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Opinion

Water-Wise Intensive Cropping in Indian Punjab

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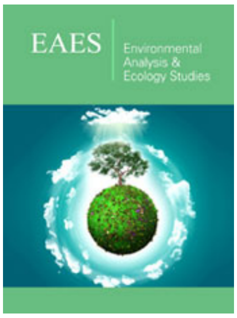

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Opinion

Rice-wheat cropping is the mainstay of Punjab state of India and occupied more than 80 percent of nearly 8.0 million hectare (M ha) gross cultivated area in 2020-21. This coupled with high productivity (4.0ton per ha of rice and 5.0 ton per ha of wheat) has helped to realize about 30 million tons of food grains in the state. It has not only improved farm economy but has also contributed towards national pool to ensure food security. This phenomenal agricultural growth over years has over-stressed water resources as indicated by alarming fall in groundwater levels. The area under rice increased nearly 10 times since late 1960's and crossed 3.0Mha in 2016. Rice has large irrigation needs due to high percolation rates of water in alluvial soils of the state. Advancement in transplant from end-June (in mid-1980's) to mid-May (in mid-1990's) further increased irrigation needs due to hot and dry weather. This is responsible for drastic depletion of groundwater resources with water table falling in all but few blocks in the south-western Punjab. The average fall in water table increased from 0.18 meter per year in 1982-87 to 0.74 meter per year in 2004-05. The Enactment of Preservation of Subsoil Water Act in 2009 by the state legislation (that banned transplanting of rice before June 10) has been a right step to reduce groundwater fall. As a consequence, average decline of water table in the past six years (2013-2018) has decreased to around 0.50 meter per year. It is feared that water table in almost half of the state will go below 30-meter depth by 2040 if groundwater extraction goes unabated at the present rate. A continuous decline of groundwater levels implies large scale replacement of centrifugal with submersible pumps that have greater energy needs for water extraction. In 2007, the state government provided 7.5 billion units (kilo Watt-hours) of energy to extract groundwater [1] that has increased to 12.5 billion units by 2017. Therefore, wise use of water is imperative to sustain cropping in Punjab.

Water Use

Water use is determined by supply of and demand for water. An analysis by Punjab Agricultural University in early 1990's estimated that the state had an annual utilizable water supply of 31.3 billion cubic meters (BCM) from canal networks (14.5 BCM) and groundwater recharge (16.8 BCM) [2]. The canal water availability has remained almost static since then; rather there has been a decline due to reduced river flows. But groundwater recharge and availability registered an increase from 16.8 BCM in early 1990's to 21.6 BCM in 2017 as per report of Water Resources and Environment Directorate of Punjab. This increase may partly be attributed to greater return-flow (of irrigation) towards recharge due to more than doubling of groundwater extraction (from 15.7 BCM in 1991 to 35.8 BCM in 2017) during this period.

The water demand includes crop Evapo-Transpiration (ET) and non-agricultural civic, industrial, and power generation use. Irrigation supplements rainfall to meet crop ET and drainage. It may be noted that seasonal drainage in rice is twice or even more of ET, whereas for other upland crops, this component is 10-20% of ET. That is why ET requirement of 1500 liters for one kg of rice (1.5kg paddy) gets translated to water input (irrigation and rain) of 4500 liters or more that accounts for ET and drainage. Irrigation demand relates with energy needs, while ET demand explains groundwater fall. The State Irrigation Plan (of Department of Agriculture and Farmers Welfare) of 2017 estimates an annual water deficit (implying water demand exceeds water availability) of around 10.0 BCM that is met through over-use of groundwater. This deficit needs to be minimized by augmenting water supply and reducing water demand.

Augmenting Water Supply

Measures to augment water supply are as under.

A. Making more canal water available in central region by rationalizing water allowance of canal systems. There is a possibility of diverting canal water from south-west region (wherein 70 percent area is canal-irrigated) to central region (wherein 14 percent area is canal-irrigated). This would also help in recharge of groundwater from canal seepage.

B. Harnessing surplus river waters during monsoons, that otherwise flow to Pakistan, by constructing of new headworks at a suitable site on the Satluj. This will create a large reservoir to store flood waters during monsoon and enhance water supply.

C. Harvesting rainwater in north-east Kandi region (that has 40 percent run-off of rainfall) by adopting in-situ water conservation and constructing a series of water harvesting structures (check dams). This will also boost groundwater recharge in the central region by lateral sub-surface flow.

D. Using skimming-well technology to extract good-quality water layer above poor-quality water aquifers in the south-west regions will supplement canal water supply.

E. Promoting rainwater harvesting in urban areas by putting grass saver tiles along roadsides and parking lots for rapid percolation of rainwater. This will help in reducing sewage water load and flooded conditions. Renovation of village ponds and diverting sediments and water to fields will be a source of plant nutrients and increase groundwater recharge.

F. Wastewater from civic and industrial use after treatment has a potential to enhance water supply for irrigation of non-food crops. As per wastewater use policy document (2017), the state has a potential to treat over 2 billion liter per day of wastewater through more than 200 treatment plants of which 73 have been completed. These augmentation measures, however, are costly and time-consuming.

Reducing Water Demand

In central region experiencing problem of groundwater depletion, field-scale interventions to reduce crop ET will be more effective to minimize water deficit. Measures like diversifying from rice to maize, basmati and kharif pulses having low ET needs; and from wheat to rabi oilseeds and gram will be a right move. A shift to use of short-duration cultivars of rice will have same effect. Similarly, synchronizing transplant time of rice with low atmospheric evaporative demand will help to reduce ET. In addition, rice-wheat culture generates huge amounts of residues (more than 45 million tons annually) of which rice residues are generally disposed of through burning. However, residue mulching helps to reduce soil water evaporation, moderate soil temperature and control weeds. These measures cause irrigation saving by reducing ET and drainage and are useful in terms of energy saving and groundwater fall [3].

A. A replacement of 1.0Mha rice area from the present 3.0Mha to maize (0.5Mha), basmati (0.4Mha) and kharif pulses (0.1Mha) will reduce ET by 2.0 BCM. These measures are meaningful when alternate crops have assured and remunerative marketing.

B. Replacement of 1.0Mha wheat area from the present 3.5Mha to rabi pulses (gram) and oilseeds (mustard and raya) will reduce ET by 1.0 BCM. This replacement may become necessary in foreseeable future in view of improved wheat production in Eastern India.

C. In rice culture, use of shorter-duration cultivars and a shift in transplanting time from June 10 to June 20 would cause an ET saving of 2.0 BCM for rice area of 2Mha.

D. Residue mulching during hot and dry periods in wide-row crops (for 50 percent area under 0.5Mha in cotton, 0.6Mha in maize including area replaced from rice and 0.1Mha in sugarcane) and residue-retained wheat (1Mha) using no-till seeders will result in ET saving of 1.5 BCM.

E. Drip irrigation in 50 percent of 0.25Mha area in fruit and vegetable crops will save ET by 0.25 BCM.

Summing Up

It is summed up that these interventions of reducing water demand can decrease water deficit by 6.8 BCM from current deficit of 10 BCM. This is equivalent to reduction in water table fall by two-third of the present rates. An annual ET saving of 6.8 BCM (4.0 BCM in rice and 2.8 BCM in other crops) gets translated to irrigation saving of 13.0 BCM using drainage to ET ratio of 1.5 in rice and 0.10 in other crops. Technologies like laser land-levellng, ridge-furrow planting and improved irrigation scheduling (in rice) cause irrigation saving due to reduction in drainage with little effect on crop ET.

a. Laser land-leveling in 1.0Mha-1 rice area will result in irrigation saving of 3.0 BCM (assuming a gain of 20 percent in application efficiency).

b. Furrow irrigation in 0.5Mha cotton will result in an irrigation saving of 0.5 BCM.

Thus, an irrigation saving of 16.5 BCM implies energy saving of more than 2.4 billion units (about 20 % of energy use in groundwater extraction). Adoption of these interventions will go a long way towards sustainable water use in intensive cropping of Punjab. In order to accomplish this, the state extension functionaries will have a pro-active role in sensitizing the stakeholders. There is also a dire need for policy shift from input (energy) subsidy to development subsidy (in terms of water conservation). This will be a step in right direction.

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