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Measures for Quantitative and Qualitative Management of Fresh Groundwater Resources-A Review

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Abstract

Injudicious surface irrigation water policies and excessive ground water pumping have resulted in depletion of groundwater resources at an alarming rate. Thus, to enhance the groundwater potential, artificial recharge of good quality water, on farm water management practices and precision irrigation (automated micro-irrigation) should be considered. Besides, water pollution has turned out to be another serious challenge chiefly due to increased use of pesticides, fertilizers, presence of heavy metal, injudicious waste management, irrigation through untreated wastewater and other sources. There arises a need for timely understanding and identification of sources of pollution and detection of contaminants associated with groundwater through appropriate measures. There is a need to review and fortify the community programs for safe use of the chemicals through improved pesticide policies. The precision agricultural tools such as LCC and N-sensors for need based fertilizers application require their promotion. Use of pesticides can be replaced through adoption of IPM, bio-pesticides, organic manures and crop diversification.

Keywords: Depletion; Water pollution; Heavy metals; Pesticides; Fertilizers; Precision

Introduction

The injudicious surface irrigation water policies, excessive ground water pumping and subsequently subsidized or free electricity, especially in Punjab state have been found responsible for depletion of ground water resources at an alarming rate. The rice-wheat crop rotation supported with free electricity, irrespective of quantity of water being pumped has encouraged the water table depletion at an alarming rate (70 cm year-1 during 2008-12) in north-east Indian Punjab during past few couple of decades [1]. The number of tube wells, which was 1.92 lakh (shallow tube wells) in Punjab during 1970, increased to 6.00 lakh in 1980 and at present the number has crossed 13.82 lakh. Out of the total groundwater potential of Punjab, about 98% is used in irrigation and rest 2% is utilized in domestic and industrial activities [2,3]. Table 1 demonstrates the present status of fresh groundwater resources and major issues of Punjab state.

Table 1: Status and issues related to groundwater quantity and quality.

Total geographical area	50,362 km^2 (~1.57% of geographical area of the country)
Zones (agro-climatologically and hydrologically)	North-East, Central and South-West comprising 19, 40 and 41% of the geographical area of the state respectively
Area under agriculture (%)	> 85%
Net irrigated area (sown area)	98%
Area irrigated through groundwater (tube wells)	72.50%
Area irrigated through canals	26.20%
Number of tube wells	>13,82,000
Stage of groundwater development	≥170%

Average stage of groundwater development	Average 206% (minimum and maximum of 170% and 264% for Ludhiana and Sangrur respectively)
Cropping intensity	>190%
Area under depleted water table	>80%
Depth to water table in central Punjab (Jalandhar, Ludhiana, Patiala, Amritsar and Sangrur)	20 to 40 mbgl
Depth to water table (Malwa region i.e. Muktsar, Ferozepur, Bathinda and Mansa)	1.5-7.5 mbgl (causes water logging at many places)
Canal network	14, 500 km
Average annual rainfall	1250 mm in the North to 350 mm in the South-West
Rainfall distribution	Erratic in nature (>70% of the annual rainfall occurs during the monsoon season i.e. July to September)
Major issues	Groundwater depletion in Central zone, soil erosion (~80 t/ha/yr) in North-East zone and water logging or pollution in South-Western zone
Fertilizer consumption	N>188.0, P2O5>58.0 and K2O >3.0 kg/ha [3]
Pesticide consumption	18% of the country

Major causes of groundwater depletion

a. Shifting of cropping pattern and cropping intensity

b. Rapid growth in population and urbanization

c. Increase in number of tube-wells

d. Subsidised or free electricity (particularly in Punjab state)

e. Uneven and decreasing rainfall

f. Dependency on groundwater

g. Least adoption of water management strategies such as micro-irrigation, water harvesting and artificial groundwater recharge

h. Limited availability of surface water and failure of monsoonal rains

Management methods

To augment the groundwater potential, artificial recharge of good quality water, on farm water management practices and precision irrigation (e.g. micro-irrigation) should be seriously considered. Followings are the possible ways for management of depleting groundwater resources.

Irrigation scheduling

Irrigation scheduling through different techniques helps to increase the water productivity (water saving). Irrigation at right time (tensiometer technology helps to save ≥20% irrigation water) in right quantity (through flow meter) in a crop like rice is need of the hour to mitigate the decline in water table.

Land leveling

Land leveling through laser leveller recommended by PAU, Ludhiana results in improved water and nutrient use efficiency (20-25% water saving), better crop establishment, saving in irrigation time and higher productivity. An exponential increase in number of laser levellers (3 in 2006 to 8000 in 2015) has been reported in past two decades [4].

Water efficient irrigation system

Drip and sprinkler irrigation (preferable in fruit and vegetable crops) with the help of timers>80% saving of water and higher yield compared to conventional methods. Continued promotion of micro-irrigation (drip and sprinkler irrigation) by department of Soil and Water Conservation along with state and central government agencies (e.g. NMMI, NCPAH and PFDC) is needed.

Conjunctive use of water

Conjunctive use (Groundwater + surface water) of water will help to lower the load on groundwater resources.

Dry farming

Dry farming (without irrigation) helps in retaining the soil moisture for crop production.

Conservation tillage

Conservation tillage (direct sowing etc.) helps to increase water absorption and reduce evaporation, erosion and compaction. It also helps in environmental safety (no residue burning) and enriches soil fertility.

Watershed development

Watershed development can help in mitigating the adverse effects of drought on crops and livestock, control desertification, encourage restoration of ecological balance and promote economic development of village community.

Use of weather apps

Automation of irrigation scheduling has become essential for precise and need based application of water. Several weather apps are now available worldwide to provide up-to-the-second precipitation reports. A collaborated use of such weather application with efficient irrigation systems can help to save

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water, which in turn will put fewer burdens on water resources (surface or groundwater). Moreover, their combination will help to save farmers money through reduced electricity bills, reduced wear and tear of the irrigation systems.

Runoff water recycling

Many factors viz. overwatering and poor soil type may result in generation of runoff, which in turn gets wasted. Further, the agricultural runoff normally contains large fractions of chemicals which in turn can pollute the surface and groundwater resources. Under such conditions, recycling runoff water may help to save a huge fraction of water to save the entire ecosystem.

Mulching and composting

It enhances the water holding capacity of soil and improves the soil structure. Compost and mulch are useful in retaining more water in the soil during dry season.

Growing cover crops

Cover crops (berseem, cowpea, field peas, lentils, soybean etc.) help to protect soil, reduce weeds, increase soil fertility and organic matter, prevent erosion and compaction and improve water holding capacity.

Going organic

A healthy soil rich in organic matter and microbial life helps to retain moisture for longer duration for plants. Organic farming methods may also help to reduce the use of agricultural chemical fertilizers which in turn can help in reducing the pollution of surface and groundwater resources. However, its adoption should be considered carefully.

Growing drought-tolerant crops

Introduction of draught resistant crops (Jowar, bajra, pulses and lentils, black pepper etc.) having lower water requirement can perform well with desired output in drought prone.

Rotational grazing

A good grazing management can help to increase the field water absorption and decrease runoff thereby making the pastures more drought resistant.

Management in waterlogged area

In areas, where the water table is high with poor quality water, following practices can be adopted:

a. Lining of canals

b. Subsurface drainage (e.g. multiple well drainage, bio-drainage etc.)

c. Growing salt tolerant crops

d. Developing brackish water aquaculture (fisheries) in water logged areas.

e. Installation of desalination plants.

Groundwater pollution

After acute groundwater depletion, water pollution has turned out to be another serious challenge chiefly due to increased use of pesticides, fertilizers, presence of heavy metal, injudicious waste management, irrigation through untreated wastewater and other sources. There arises a need for timely understanding and identification of sources of pollution and detection of contaminants associated with groundwater through appropriate measures such as complete blood analysis, physical and chemical analysis of water separately on seasonal basis. There is a need to review and fortify the community programs for safe use of the chemicals through improved pesticide policies. The soilless cultivation of vegetable crops can also be adopted to have reduced water and soil pollution through controlled use of fertilizers.

Management of groundwater pollution

i. Adoption of precision agricultural practices or resource conservation techniques for optimal use of input resources such as fertilizers.

a. Use of LCC (rice, wheat and maize) recommended by PAU Ludhiana for supplying required quantity of nitrogen to be applied in crops at right time to get the maximum productivity.

b. Use of sensors to determine fertilizer requirement by observing and recording various indices for different crops and taking soil samples. Example: tractor mounted N-sensor (Yara International make) to predict nitrogen (N) requirement for wheat.

ii. Efficient use of agro-chemicals such as pesticides (insecticides, nematicides and fungicides etc.)

iii. Promotion of organic manures with a significant reduction on use of artificial chemical fertilizers.

iv. Promotion of soilless cultivation practices (substrate culture cultivation, hydroponics and aeroponics etc.) particularly in vegetable crops (examples: tomato, capsicum, cucumber, etc.) and fruit crops (example: strawberry). This technology can help to reduce the water pollution through controlled (re-circulation of nutrient solution) and reduced use of fertilizers (no wastage) along with saving in water use and improved crop yields [5].

v. The chemical pesticides can be replaced with the following practices to control pollution.

a. Integrated Pest Management (IPM): Mechanical and biological control with greater emphasis on use of crop rotation, bio-pesticides and pesticides for plant origin like neem formulation.

b. Bio pesticides: The pesticides derived naturally from the waste materials from animals, plants, bacteria and minerals. It includes neem and the plant-based formulations alike Indene, Repline, Neemmark and Guava family.

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c. Organic farming: It is dependent upon crop rotation, animal manures, crop residues, off-farm organic wastes, mineral grade rock additives and biological system of nutrients mobilization and plant protection.

d. Crop diversification: Shifting from one particular cropping system to a diverse and multi cropping system to stabilize farm income in order to protect the natural resources.

Conclusion

The quantitative management of groundwater resources through artificial recharge with good quality water, on farm water management practices and precision irrigation (micro-irrigation) has become need of the hour. There arises a need for timely understanding and identification of sources of pollution and detection of contaminants associated with groundwater through appropriate measures. Use of precision agricultural tools such as LCC and N-sensors for need based fertilizers application requires their promotion in the state. Moreover, use of pesticides can be replaced through adoption of IPM, bio-pesticides, organic manures and crop diversification.

References

1. Gulati A, Roy R, Hussain S (2017) Getting Punjab agriculture back on high growth path: sources, drivers and policy lessons, p. 42.
2. Srivastava SK, Chand R, Raju SS, Jain R, Kingsly I, et al. (2015) Unsustainable groundwater use in Punjab Agriculture: Insights from cost of cultivation survey. Indian J Agric Econ 70(3): 365-378.
3. GoI (2014) Water quality issues and challenges in Punjab. CGWB, Ministry of Water Resources, Faridabad, India.
4. Kumar S, Singh M, Mirzakhaninafchi H, Rajesh UM, Ali M, Bhardwaj M, Soni R (2018) Practical and affordable technologies for precision agriculture in small fields: present status and scope in India. Proceedings of the 14th International Conference on Precision Agriculture, 24-27 Montreal, Quebec, Canada, p 1-9.
5. Singh MC, Kachwaya DS, Kalsi K (2018) Soilless cucumber cultivation under protective structures in relation to irrigation coupled fertigation management, economic viability and potential benefits-a review. Int J Curr Microbiol App Sci 7(3): 2451-2468.

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