

GROUNDWATER DEPLETION IN THE STATE OF PUNJAB, INDIA: ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPLICATIONS

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ABSTRACT:

Punjab is agriculturally the most advanced state of India. Although Punjab occupies just over two percent of the national agricultural land, its agricultural output today accounts for a third of the wheat and rice procured by public agencies. Rice-wheat monoculture is followed in a major part of Punjab. Due to irregular patterns of rainfall and inefficient and unreliable canal irrigation network throughout the state, farmers depend on groundwater as the primary source of irrigation for the crops. Over-exploitation of groundwater resources has resulted in the depletion of water table. This paper provides an analysis of the economic, social and environmental implications of groundwater depletion in the state of Punjab and a plan to address the issue is proposed.

1. INTRODUCTION

Punjab is agriculturally the most advanced state of India. Although Punjab occupies just over two percent of the national agricultural land, its agricultural output today accounts for a third of the wheat and rice procured by public agencies. This is an outcome of the widespread adoption of green revolution technologies including high-yielding variety seeds, use of chemical fertilizers, and groundwater irrigation.

Rice-wheat monoculture is followed in a major part of Punjab. Due to irregular patterns of rainfall and inefficient and unreliable canal irrigation network throughout the state, farmers depend on groundwater as the primary source of irrigation for the crops. Government schemes provide

subsidized credit to farmers as well as free power supply for groundwater extraction. As a result, farmers have extensively invested in groundwater extraction systems such as submersible pumps.

2. CURRENT ECONOMIC AND ENVIRONMENTAL PROBLEMS

The negative consequences of the green revolution and intensive farming practices in Punjab have become evident in recent years. Over-exploitation of groundwater resources has resulted in the depletion of water table. Depleting groundwater resources not only disrupt the ecological balance but also put a heavy financial burden on farmers. NASA found that groundwater levels have been declining by an average of one meter every three years and over 26 cubic miles of groundwater disappeared between 2002 and 2008. Degradation of soil health is another problem associated with intensive agriculture and rice-wheat monoculture. The burning of crop residue has further added to environmental problems as it causes air pollution and also loss of soil organic matter and nutrients.

3. CURRENT REGULATIONS AND GOVERNMENT SUPPORT

The State and Central Governments have come with several regulations and policy initiatives. The Punjab Preservation of Subsoil Water Act, prohibits farmers from sowing the nursery of paddy before 10th May and transplanting paddy before 10th June in a year. The purpose of the Act is to save groundwater by prohibiting sowing and transplanting paddy before specified dates in hot and dry periods. Crop diversification programs have been launched where the government is trying to incentivize the farmers to other crops which require less water. The government has launched several programs for providing subsidies for the promotion of drip irrigation systems and poly-house technology to conserve water.

The positive of impact government regulations and policy initiatives have been very limited. Due to the lack of regulation for ensuring minimum support price (MSP) for crops other than rice and wheat and the absence of a proper canal-irrigation network throughout the state, farmers continue to adopt intensive rice-wheat monoculture utilizing groundwater resources.



4. SUSTAINABILITY OF CURRENT FARMING PRACTICE

The current farming practice is not sustainable in terms of economics and environment. The rate of groundwater depletion has reached alarming levels and if measures are not taken to ensure sustainable groundwater usage, the consequences may be severe both economically and environmentally including the shortage of potable water and collapse of agricultural production which is largely dependent on groundwater resources.

5. PREFERRED SITUATION

The preferred situation would be to reduce the dependence on groundwater irrigation and opting for less water-consuming crops such as sugarcane, potato, maize, and pulses. Farmers should opt for water-saving technologies such as laser land leveling, drip irrigation systems, and poly-house technology to conserve water. Water table depletion should be reversed in the preferred situation.

6. CHANGE IN CURRENT PRACTICES

Farmers should adopt conservation practices such as:

- **Planting on permanent raised beds:** Crop cultivation on permanent raised beds brings down water usage as compared to flat planting technique as water is only supplied in furrows instead of the entire field. Permanent raised beds improve crop yields and also save cost involved in tillage. Furrow irrigation in row crops can result in up to 25 % water saving over conventional flood irrigation.
- **Laser Land Levelling:** Fields that have been leveled uniformly using laser leveling require less amount of water for irrigation. Laser leveling not only brings down water usage but also improves yields.
- **Standardize the use of water for irrigation:** Standardizing the use of water for irrigation through devices such as tensiometers can help in saving water. Typically farmers cultivating rice are under an impression that standing water condition in fields improves yields, though empirical evidence doesn't support this belief. By measuring soil moisture and standardizing the use of water for irrigation, the efficiency of water usage can be improved.
- **Delaying the transplanting of rice nursery till the onset of monsoon:** If transplanting of rice nursery is delayed till the onset of rainy monsoon season in July month, a significant amount of water can be saved.
- **Zero-Tillage:** Zero-Tillage is a conservation practice in which fields are sown with a new crop without tilling while the residue from the previous crop is still there. Zero tillage helps in reducing the cost of cultivation and also saves water.
- **Crop-diversification:** Farmers should be encouraged and given incentives to shift from rice-wheat monoculture to diversify to other crops such as sugarcane, potato, maize, and pulses, which consume less water.
- **Micro-irrigation:** Micro-irrigation techniques like drip or sprinkler irrigation are the best options for the sustainable development of agriculture in the state. Some studies have predicted that converting 1% of wheat area in a year on drip irrigation system under a rice-wheat cropping

system, can arrest the decline of groundwater by 3cm per year.

- **Protective-technologies:** Protective-technologies such as Net-House or Poly-house can help in conserving water.
- **Rain-water harvesting:** Rain-water harvesting techniques should be encouraged in the state. There are about 12,000 village ponds that can be renovated and utilized for water storage and rain-water harvesting.
- **Underground pipeline system:** Low-efficiency field irrigation channels should be replaced with underground pipeline systems for which can reduce conveyance losses by up to 30%.

7. ISSUES AND CHALLENGES

- **Capital investment in adoption of new technologies:** Adoption of new technologies such as micro-irrigation, underground pipeline system, and poly-house require huge capital investments. The average landholding in Punjab is around 2.5 acres which means that a majority of farmers are small farmers who cannot make huge capital investments in the adoption of new technologies.
- **Lack of access to advanced machinery:** Most farmers do not have access to advanced machinery such as seeders for zero-till cultivation and laser land leveling equipment.
- **Shortage of funds for the research community:** There is a shortage of government funding for researchers working on addressing agriculture and water conservation problems.
- **Inadequate policy initiatives from the Government:** While the government has been trying to encourage crop diversification, the absence of a compatible policy set and minimum support price (MSP) for crops other than wheat and rice is a major hurdle in achieving crop diversification. If farmers get at least the same amount of per-hectare returns which they are getting from wheat and rice, only then they will be willing to diversify to other crops.



8. PLAN TO ACHIEVE THE PREFERRED SITUATION

- **Development of best management practices (BMPs) for water conservation:** BMPs for water conservation need to be developed for the state of Punjab. BMPs can become successful only when they take into consideration the triple bottom line, i.e., people (social equity), profit (economic prosperity), and planet (environmental stewardship).
- **Incentivize farmers for crop diversification:** Farmers should be given incentives to shift from rice-wheat monoculture to other crops which consume less water.
- **Awareness programs for farmers:** Awareness needs to be brought among the farmers through various awareness programs and workshops to reduce the injudicious use of water and adopt conservation practices.
- **Policy initiatives from Government:** Government needs to build comprehensive agriculture and water policies which are linked with each other. Minimum support price (MSP) should be guaranteed for crops other than wheat and rice to encourage farmers to shift from monoculture to other crops. The free power policy for agriculture needs to be rationalized.
- **Soil Testing and crop recommendations:** More soil testing laboratories need to be established within the state and farmers should be encouraged to get the soil in their fields tested so that crop, irrigation, and fertilizer recommendations can be made.
- **Community role in water conservation practices:** Village communities should come together in adopting water conservation practices such as rain-water harvesting and community farming. Farmers can pool-in resources and save on costs involved in adopting various conservation techniques.
- **University research programs:** Universities related to agriculture should start more research programs on water conservation practices and alternative crops suited for the region.
- **Infrastructure development:** The canal irrigation network needs to be improved and more watercourses and field distributaries should be built.

9. MEASURING ADOPTION

The adoption of best management practices for water conservation can be measured by creating a network of observation wells throughout the state. Water table depth can be measured at regular intervals at different locations and correlated with various best management practices being adopted. A database and repository of such water table measurements at different locations in the state should be made accessible to all the stakeholders involved.

10. INPUTS NEEDED

- **People:** Inputs are needed from people from different backgrounds for executing the plan, including farmers, researchers, the village community, and government officials.
- **Money:** Funds are required for executing the plan and performing activities as described in the previous section.
- **Time:** Even if people and money are available, reversing the depletion of the water table is going to take time. The practices and action items listed in the plan above need to be followed seriously for a couple of years or even decades before we see any significant results.

11. OUTPUTS OF PREFERRED SITUATION PLAN

The outputs of the plan to achieve the preferred situation will be as follows:

- **Awareness among farmers:** Awareness will be brought among the farmers through various awareness programs and workshops. The importance and benefits of water conservation practices and best management practices will be highlighted in such programs and workshops. Given sufficient funds, grants and resources, reaching out to around 50% of the farmers in the state would not be an issue.
- **Funds and Grants:** Proposals for development of water conservation practices and best management practices will be developed in collaboration with regional universities and research institutions. Such proposals will be submitted to government funding agencies.
- **Educational Resources:** Resources for educating the farmers including videos and guidebooks will be developed. With the help of non-governmental organizations (NGOs) such resources will be publicized among the farmers and village communities.
- **Crop diversification plans:** Different crop diversification plans will be developed keeping into consideration the soil type and climate.
- **Rain-water harvesting plans:** Plans for harvesting rain-water for recharging of aquifers will be developed. With the help of village local bodies (panchayats), the task of renovation of village ponds will be initiated.
- **Community farming:** As the average land holding in the state is small (around 2.5 acre), most farmers cannot spend much on expensive machinery and technologies for conserving water. Therefore, a plan for community farming will be developed and promoted among the farmers where a group of farmers can pool-in resources and base their agricultural activities on sustainable practices.

12. IMPACTS OF IMPLEMENTING PREFERRED SITUATION PLAN

Impacts of implementing the preferred situation plan will be as follows:

- **Reversing the depletion of the water table:** The trend of depleting water table will be reversed by adopting sustainable agricultural and water conservation practices.
- **Increase in farm profits:** With the support of government and public agencies, farmers will get the adequate support prices for procurement of the agricultural produce which is currently only limited to wheat and rice. This will encourage farmers to diversify to other crops and also increase their profits from such crops.
- **Financial support for adopting sustainable practices:** Farmers will get support from government for adopting sustainable agricultural and water conservation practices.
- **Support for new BMP process:** As farmers become aware about sustainable agricultural and water conservation practices and adopt new best management practices (BMPs), it will not only have a positive impact on the farming economics but also on the environment.
- **Share the success:** The success achieved in adoption of sustainable agricultural and water conservation practices will be documented and published in the form of research papers and academic books.