Increasing Irrigation Water Use Efficiency: Challenges and Way Forward for Punjab

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Abstract

During 1960-61, Punjab farmers produced about 3 million-tons of wheat and oilseeds, which was not even enough to feed the population of Punjab. However, by the year 2000, harvest increased to 25 million-tons, mainly wheat and rice, which was enough to feed Punjab and some surplus for exports. This enormous leap is attributed to introduction of high yielding varieties and advancements in irrigation and farm mechanization sectors. This, however, has come at a price in terms of deterioration of water resources as agriculture sector alone consumes approx 75% of available water. Reduced surface water in-flows and erratic precipitation due to climate change effects and supply of free power to agriculture sector has further compounded the problem of water scarcity with more than 75% of state's area now under water stress of one kind or the other. The situation would have been far worse had the concerted efforts for water conservation through introduction of underground pipeline system and micro irrigation not initiated by the state during early 2000's.

The Soil and Water Conservation Department has been instrumental in converting approx 45,000 kms of open channels to pipeline based systems benefitting 4.8 lakh-ha and introducing micro irrigation on 34000 ha besides commissioning projects for use of 150 MLD of treated water from sewerage treatment plants for irrigation. The evaluation studies carried out by ICAR, NABARD reveals that interventions have significantly increased irrigation water use efficiency and scaling up of these activities is the way forward. Comprehensive plans in line with SDG's have been formulated by the department to substantially increase water use efficiency in agriculture sector. Strict implementation of water conservation plans with adequate budgetary support from governments and participation of private sector shall be a key to meet intended UN-SDG targets.

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Access to safe water and sanitation and the sound management of freshwater ecosystems are at the very core of sustainable development. The successful implementation of the 2030 agenda will strongly depend on meeting Sustainable Development Goal No. 6 (*CBS, 2016*). Increasing water-use efficiency over time is strongly linked with other SDG's such as sustainable food production (SDG 2), economic growth (SDG 8), infrastructure and industrialization (SDG 9), cities and human settlements (SDG 11), and as consumption and production (SDG 12). The paper discusses the present water resource scenario, challenges, initiatives and interventions for increasing water use efficiency in agriculture sector, the largest consumer of water resource in the state.

1. Introduction

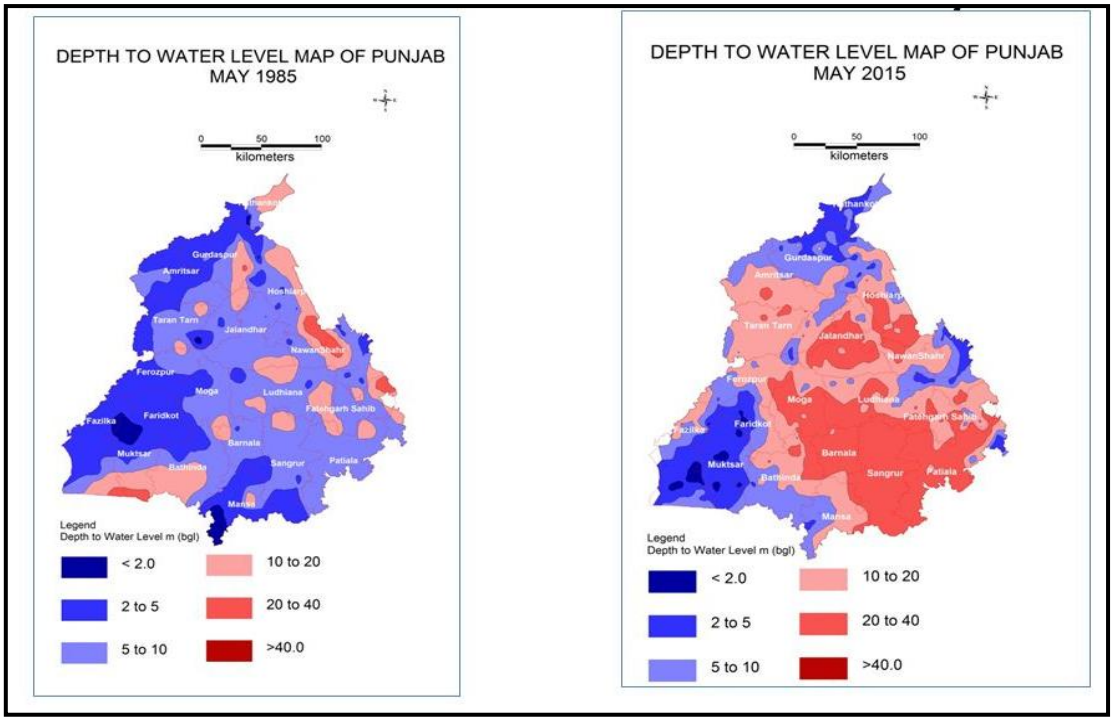
The state of Punjab having an area of 50,362 square kms is the most developed State of India in many respects where all the villages are approachable by metalled roads and are cent-percent electrified. The State of Punjab is a part of the Indus River System and is separated from the Ganga basin by the Ghaggar River. The major perennial rivers are Ravi, Beas and Sutlej which are fed by Himalayan glacial melt upto the extent of 60 percent of the water supply in these rivers. The climate of the state is semi-humid and semi-arid. The rainfall decreases progressively from 1125 mm in Northeast (Pathankot) to about 300 mm in Southwest (Fazilka). The state has a well-defined rainy period in summer from July to September and a long dry spell puts pressure on man-made irrigation systems. The deep water levels are recorded in the Kandi belt whereas water logging conditions exist in some parts of south-western districts. All the rivers are tapped by using dams at different levels in the catchment areas and stored water is utilized for irrigation through a strong network of canals in the command areas.

2. Genesis of State's Water Crisis

From the time of independence in 1947 until 1965, agricultural production in India was unable to meet the country's needs. The state during a period from 1965 onwards has been one of the world's most remarkable examples of agricultural growth characterized by adoption of new, high-yielding varieties (HYV's) of wheat, rice and other food crops. The cropping intensity which was 126% during 1960's increased to 180 % by the end of twentieth

century. The total irrigated area increased from about 38% to 98% and area under paddy increased from about 2.27 lac ha in 1960s to about 28.5 lac hectare by 2014 (*Statistical Abstract, GoP*). Agriculture in Punjab grew at a high growth rate of 5.7 per cent during 1971-72 to 1985-86, which was more than double the all-India growth rate of 2.31 per cent during this period. However Punjab's agriculture GDP grew at only 1.61 per cent per annum, which is less than half the all-India average growth rate of 3.5 per cent in the period between 2005-06 and 2014-15 (*CSO, GoI*).

Punjab model of irrigation is characterized by high demand of canal water for irrigation coupled with unconstrained mining of groundwater. Data from minor irrigation census 2011 shows that the three states (Punjab, Haryana and UP) account for 55 percent of the tube wells in India. On an average there are 28 tube wells per sq. km. of net sown area in Punjab alone. Continuous growth in population, sowing of high-water consuming and high yielding cash crops and also expansion of economic activities has led to increasing demand of water for diverse purposes, causing a great stress on available water resources in the State. Intensive agriculture, based on wheat-rice rotation, has led to a serious imbalance in use and availability of ground water resources. According to an estimate, the total water supply of 3.13 m ham falls short by 1.27 m ham of the total water demand of 4.40 m ham (*A K Jain and Raj-Kumar, 2007*). In recent decades, state's water table has been reducing at an alarming rate, with most of the demand coming from irrigation. The number of tubewells pumping out ground water increased from 1.2 lakh during 1960's to 14 lakh by 2017 (*PAU, 2017*). The current situation of groundwater development is most critical as 80 per cent of the monitored wells are considered overexploited as per Central Ground Water Board. Annual ground water extraction in Punjab is 31.16 billion cum as opposed to 21.44 billion cum availability. Out of 138 blocks studied in the state, only 23 are safe whereas 110 are over exploited and 5 are critical (*CGWB, MoWR*). The irony is that these safe blocks mostly fall in south-western zone, where ground water is unfit for use in agriculture. So, practically all available ground water in Punjab is over exploited.



Source: Central Ground Water Board

3. Water Resource Availability and Demand

At present, water demand for all purposes in Punjab state has estimated as 44104.94 MCM, of which major share (41685.62 MCM) goes to agriculture sector, followed by water demand for domestic use (1303.83 MCM) and industry (326.77 MCM). The total water demand is expected to be 44227.87 MCM by 2021 (*SIP-PMKSY*). Surface based irrigation projects operate at an efficiency of 30-40%, whereas efficiency in tubewell sector is slightly higher at 50-60%, thereby losing almost half of water during conveyance and application (*Planning Commission, 2009*).

The total water deficit of the State is 8994.97 MCM annually which will increase to 9117.90 MCM by 2020. All the districts except Fazilka, Muktsar Sahib and Ferozepur had negative water balance i.e. demand is more than availability during 2015 and same will continue even upto 2020.

4. Challenges

Target 6.4 of SDG Goal 6 contemplates “By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity". This target aims to ensure there is sufficient water for people, the economy and the environment, by reducing water withdrawals and increasing water-use efficiency across all sectors of society. The 14 proposed indicators for this target are mainly focused on the

efficiency of consumptive water use – agriculture, industry and domestic, though some indicators refer to freshwater storage and the non-consumptive uses of energy production and ecological requirements. While six of the indicators propose some percentage measurement of water use, the other just recommend the balancing of water supply with demand. The indicators proposed for agricultural water are focused on withdrawals and productivity.

Price structure of different competing crops has been tilted in favor of rice and wheat because of the procurement needs of the country. The alternative crops have been put on a disadvantage both in terms of competitive price and market uncertainty. Shrinking land holdings mainly due to inheritance has also put additional pressure on water resources as each individual farmer wants his own water source. There are other policy issues too that are putting pressure on water resources but are beyond the purview of this paper.

5. State's Initiatives for Enhancing Irrigation Water Use Efficiency

As the effects of water crisis of the state became more than visible during late 90's and early 2000, the state embarked upon a number of programmes through supply-side management practices which include watershed development and water resource development through major, medium and minor irrigation projects and secondly through the demand management practices which include improved water management technologies/practices. For meeting Sustainable Development Goals, Department of Soil and Water Conservation (DSWC), Punjab, is implementing a host of activities for water conservation and management, major of which are discussed below.

i) Increasing Irrigation Water Conveyance Efficiency

Irrigation water conveyance from canal outlets and tubewells in Punjab was traditionally through open channels, which results in considerable losses in the form of evaporation and seepage. The state implemented a major programme of lining of surface water courses from canal outlets and tubewells, during 1970's and 80's. The programme helped in curbing losses to an extent but recurring costs regular maintenance of these channels was a major concern. These channels also become obstacles in the way of free drainage of water across these during rainy season and thus results in submerging standing crops and even villages at times. The government of Punjab initiated a subsidy cum loan based programme for laying of underground pipelines for individual farmers during late 1980's but this was on a very limited scale.

As water crisis deepened, a comprehensive programme to increase irrigation water conveyance efficiency was initiated in 2005 under Rastriya Krishi Vikas Yojana (RKVY).

This programme envisaged laying of underground pipelines to replace open channel both from canal outlets and tubewells. The projects are both community based, wherein a group of 7 or more farmers form a water user society to avail assistance from government and individual farmer based. The type of pipelines being laid are Reinforced Cement Concrete(RCC), Poly Vinyl Chloride(PVC) and HDPE (High Density Poly Ethylene) depending upon particular pressure requirements. PVC and HDPE pipes are preferred where operating pressure exceeds 5m to 6m and directly coupled pumping system is required. As most of the piped distribution system is underground, right of way problems are significantly reduced, allowing better layouts. The system also ensures no hindrance in movement to the farmers and farm equipments. Because of shorter transit times for water from source to field, there are lower conveyance losses and the smaller volumes of water in the conveyance system, pipe systems can deliver a supply which is more flexible in both duration and timing, in a way not possible in the earlier open channel system, so enabling intensification and diversification into higher value crops. The execution time for construction of piped network is one-fourth as compared to construction of conventional lined water channel. The Department, has till date laid about 45000 kms of underground pipeline benefitting 4.82 lakh hectares in the state.

ICAR- Indian Institute of Soil and Water Conservation conducted an evaluation study of underground pipeline projects during 2015. The study was conducted in 105 villages across 16 districts of the state for which 474 projects were randomly selected for evaluation. The study concluded that efficient water efficiency through conventional open course based system is 30-35% approximately 1 million ha water is lost in these unlined channels. Apart from it, approximately 10 thousand hectares of land surface is covered by open water courses. The underground pipeline System has helped increase water use efficiency by 15-25% saving of 1% of land besides reducing energy and labour costs. The major outcomes of ICAR evaluation are:

- Due to laying of underground pipeline, not only the conveyance losses have minimized but there has been considerable saving for farmers on labour and energy costs besides the additional availability of land for cultivation otherwise lost on account of construction of open channels
- Conjunctive use of water resulted in increase in area of paddy and wheat crops by 29 and 31% respectively.

- After laying UGPS about 100 sq.m land per ha was saved and 2750 cu.m /ha water was saved per year in rice-wheat system. This resulted in increase of wheat and rice yield by 3 quintal and 3.8 quintal respectively besides the increase in fodder crops.
- Availability of both dry and green fodder increased after project due to availability of assured and good quality of irrigation water as a result of which there has been a considerable increase of milk yielding cattle population.
- After the project per capita net income per annum increased by 57% from Rs.60602 to 95283. This is mainly due to farmers getting assured source of irrigation in areas falling at tail end of canal system.

Another study conducted by NABCONS in states of Punjab and Haryana during 2013 also brings out that underground pipeline has vastly contributed in increasing irrigation water conveyance efficiency. The study area was brackish underground water zones of the states, where ground water is unfit for irrigation and pipelines are laid for conjunctive use of water. The major outcomes of study are:

- The average saving of water in irrigating one acre of paddy field is 36.1% whereas the same is 43.3% for the wheat crop.
- crop productivity increase was 18% for paddy, 52% for wheat and 161% for Sorghum due to use of pipeline system in the fields.
- The UGPL system has helped in reduction of labour cost and drudgery for the farmers.
- Other benefits reported were, land saving, elimination of water logging near channel to the extent of 1.5%, elimination of additional wells in the area, safety in operations etc.

ii) Increasing On-farm Water Use Efficiency:

To achieve optimum level of water use efficiency in agriculture, every drop of water available at delivery system needs to be utilized at farms judiciously. Micro-irrigation technology which involves drip and sprinkler irrigation ensures increase in water use efficiency as much as 50- 90% due to reduced runoff, evaporation, seepage and deep percolation losses significantly. The on-farm irrigation efficiency of properly designed and managed drip irrigation system is estimated to be about 90 percent whereas in sprinkler irrigation method, water saving is up to 70 percent (INCID, 1994). The Micro Irrigation programme was initiated in the state as well as in the country during early 1990's but due to lack of awareness among farmers and technological capacities and support of implementers, the programme could not succeed much. The programme remained discontinued for about a

decade in the state until Centrally Sponsored Scheme on Micro Irrigation was launched by Govt of India during 2006. In June, 2010, it was up-scaled to National Mission on Micro Irrigation (NMMI). From 1st April 2015, Micro Irrigation component of On Farm Water Management (OFWM) has been subsumed under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) as per the same pattern of assistance and cost norms as were prevailing under OFWM.

A study conducted by International Water Management Institute (IWMI)-Tata during 2012 had calculated state's micro irrigation potential area at 3.34 lakh but the state has till date covered just 34,000 ha (excluding protected cultivation) i.e only 1% of total potential area besides hitherto non-scarcity of water in major part of the state. The major causes for lower rate of adoption of this system is cropping pattern of wheat-paddy and availability of free power for farming community of the state. Evaluation study conducted by NCPAH through NABCONS concluded that adoption of micro irrigation has brought about significant increase in yields and have motivated farmers in shifting from low duty to high duty high value crops.

iii) Development of Alternate Source of Irrigation Water

The State has registered 45% increase in its population during the last two decades. It is the 6th most urbanized state in the country with urban population increasing to 37.49% against a national average of 31.16% (Census, 2011). Highest per capita water availability, growing economy, urbanization, population along with rapid industrialization has increased the generation of waste water many folds during the last few decades. The State has laid special impetus on treatment of urban waste waters through installation of sewerage treatment plants and presently 1600 MLD of water is being treated in various treatment plants which shall be augmented to 2300 MLD during next one year (PWSSB). Punjab is amongst the leading states in terms of installed sewerage water treatment capacity as per report tabled in Lok Sabha in 2017. This treated water offers a great opportunity for agriculture sector as the availability of irrigation water from sewerage treatment plants provides an additional source of water, thereby reducing diversion of potable water supply to agricultural sector. At present treatment levels, if water is fully utilized in agriculture, an area of approx 70,000 hectares can be brought under irrigation, which would entail replacement of atleast 30,000 tubewells in intensive ground water use area. The volume of sewerage water treatment capacity pertains only to Class-I and Class-II cities/towns of the state and as more and more semi-urban and rural habitations are brought under its ambit, the

capacity of treated water generated will increase manifold. Punjab Water Supply and Sanitation Department has already brought approx 9,500 of out of 12,581 villages under piped drinking water supply. Silver-lining to this source of water is its continuous availability irrespective of climatic variabilities/changes and with other water sources diminishing, the treated wastewater holds most promising potential for supplementing and adding to state's water resources.

The Department initiated irrigation projects for use of treated water for irrigation during 2012-13 with projects promoted by Punjab Pollution Control Board. Success and acceptability of projects by farmers motivated department to formulate a dedicated programme for use of treated water, first of its kind in the country. The department initiated a NABARD funded 'Project for Utilization of Treated Water from Sewerage Treatment Plants of State' during 2014. Till date 29 irrigation projects from sewerage treatment plants have been commissioned utilizing approx 150 MLD of treated water. The projects are implemented on community basis and are handed over to Water User Associations formed amongst the farmers who are then responsible for operation and maintenance of these projects.

iv) Integrated Solar Lift-Micro Irrigation Project

The department executed an innovative 'Community based Integrated Solar Lift-Micro Irrigation Project' in Talwara and Hajipur blocks of District Hoshiarpur. The project which is first of its kind in the country was commissioned during August, 2017 and has a command area of 664 hectares spread across 14 villages. Irrigation infrastructure created from Kandi canal outlet is fully automated and powered by solar energy for which 3798 solar photovoltaic panels generating 1.1 MW and 46 pumpsets of 18 to 23 hp capacity have been installed. Due to project interventions, barren lands are now brimming with agricultural activity. Farmers have for the first time ever; have grown crops in rabi season besides, productivity has increased by over 100% in just last two seasons since farmers started getting irrigation water. Fencing erected as part of project has thwarted the threat of wild animals, helping farmers to diversify into vegetables and horticulture crops. People who earlier migrated are now tilling their land and linkages established with local processing units are helping producers getting instant cash returns. Training centre besides a demonstration farm provides farmers the latest knowhow by roping in of experts from prestigious institutions. Self-sustainability and minimal recurring costs of project shall further increase profit margins. The project finds a mention in 'Guidelines on Planning and Design of Piped Networks' issued by Central Water Commission, Govt of India during 2017.

v) Legislations by State for Water Conservation

a. Punjab Preservation of Subsoil Water Act: The Government of Punjab enacted the Punjab Preservation of Subsoil Water Act in 2009 to check groundwater depletion. The Act stipulates sowing of paddy nursery after 10th May and its transplantation after 20th June. The transplantation date fixed in 2009 Act was 10th June, which has been revised to 20th June during 2018. As paddy crop requires vast amount of water during its initial growing stage and its raising, therefore, if done earlier than onset of Monsoon when the climate is hot and humid puts additional pressure on water and energy resources. Deferring of paddy transplantation till the arrival of monsoon season during end of June and July helps in conservation of water resources.

b. Right of Way to lay Underground Pipelines Act: The State government enacted 'Right of Way' Act to lay underground pipelines by way of an Amendment in Punjab Land Improvement Schemes Act, 1963 in December, 2017. The Act allows the department and farmers to lay underground irrigation pipelines in the land of another landholder. The Act was necessitated as sometimes neighboring land holders do not allow the underground pipeline to pass through their lands thus depriving the farmer, whose land is located on the other side of a water source, of his due share of irrigation facilities.

6. The Way Forward

India is one of the 193 United Nations member states to adopt the SDGs and commit itself as a stakeholder to meet the 2030 agenda for sustainable development. This implies that the goals should shape all social policy, planning, and development action, as well as impact monitoring and evaluation at the central, state, regional, and local level.

As one of the most important natural resources that does not have an alternate like the food crops etc, water needs a serious regulatory system of use to ensure that it is treated as a state property and used judiciously. Formulation of a robust state water policy and agriculture policy and its implementation will go a long way in achieving the desired SDG targets. Data collection and validation needs to be strengthened emphatically to keep a tab on the progress in achieving targets. The policy of free power facility to farming sector needs to be revisited. Saving just a fraction of water from agriculture sector can significantly alleviate water stress in other sectors. Employing smart technological solutions can help to increase irrigation efficiency, and using treated wastewater can help to reduce freshwater withdrawals.

Other reforms that need to be undertaken include restructuring of departments associated with water resource conservation and management to bridge the knowledge gap in planning, development and management of water resources in a sustainable manner as also making it more user centric and professionally more competent. Most of state government entities at present are now working in isolation, which needs to be synergized

to achieve practical results. It becomes the more necessary in wake of Pradhan Mantri Krishi Sichayee Yojana (PMKSY), which merged various agricultural, irrigation and water conservation based programmes of different ministries into a single platform. Setting up of State Water Resources Regulatory Authority to regulate water allocation across various sectors shall also be a positive step for judicious, equitable and sustainable allocation/ distribution of water and its utilization. The initiatives for enhancing water use efficiency in agriculture sector need to be brought into mission mode for achieving optimum benefits.

State will have to raise adequate resources and also acquire the necessary technology to help achieve its SDG objectives. Incorporating and aligning the local challenges for implementing SDGs goals would require Strengthening and prioritizing the budget spending in accordance with the SDG goals and targets. Corporate sector needs to be encouraged for investing more in water conservation and management activities. CSR funds can be channelized for bridging gap in government's water sector projects. National and International funding agencies need to pump in sufficient funds to the state government if the desired SDG goals and targets are to be achieved till 2030, otherwise, it is a far cry.

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