



Assessing the Impact of Irrigation Projects on Sustainable Agricultural Development and SDG Achievement

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Abstract:

Agriculture is the cornerstone of global food security and a primary source of income for billions of people, particularly in developing countries. However, agricultural productivity is highly susceptible to weather fluctuations, particularly in water-scarce regions, where rain-fed agriculture often leads to low yields and crop failures. Irrigation projects have become essential in mitigating these challenges by providing reliable water supplies, increasing agricultural yields, and supporting rural economies. The United Nations' Sustainable Development Goals (SDGs), adopted in 2015, emphasize the need for sustainable agricultural practices to ensure food security, eradicate poverty, and protect water resources. Among the 17 SDGs, Goal 2 (Zero Hunger), Goal 6 (Clean Water and Sanitation), and Goal 12 (Responsible Consumption and Production) directly relate to agriculture, water management, and sustainability. Irrigation projects have long been central to enhancing agricultural productivity, particularly in water-scarce regions, by ensuring a consistent and reliable water supply. However, these projects also pose significant challenges, including environmental degradation, social equity, and resource overexploitation. This paper aims to assess how irrigation projects contribute to achieving the SDGs and sustainable agricultural development while identifying key barriers and proposing strategies for maximizing their effectiveness.

Keywords: Irrigation, Sustainable Agriculture, SDGs, Food Security, Poverty Reduction, Water Management

Introduction:

Irrigation plays a pivotal role in India's agricultural sector, which is the backbone of the economy, employing more than 50% of the country's workforce and contributing significantly to food security. India's agriculture largely depends on irrigation, especially in regions where rainfall is erratic or insufficient. India has a vast network of irrigation systems, including canal irrigation, groundwater-based systems, and rainwater harvesting. However, despite significant investment and expansion of irrigation infrastructure, challenges persist in terms of water

availability, inefficient water use, and uneven distribution of resources. Many irrigation projects in India, especially those relying on groundwater, face the risk of depletion due to over-extraction, leading to concerns about water scarcity in key agricultural areas. The importance of sustainable irrigation in India cannot be overstated, as it is essential for maintaining crop production, improving water-use efficiency, and mitigating the adverse effects of climate change. Sustainable irrigation practices involve using water resources to meet current agricultural demands without compromising the ability of future

generations to meet their own needs. These practices include the use of water-efficient irrigation technologies, the adoption of climate-resilient farming practices, and integrated water resource management to ensure that water resources are utilized effectively and conserved for the future. This paper aims to explore the role of sustainable irrigation practices in India, identifying current trends, challenges, and the future directions necessary to enhance water-use efficiency, ensure agricultural sustainability, and strengthen food security. By addressing the gaps in irrigation management, adopting new technologies, and implementing policy reforms, India can move towards a more sustainable and resilient agricultural future. With the increasing emphasis on achieving the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), and SDG 12 (Responsible Consumption and Production), sustainable irrigation will be a key factor in meeting the country's agricultural and environmental goals.

Objectives

1. To evaluate the role of irrigation projects in enhancing agricultural productivity and food security, contributing to SDG 2 (Zero Hunger).
2. To assess the impact of irrigation systems on water management, efficiency, and sanitation, aligning with SDG 6 (Clean Water and Sanitation).
3. To analyse the role of irrigation in promoting sustainable land and water management, contributing to SDG 15 (Life on Land).
4. To identify the challenges associated with irrigation projects, including

water scarcity, inefficiency, and environmental degradation.

5. To propose strategies and policy recommendations for improving irrigation systems to maximize their contribution to sustainable agricultural development and SDG achievement.

Methodology:

The methodology for assessing the impact of irrigation projects on sustainable agricultural development and SDG achievement using secondary data involves a detailed analysis of existing reports, project evaluations, and statistical datasets. Secondary data have been collected from a variety of sources, including government publications, academic research, international organizations, and project monitoring reports.

Irrigation, agriculture growth, and achievement of SDG:

Irrigation is critical for enhancing agricultural productivity, especially in arid and semi-arid regions. It plays a pivotal role in stabilizing crop yields, reducing vulnerability to climate variability, and improving food security. Efficient irrigation systems help farmers cultivate crops in regions with insufficient rainfall, thus contributing to higher income levels and better food availability. By improving agricultural productivity, irrigation also contributes to rural development and poverty alleviation. Irrigation projects directly influence several SDGs, particularly.

Impact on Agricultural Productivity (SDG 2 - Zero Hunger):

Irrigation has significantly boosted agricultural productivity in areas

with limited rainfall. For example, in Punjab and Haryana, where the Green Revolution led to widespread irrigation infrastructure development, crop yields of wheat and rice have increased. Irrigation provides farmers with a reliable water source, allowing them to grow multiple crops per year, thereby increasing overall food production. However, challenges such as crop diversification and over-reliance on water-intensive crops like rice and sugarcane are emerging. A transition to more water-efficient and climate-resilient crops is essential to ensure long-term food security.

Water Management and Efficiency (SDG 6 - Clean Water and Sanitation):

Efficient water management is crucial for achieving SDG 6. The study found that areas implementing drip irrigation and sprinkler systems have experienced a substantial reduction in water usage compared to traditional flood irrigation. For instance, in Maharashtra, the adoption of drip irrigation has reduced water consumption by nearly 40% while increasing crop yields. Efficient irrigation technologies like drip and sprinkler systems help conserve water and promote the sustainable use of water resources. This is critical for water-scarce regions in India, ensuring that water is used efficiently and sustainably. Irrigation infrastructure contributes to improving access to water for agricultural communities, especially in arid and semi-arid regions, where it is crucial to meet the needs of both agricultural and drinking water requirements. The restoration of water bodies and the implementation of rainwater harvesting techniques in irrigation systems also

promote better water management and quality.

Responsible Consumption and Production (SDG-12):

Sustainable irrigation practices help reduce water waste and ensure that agricultural practices do not deplete natural resources. Micro-irrigation systems and rainwater harvesting ensure that water use is efficient and sustainable. Irrigation projects also promote the use of sustainable farming techniques, such as crop rotation, integrated pest management, and organic farming, which reduce the reliance on harmful chemicals and fertilizers, leading to production that is more responsible practices. By improving agricultural efficiency, irrigation contributes to reducing food wastage by ensuring better-quality crops and consistent yields.

Environmental Sustainability (SDG 15 - Life on Land):

While irrigation can boost productivity, its environmental impact is often overlooked. Waterlogging, salinization, and soil erosion are significant risks associated with inefficient irrigation systems. Regions that rely heavily on flood irrigation face substantial challenges in maintaining soil health and water quality. The research indicates that regions that have implemented integrated water resource management (IWRM) practices, including soil conservation, agroforestry, and ecosystem restoration, have seen better environmental outcomes.

SDG Goal -wise Performance of India



Government Programs and Policies:

Government initiatives like PMKSY, the National Mission on Micro Irrigation, and the Jal Jeevan Mission aim to improve irrigation infrastructure and promote water-use efficiency, expanding the area under irrigation and integrating water conservation efforts at the community level.

Prime Minister Krishi Sinchayee Yojana:

The government of India is committed to accord high priority to water conservation and its management. To this effect Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) has been formulated with the vision of extending the coverage of irrigation 'Har Khet ko pani' and improving water use efficiency 'More crop per drop' in a focused manner with an end-to-end solution on source creation, distribution, management, field application, and extension activities. The Cabinet Committee on Economic Affairs chaired by the Hon'ble Prime Minister has accorded the approval of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) in its meeting held on 1st July 2015. DA&FW is implementing the Per Drop More Crop scheme which is operational from 2015-16 in the Country. The Per Drop More Crop scheme mainly focuses on water use efficiency at the farm level through

Micro Irrigation (Drip and Sprinkler Irrigation System). PDMC is being implemented under RKVY from 2022-23.

National Mission on Micro Irrigation:

A Centrally sponsored scheme on micro irrigation (MI) was launched in January 2006 for promoting water-use efficiency by adopting drip and sprinkler irrigation. All States and Union Territories and all horticultural as well as agricultural crops are covered under the scheme. The National Committee on Plasticulture Applications in Horticulture (NCPAH) provides the required technical guidance in association with Precision Farming Development Centres (PFDCs) at 22 locations. The PRIs are involved in selecting the beneficiaries. Since its inception, about 10 lakh ha has been covered under drip and sprinkler irrigation and a sum of 1425.23 crore has been released as Government of India share (40 per cent of the total cost) in the scheme.

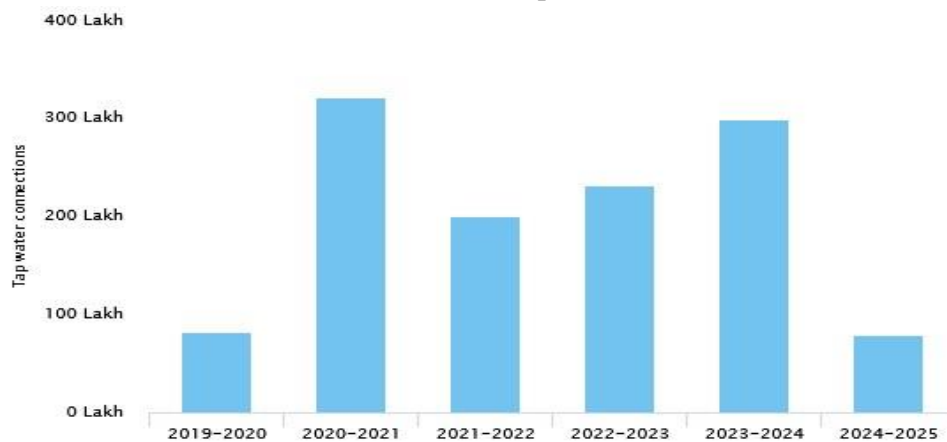
Jal Jeevan Mission:

The Jal Jeevan Mission (JJM), launched by the Government of India in 2019, aims to provide functional household tap connections (FHTCs) to every rural household by 2024, ensuring access to safe drinking water for all. The mission focuses on improving water quality, promoting sustainable water management practices, and

ensuring community participation in water supply systems. It seeks to reduce the time spent by women and children in collecting water, empowering them and contributing to economic and social development. With a 50:50 funding model between the central and state governments, JJM emphasizes decentralized water management, involving local bodies in planning and execution. The mission not only aims to improve public health by providing clean

drinking water but also focuses on sustainable water use through measures like rainwater harvesting and groundwater recharge. Despite challenges such as groundwater depletion, infrastructure maintenance, and financial constraints, JJM has the potential to significantly transform water access and sanitation in rural India, contributing to the country's broader goals of water security, economic growth, and improved quality of life.

Status of households with tap water connection:



Challenges to Sustainable Irrigation Projects in India:

Despite significant advancements in irrigation infrastructure and water management practices, sustainable irrigation in India faces several challenges. These challenges affect the long-term effectiveness and sustainability of irrigation systems, which are critical to ensuring food security, reducing water wastage, and improving agricultural productivity. Sustainable irrigation projects in India face several significant challenges, including the over-extraction of groundwater, leading to the depletion of water tables, especially in water-scarce regions. The uneven distribution of water resources across the country exacerbates water scarcity in certain areas. Inefficient irrigation systems, such

as flood irrigation, continue to wastewater, while climate change brings erratic weather patterns, including droughts and floods, which disrupt irrigation schedules. Additionally, poor maintenance of irrigation infrastructure, financial constraints, and lack of awareness among farmers about modern irrigation technologies hinder effective water management. Institutional and policy fragmentation, water pollution, and inter-state political disputes over water allocation further complicate sustainable irrigation efforts. Moreover, land degradation and soil erosion from improper irrigation practices and conflicts over water usage between agricultural, industrial, and domestic sectors add to the challenges, limiting the

potential for achieving long-term sustainability in irrigation systems.

Future Directions for Sustainable Irrigation in India:

The future direction for sustainable irrigation in India lies in the adoption of advanced water-saving technologies such as drip irrigation, sprinkler systems, and precision farming techniques that enhance water-use efficiency. Integrating climate-smart agriculture practices, such as using weather forecasting tools and drought-resistant crops, will help mitigate the impact of changing weather patterns. Investment in groundwater recharge and rainwater harvesting will be crucial to replenish water sources and ensure long-term sustainability. Policies should focus on improving water governance, encouraging community-based management of irrigation systems, and promoting integrated water resource management to address regional disparities. Moreover, strengthening extension services and raising farmers' awareness about modern irrigation technologies will drive broader adoption of efficient practices. Public-private partnerships can further accelerate the development of infrastructure and access to resources. Lastly, the incorporation of renewable energy for irrigation, particularly solar-powered pumps, will not only reduce dependency on electricity but also promote sustainability and resilience in water-scarce regions. These combined efforts will help ensure a more efficient, equitable, and resilient irrigation system for India's agricultural future.

Conclusion:

Irrigation projects are essential for ensuring food security and achieving Sustainable Development Goals in agriculture. By improving agricultural productivity, ensuring efficient water management, and promoting environmental sustainability, irrigation systems contribute directly to the achievement of SDGs 2, 6, and 15. However, their success is contingent on addressing environmental, economic, and social challenges, particularly in developing countries. By adopting modern, efficient irrigation technologies, promoting capacity building for farmers, and ensuring equitable access to water resources, irrigation projects can contribute significantly to sustainable agricultural growth. Governments and international organizations must continue to support policies and programs that prioritize sustainability, ensuring that irrigation projects meet the needs of both present and future generations.



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