efficiency at farm level through micro-irrigation systems (Drip, Sprinkler, Fogger etc.). This component also supports micro level storage or water conservation/management activities to supplement source creation for micro-irrigation. During 2015-16 to March, 2021, micro-irrigation has achieved an impressive coverage of 53.69 lakh hectare on All-India basis. In addition, 4.84 lakh micro level water harvesting/secondary storage structures have been created to supplement the micro-irrigation. To provide impetus to micro-irrigation, Government of India created a special Micro-Irrigation Fund with a corpus of Rs. 5,000 crore during 2018-19 with NABARD as implementing agency. This fund facilitates the States in further mobilising the resources to provide additional incentives to farmers beyond the provisions available under PMKSY-PDMC. This fund is facilitating to bring another 12.83 lakh hectares area under micro-irrigation in the States of Andhra Pradesh, Gujarat, Tamil Nadu, Haryana, West Bengal, Punjab and Uttarakhand. In view of growing interest of many other States in micro-irrigation, Government of India, in its budget for 2021-22, has doubled the initial corpus of Rs 5,000 crore by augmenting in by another Rs 5,000 crore. In addition to efficient use of water, micro-irrigation ensured higher productivity, reduction in labour cost, saving in power consumption, and reduction in fertilizer use. Micro-irrigation techniques help farmers to get better returns due to higher productivity, high quality of produce and savings on other inputs.

Several State Governments also acted simultaneously and designed their own participatory irrigation management programmes. In the State of Bihar, interventions by 'Jal Jeevan Hariyali Abhiyan' have increased the number of water structures (over 2,600 checks dams constructed); developed plantations (over 41,600 plantations); and enhanced the use of micro irrigation significantly. In Chattisgarh, construction of small dams, canals and dykes resulted in additional groundwater recharge. The State of Jharkhand launched a special scheme, 'Neelambar Pitambar Jal Samridhi Yojana' in May, 2020 for creation of field bunding, rejuvenation of *nalas* and construction of soak pits. As a result, currently, on an average five schemes of water conservation are running in every village in the Lohardaga district of Jharkhand. 'Birsa Munda Krishi Kranti Yojana' in Maharashtra has increased micro-irrigation area and took up construction of new wells and ponds along with repair of unused wells. Now, irrigation water is available in water scarce tribal areas.

Conservation is Another Key

Among various water conservation techniques, mulching is a simple, 'easy-to-do', effective and comparatively low cost means that reduces water loss by checking evaporation from soil surface. Mulch is any covering material, either organic or inorganic, applied on soil surface to create a barricade which does not allow escape of soil moisture. The moisture is conserved for many days thus reducing the demand of irrigation during the period of crop cultivation. Additionally, mulching improves soil structure, reduces soil salinity and also controls weeds. Various types of plastic mulches are available in market, but mulching can also be effectively done by using agri wastes such as wheat straw, gross clippings, leaf debris, etc. Plastic film lining has proved to be an effective tool against loss of water through seepage in canals, ponds and reservoirs. By reducing seepage losses up to 100 percent, it improves water availability over a longer period of time for irrigation purposes. It also prevents soil erosion and is highly useful in porous soils where water retention in ponds in a

Participatory Irrigation Management (PIM)

Participatory Irrigation Management (PIM) broadly refers to the formation of groups of water users, mainly farmers, in a formal body for the purpose of managing parts or whole of an irrigation system. Such bodies are generally called Water Users' Associations (WUA), but are also known by the names such as *Pani Panchayat, Pani Samiti* or irrigation cooperatives. In this approach, water users/farmers are involved as active stakeholders in management of irrigation systems right from planning and design to construction, design, maintenance, distribution and even financing. PIM policy of Government of India aims to create a sense of ownership of water resources and irrigation system among the users, so as to promote economy and efficiency in water use. Such type of ownership encourages better use of water through better choice of crops, cropping sequences and also regulates timing, period and frequency of water supply for optimum utilisation of irrigation water. In PIM based irrigation systems, it is the combined responsibility of the farmers to collect water charges from users and make payment to irrigation agency. Thus, a healthy relationship gets created and maintained between the irrigation agency and users.

To develop and popularise PIM as a viable tool of irrigation water management, a legal framework was needed in the country. Accordingly, the Ministry of Water Resources brought out a Model Act to be adopted by State Legislatures for enacting new irrigation acts or amending the existing ones to facilitate PIM. A good number of States have enacted new irrigation acts which now govern/regulate the constitution and functioning of Water Users Associations. Farmer Organisations are tier for minor and medium irrigation projects, four-tier for major irrigation projects are mentioned below:

- **Water User' Association (WUA):** In a WUA, all water users are its members and it has a Managing Committee (President and 4-10 members). Each WUA has a delineated command area. Generally it covers a group of outlets or a minor irrigation system.
- **Distributary committee (DC):** It comprises five or more WUAs. All the presidents of WUAs will comprise general body of the Distributary Committee.
- **Project Committee (PC):** This is the apex committee of an irrigation system and presidents of the DCs in the project area shall constitute general body of the PC.

Water Users Associations are scripting impressive success stories across the country in terms of saving of water, increase in irrigated area and productivity. For example, WUAs formed in collaboration with the Waghad project in Nashik district (Maharashtra) have not only effectively saved water but also increased the yield. The current irrigation level of the farm land at Waghad is more than 140 percent of the targeted area for irrigation. The project has 24 WUAs with 16,958 members. There are a total of 234 directors for these WUAs who run the system. Of these 234 directors, 72 are women. Farmers are now able to produce crops even during drought. It has also elevated the lifestyle of members.

challenging issue.

Rainwater harvesting and recharging groundwater is one of the most popular strategy by which rainwater is gathered and stored for irrigation during lean periods. Rainwater harvesting systems are cost-effective and considerably easy to maintain with additional benefit of recharging local aquifers. Rainwater harvesting structures allow collection of large amounts of water that have the potential to mitigate the effects of drought. It also reduces soil erosion and flood hazards by collecting rainwater and reducing the flow of storm water to fields and rural habitats. Various schemes run by Central and State Governments are promoting/financing construction of new water harvesting structures such as check Dam/Cement Plug/ Nala Bund, Percolation Tank, Dugwell Recharge, Contour Bund, Gully Plug etc.; and also helping rejuvenation/repair of old and traditional water harvesting structures. Although rainwater harvesting seems to be a modern concept, India has a long tradition of rainwater harvesting methods which are still in use in various regions. *Baoli, Dighi, Johar, Kund, Tanka, Dang, Kul, Naula* and *Zing* are some of the popular structures seen in rural areas of the country.

To further accelerate the pace of rainwater harvesting, Ministry of Jal Shakti launched a special

campaign 'Jal Shakti Abhiyan: Catch the Rain' with the tag lines '*Catch the rain, where it falls, when it falls*' during 22 March to 30 November 2021. It covered all blocks of all districts across the country including both rural and urban areas. Campaign included creation of new and maintenance of old rainwater harvesting structures and revival of traditional rainwater structures; to motivate farmers for growing less water intensive crops; afforestation; preparation of scientific water conservation plans; and most importantly setting up of Jal Shakti Kendras. In this context, ICAR-Krishi Vigyan Kendras organised training and awareness programmes for farmers across the country. Ministry of Jal Shakti, under its National Water Mission, launched a special awareness programme called 'Sahi Fasal' in 2019 to nudge the farmers to grow less water intensive crops in water stressed areas. A series of workshops were organised in desired regions wherein exports recommended cultivation of appropriate crops with micro-irrigation techniques. 'Atal Bhujal Yojana', a centrally sponsored scheme, is dedicatedly pursuing sustainable ground water management in identified water stressed areas through community participation and demand side interventions. Currently, the scheme is being implemented in 8,774 gram panchayats of 81 districts of seven States (Haryana, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh). Central Ground Water Board (CGWB) is working towards aquifer rejuvenation, water conservation and artificial recharge by implementing innovative schemes. It has prepared a 'Master Plan for Artificial Recharge to Groundwater-2020' indicating various structures for different terrain conditions. The master plan envisages construction of about 1.42 crore rainwater harvesting and artificial recharge structures to harness 185 BCM of monsoon rainfall. Further, CGWB is organising Public Interaction Programmes at grassroots level to disseminate nuances of the aquifer management plans for the benefit of stakeholders. So far, over 1,000 such programmes have been conducted in different regions in which over 84,000 people have participated.

Over the last eight years, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) has emerged as a driving force in water conservation efforts across rural India. Nearly 75 percent activities (works) permissible under the scheme directly improve the water security and water conservation efforts. The major works taken up under natural resource management include construction of check dams, ponds, renovation of traditional water bodies, land development, embankment, fields bunds, field channels, plantations, contour trenches, etc. Encouraged by the results, many States are pooling their own resources along with MGNREGS funds to take up water conservation works. A national evaluation has found increase in productivity, income of farmers, fodder availability acreage and significant rise in water table due to NRM works.

Way Forward

Management of water in agriculture is vital not only for increasing productivity of crops but also for sustainable employment and income in agriculture sector. In this context, farmers need to be educated on various aspects of irrigation management to increase water use efficiency and equity. Use of Information Technology, drones and other cutting-edge technologies in management of irrigation systems can play a positive role in sustainable use of water. Participatory Irrigation Management has been conceived as the thrust area as progressive involvement of farmers in water management has yielded desirable results in terms of equity, efficiency and economy. Creating appropriate infrastructures and adopting scientific management practices will help augment water resources and improve the efficiency of the facilities. In nutshell, the future programmes and policies of the Government for irrigation development need to be focused on increasing per capita availability of water; reduction in cost and time of irrigation projects; rationalisation of water rates; better maintenance of works and infrastructures; and sustainable management of all natural resources including water.

(The author is Former Chief Editor, Indian Council of Agricultural Research, New Delhi. Views expressed are personal. Email: jagdeepsaxena@yahoo.com)