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On Farm Water Management in Pakistan - An Overview

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Abstract: Being a water-stressed country, the current scenario reflects worst-ever water crisis is ahead in the agriculture of Pakistan, threatening food security. Despite having the world's largest contiguous surface water irrigation system, Pakistan has one of the world's most water-intensive economies. More than 90% of freshwater is used for agriculture, with rice, wheat, cotton, maize and sugarcane using more than 80% of it. Agriculture contributes 24% of the Gross Domestic Product (GDP). The country's largest water user is the irrigation industry. The water crisis is largely caused by seepage from rivers and canals, poor management, unequal distribution and pollution and salinization. The problem is getting worse due to climatic factors, global warming and the drying out of the land from a lack of rainfall. Despite being Pakistan's best canal system, significant water losses occur in agriculture. To improve water conservation, raising awareness among farmers, water budgeting, using technology and software, distributing irrigation water equally and government regulations will all help to resolve and save the nation from calamity. By creating dams, reservoirs and ponds, storage capacity can be increased. Today, hydrogeological surveys are required. Applying water management research to the identification, evaluation, pilot testing and demonstration of water management interventions as well as the practical training of stakeholders is necessary for the successful adoption of new technologies and practices considering the water insecurity in agriculture, low water productivity and emerging climate issues.

Key words: Water Crisis · Agriculture · Food Security · Pakistan · Management Strategies

INTRODUCTION

In 1947, Pakistan was a country with an abundance of water, with more than 1600 m^3 of water per person. Pakistan may soon be among the countries with limited water supplies (those with fewer than 1000 m^3 of water per person). The Indus River system and its tributaries, which are primarily fueled by snow and glacier melt in the larger Himalayas, are the only sources of water for the nation. Pakistan, which has a per capita water availability of 1017 cubic meters, is the third most susceptible country in terms of the water problem, according to the International Monetary Fund (IMF) [1]. According to GDP, Pakistan is ranked first in terms of water consumption. Water is the primary input for agriculture, yet there are growing problems with irrigated agriculture, such as insufficient water availability for crop productivity and ineffective irrigation for crop production, poor irrigation efficiency and low water productivity is mostly hampered by over- or under-irrigation [2]. Pakistan will experience a severe water crisis by 2025 [3].

According to the 2018 National Water Policy, more than 50% of canal water diverted from the Indus system does not get to the agricultural level. So, 1 million tube wells, extracting roughly 55 MAF, provide nearly 20% of agricultural demands [4]. Therefore, the nation's agriculture, which generates roughly 24% of the GDP and provides 42.3% of sources of income for subsistence

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(Pakistan Bureau of Statistics, 2022), is in danger [5]. While over 90% of water is used for agriculture [3] and over 80% of it is used simply for agriculture by wheat, cotton, maize, sugarcane and rice. Pakistan has major crops which need water in abundance. ¾ area of the country has less than 250 mm of annual rainfall. 70% of our rain is during monsoon (July-August). Rivers are the major source of water followed by rainfall [6].

According to the Water Apportionment Accord, Punjab received 37% of surface water, Sindh received 37%, Baluchistan received 12% and NWFP received 14% [7]. About 7 MAF of the annual groundwater abstraction for crop cultivation comes from rainfall, compared to 33 MAF from groundwater. On the other hand, there are significant water losses (37 MAF) across the system, including 12 MAF in the distribution system, which consists of around 58, 500 watercourses and includes main/branch canals, distributaries, minors and tertiary conveyance systems. It is imperative to research water management technology to ensure optimal use of the limited water supply and prudent or efficient irrigation for crops [2].

In terms of the depletion of subsurface water, Pakistan is placed second among all other nations. 3000 million acre-feet of groundwater are potentially available. Every year, we extract 50 MAF. The country's subterranean water table is vanishing every day. Farmers would be taxed for irrigation based on the amount of water used per unit [8].

To properly utilize water, a valuable natural resource, at the farm level, emphasis must be given to water management. Water development, conservation and utilization are crucial for the economy of the nation since they improve agricultural output [9]. For irrigated agriculture, the country's water resources are constrained and steadily declining. It will soon become a scarce resource for irrigated agriculture due to the population's exponential growth, rising demands for a variety of applications because of peoples' continuously improving living standards and rising industry standards. Soil moisture monitoring and smart climate agriculture techniques should be used in conjunction with the novel water management systems for improving water productivity [10].

Causes of Water Scarcity

Enhancement of Water Pollution: Our water supplies are being contaminated by insecticides and herbicides, sewage from cities, industrial waste and fertilizers [11]. Fresh water is dwindling with time because brackish and saline water is unsuitable for irrigation [12].

Limited Storage Capacity: 13 million acre-feet (MAF) of the 145 MAF of limited storage are available for 30 days only. 120 days are typical worldwide. Our distribution system is dated. Pakistan loses 24 MAFs each year [13].

Unequal Distribution of Water: Distribution of irrigation water is still a significant problem both within and between provinces. In the past, certain regions have remained flooded while others simultaneously dried out. Some landholders are using more water at the start of the canal while depriving poor farmers [13].

Illegal/Misuse and Mismanagement of Water: Another issue in agriculture is the theft of water directly from rivers and canals. In this sense, the irrigation department's strict measures are essential. While there is occasionally enough water, poor management is one of the main issues [13].

Global Warming/Climate Change: Pakistan is one of the nations with the worst climate change and global warming problems [10].

Role of Institutions in Water Management for Agriculture: Numerous institutions, including well-known institutions, are working to improve water management.

Plant Physiology Involved in Water Usage: Without water, all physiological processes are impossible. So, water is a necessary component of life. Since plants receive all types of nutrients from the soil through transpiration, it is physiologically essential for plants to transpire water through stomata to thrive. The link between transpiration patterns and drying soil is strong. As the soil dries under constant ambient circumstances, the transpiration rate stays constant. Oil drying causes a gradual closing of stomata and a reduction in the overall transpiration rate. Once a certain level of soil-water content is reached, it will, however, start to fall linearly.

Management Strategies for Alleviation of Water Crises: Following Management strategies for the alleviation of water crises are urgently needed at the time.

Awareness of Farmers/Public: The first and most important technique is to raise awareness of the impending water crisis and its dire state among farmers and the public. We cannot complete the mission until and unless farmers are willing. Seminars, conferences, etc., should be planned for this purpose.

Research and Demonstration: Focusing on research water management methods by creating research experiments is the first step to enhancing water usage effectiveness and water productivity. No useful technique could be used without investigation [14]. To address the problem of water scarcity and increase water productivity, drought-resistant cultivars should be grown.

Soil Analysis Through Water Filtration Apparatus: Water filtration time is measured with a metal device. The ability of the soil to retain water can be improved by soil analysis. Water could be used appropriately.

Selected Tree Plantation: Massive tree planting with carefully chosen species in suitable areas is needed to combat climate change and global warming. A high water-transpiring eucalyptus crop should be avoided.

Construction of Dams/ Water Reservoirs/Ponds: Sadly, the nation's desire in building dams, water reservoirs and ponds didn't receive priority. The lack of funding for dam construction further slowed down the process. Therefore, action must be taken immediately to address this despicable condition.

Irrigation Scheduling: Water availability in canals and efficient and timely irrigation at farms are two other essential management practices [15].

Crop-Watt Models: Use of artificial intelligence had made it easier to develop irrigation schedules. Crop-Watt Models are a collection of computer programs used to create irrigation schedules for orchards and crops in any location during any season.

High-Efficiency Irrigation System: In this case, great efficiency is required to improve water use efficiency (WUE). Different plans have been made for the future security of water depending on the season, area and crop [16].

Waste/Saline Water Treatment: Fresh and clean water is decreasing day by day so the need of the day is to treat water and make it fit for agricultural use [17, 18]. Because ions and metals present in the water are hazardous to plants [19]. Phytoextraction strategy is proven to be effective for extracting heavy metals from water [20]. So this treated water could be used for agricultural purpose [21].

Laser Land Leveling: Laser land leveling is one of the vital technologies in this regard leveling of agricultural lands by laser land leveler. It saves water up to 30%.

Zone Size of Cultivated Field (Border Designing): The zone size of cultivated land relies on the kind of soil and discharge rate that would be practiced to prevent the haphazard flow of water in the field.

Sub-Surface Irrigation: It is applied below the soil surface close to root zone of plants. Most subsurface irrigation systems with soil pipes are appropriate for growing vegetables.

Water Harvesting Ponds: To utilize on days when there will be a water shortage, store water. Where rain is a significant supply of water, it gathers rainfall water which is applied for crops.

Lining of Canals and Water Courses: To conserve water for seepage and percolation lining of water courses is inevitable. More than this would result in a lower water table because only around 50% of the canals need to be lined. Additionally, maintaining waterways is also vital.

Nakka/Nako (Outlet for Water Flow): The right size and type of nakkas (big water outlets) and nakkos (small water outlets) are crucial to water conservation based on the irrigation and drainage (I & D) concept. For this use, pipe-type nakkas are more effective.

Flumes Flumes are the most popular way to quantify water outflow. Cut-throat flumes measure the amount of water that exits the water channel, which is essential for accurately measuring the amount of water that is applied in accordance with the needs of the crop.

Water-Saving Irrigation Systems: Drip/trickle Irrigation This is basically a type of micro-irrigation. Drop by drop water for crops at their root zone, especially for orchards. It also filters water to some extent. This helps even in undulated lands.

Automated Drip Irrigation This is an advanced form of drip irrigation that works as and when water is required in the soil.

Sprinkler Irrigation Both top sprinklers and surface sprinklers are performing better to save water. Over Head Sprinkler sprays have nozzles above plants and irrigate from height.

Rain gun and Water (Hose) Reels It throws water with high-pressure water with a rain gun at the end of the reel.

Central Pivot Irrigation System For barren and vast areas with unlevelled lands central pivot irrigation from the top sprinkler downward like rain uniformly. However, it irrigates circular fields.

Gated Pipes Metal/plastic pipes with opening and closing automated gated pipes are altering the designs of flood irrigation.

Automated Gated Pipes It is an advanced form of gated pipes that automatically irrigate as and when required.

Application of Gadgets: Handy Soil Moisture Meter Handy soil moisture meter is a portable device that quickly measures a digital value at any point in the field and at any depth. It is easy to use and easy to carry anywhere. Just put it in the soil and moisture contents will be displayed in digits on small screen.

EnviroSCAN EnviroSCAN is a highly efficient system for real-time measuring moisture levels at various soil depths, showing outcomes on a mobile phone/laptop. It must be inserted or installed in the laser land levelled soil.

Chameleon Wi-Fi Reader A battery-operated device having three lights that measure moisture percentage at different levels with three probes that are inserted at different depths in the soil. It measures soil moisture by blinking lights of different colors with respect to moisture levels at various depths.

Full Stop Moisture Meter Two different probes are inserted in the soil at different depths in root zones. The length of indicators depicts moisture levels in the soil.

Digital Flow Meter Digital flow meter is proven to be very effective to measure the discharge of water. It is used for measuring tube well discharge. It has two claws with magnet connected with its control box. Attach the claws with pipe of flowing water. It records the water discharge in LPS.

Future Strategies and Government Policies: On tube wells, discharge meters will be fitted so that the amount of water discharged may be measured. To some extent, it will conserve water. As an IT (Information & Technology) method that can forecast water requirements before irrigation, mobile applications, software and models are required. To make efforts practicable, effective hydraulic methods are required.

CONCLUSION

The main problems endangering the security of food and water are ineffective irrigation methods, sluggish water productivity and the scarcity and cost of water management technologies. To deal with the impending water problem, an integrated strategy for sustainable water management is essential. Scheduling irrigation at the farm level is crucial for increasing water productivity. The focus must be placed on an integrated and comprehensive approach to the study and pilot testing of soil moisture sensing devices. The plant breeding organizations concentrate on creating types that are resistant to drought.

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