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Influence of Water Resource Availability on Agricultural Development and Productivity

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ABSTRACT

India is a major player in the agricultural sector, yet the country's water management is woefully inadequate. About 62% of its 195 MH of arable land is watered by rain, while 37% requires irrigation. Inefficiently, agriculture consumes 85% of the world's water resources. The impact of water resource fluctuations on irrigation methods, crop diversity, and farm production, as well as their regional and temporal variations, are analyzed in this study to determine the link between water availability and agricultural growth. The study shows that agricultural output and rural lives are greatly impacted by rainfall variability, groundwater loss, and surface water distribution inequalities.

Keywords: *Water, Rural, Irrigation, Rainfall, Groundwater.*

I. INTRODUCTION

Even though water covers more than two-thirds of Earth's surface, about 450 million people in 29 countries are suffering from a serious lack of water, and an additional three billion people will need at least 20% more water to sustain them. Due to its high salinity, nearly all ocean water is inaccessible to humans; another 2.49 percent is frozen solid; and finally, just 0.01 percent can be economically and technologically accessed for human use, whether from surface or underground sources. The current crop of water-saving technology is, thus, highly relevant for widespread user adoption. The agricultural sector accounts for a disproportionate share of the world's water use, despite water's centrality to environmental and biological support. For agriculture to continue growing and developing sustainably, water is essential. It used to be that conservation land treatments were the main reason people thought about rainfed agriculture when they wanted to prevent soil erosion and degradation. Water management for crop production should also include the possibility of collecting rainwater in regions that experience moderate to heavy rainfall; this water could then be used for irrigation or to irrigate crops in a way that prevents crop failure.

There is a distinction between the goals of water management in situations where there is an abundance of water available from perennial sources, such as lakes and rivers, and in situations where there is a limited supply, such as when rainwater is collected through structures. The first one relates to getting the most crop yield per area watered, while the second one says that you may get more agricultural productivity per area watered, even when you use rainwater for irrigation and manage it well. In order to achieve greater water usage efficiency and appropriate use of water resources, the agricultural growth of the country views both irrigation water and rainfall as equally crucial.

The nation's water resources are negligible in comparison to the world's overall water resources. An estimated 1500 million m3 of water makes up the hydrosphere. The seas and oceans contain nearly all of the Earth's surface. About half of the fresh water that makes up the other 5% is frozen, with the polar ice caps storing the other 4/5 in the form of permafrost. Water on Earth, including frozen and fresh, makes up a meagre 1% of the whole hydrosphere. Most of it, around 0.9%, is in the ground, while just a little fraction is in bodies of water like lakes, rivers, and the air. With a significant portion lying between 500 and 1,000 meters below earth, half of the world's freshwater is located below 1,000 meters. The cost of extracting water from these depths is high.

II. REVIEW OF LITERATURE

Rastogi, Mausmi et al., (2024) Water conservation practices in Indian agriculture: their influence and development, and how they're helping to promote sustainable resource management in the face of growing water shortages throughout the world. It starts by delving into conventional wisdom about water management, shedding light on its usefulness in the past and the challenges it faces in adapting to modern agricultural needs. We next move on to more contemporary approaches to water conservation, which include irrigation technology developments like subsurface irrigation, drip irrigation, and sprinkler systems, as well as agronomic practices that improve water efficiency, such as crop rotation, soil moisture management, and mulching. Precision agriculture is highlighted, with a focus on sensors and the Internet of Things (IoT) for water management, remote sensing, satellite imagery, and data-driven methodologies integrating artificial intelligence (AI), machine learning (ML), and decision support systems. The article delves into the significant impact of technology and innovation on Indian agriculture. It also looks at innovative solutions like solar-powered irrigation systems and hydrogel technology to retain water in soil.

Shang, Mingming & Xie, Jun. (2024) This paper systematically explores key areas of agricultural sustainable development, encompassing soil health and conservation, water resource management, biodiversity preservation, climate change adaptation and mitigation, and agricultural technological innovation. In terms of soil health and conservation, the paper discusses sustainable farming practices, nutrient management, and optimal use of agricultural chemicals to ensure the long-term agricultural productivity of the soil. The section on water resource management focuses on efficient water utilization, water-saving irrigation technologies, and strategies to prevent water source pollution. Biodiversity preservation emphasizes diverse planting in agricultural ecosystems and reducing disturbances to wild flora and fauna. The section on climate change adaptation and mitigation investigates adaptive strategies within agricultural systems to cope with climate change, the breeding of resilient crop varieties, and technologies and methods to reduce greenhouse gas emissions. Finally, agricultural technological innovation focuses on emerging agricultural technologies, including precision agriculture, digital management, and the development of sustainable agricultural practices. By integrating research in these areas, this paper provides a comprehensive framework for agricultural sustainable development, emphasizing its overall impact on soil, water resources, biodiversity, climate, and technology. This comprehensive study aims to offer valuable guidance for achieving the health, eco-friendliness, and socio-economic sustainability of agricultural systems.

Abdel-Qader, et al., (2021) A worldwide issue, water stress stems from an imbalance between supply and demand, which has far-reaching social and economic consequences. A decline in the amount of conveniently accessible, high-quality water at a reasonable price corresponds to an increase in water demand across all sectors. Since the turn of the millennium, numerous studies have pointed to the water crisis as the imminent doom for the Middle Eastern population. Of course, Iraq will be among the most hit hard by this water catastrophe, as the sources of the Tigris and Euphrates rivers lie beyond its borders and extend into neighbouring Turkey.

Kariznovi, Ali et al., (2021) Because water is one of the effective factors in agriculture and plays a crucial role in the production of agricultural products, agricultural education is an issue that should be thoroughly researched and given due consideration if sustainable agricultural and rural development are to be achieved. The country's poor water production is due to a number of issues, one of which is the widespread and inefficient use of water. Clearly, farmers can save money now, have more productive crops and orchards, and increase their revenue in the future by raising their knowledge of the best ways to manage agricultural water resources.

Zaman, Aftab et al., (2017) Maintaining agricultural output over the long run is dependent on preventing additional degradation of the land, water, and forests that support it. Agricultural production, land degradation, and water pollution may all be mitigated with better management of water resources. A more cautious approach to drainage and the management of water quantities via effective use of irrigation water may address salinisation, alkalisation, and water logging. This is necessary because water has to be given to growing crops at suitable times and in acceptable amounts. Efficient and optimal use of irrigation water is essential for integrated water resource management. When irrigation potential is developed to boost agricultural output, it must be used wisely and economically. The idea of rainwater management is an integral part of integrated water resources management and is critically crucial for the advancement of rainfed agricultural systems. For the continued expansion and growth of agriculture, it is especially pertinent to the installation of small-scale irrigation systems that rely on the participation of farmers in order to produce crops in a sustainable manner. When water is limited and traditional irrigation methods are not feasible due to terrain or soil conditions, it is recommended to use modern irrigation systems such as sprinklers and drippers.

Upadhyaya, Ashutosh (2016) efficient water management has to be tackled promptly in order to ensure sustained agricultural growth, since irrigation and drainage are complementary aspects of water management. The artificial application of water to crops, known as irrigation, has the potential to significantly increase agricultural yields when done properly, equitably, and at the right time. The majority of the time, there is either too much or too little water to irrigate crops to the necessary degree. Planners and policymakers should pay attention to accessibility and affordability as important problems if it is available. The phrase "Water Productivity," defined as yields per unit of water, is now being used by professionals in water management to describe yields in relation to water. Only by doing one of two things can water productivity is enhanced: either increasing yield while decreasing water consumption, or maintaining yield while decreasing water consumption. In order to do this, it is necessary to use modern and efficient water management technology in farmers' fields while considering their socio-economic status and other existing limitations.

Chartzoulakis, Konstantinos & Bertaki, Maria (2015) For sustainable agricultural growth on a global scale, water is the most important resource. In the future years, there will be a shift in water allocation away from agriculture and toward home and industrial uses, leading to an expansion of irrigated land. Irrigation is also inefficient since crops only absorb about 65 percent of the water that is applied to them. Agriculture in dry regions places a premium on the efficient and environmentally friendly use of irrigation water. Consequently, in response to water scarcity and climate change, several policies have been put in place to promote water efficiency. These policies are founded on the belief that more may be accomplished with less water if it is properly managed. Improving water allocation and/or irrigation water efficiency is a common definition of better management. While the latter is dependent on irrigation technology, weather, and water application schedule, the former is strongly tied to reasonable cost. Sustainable water management in agriculture and environmental protection are interconnected concepts in agricultural operations including pest and disease control, irrigation and fertiliser application, and soil management. Water resources for farming are becoming scarcer due to societal and environmental concerns.

III. WATER AVAILABLE FOR AGRICULTURAL PRODUCTION

Available Water

Water scarcity is already a problem in India, and the country is facing additional threats from climate change, massive waste caused in part by inefficient management, and unfair water price regulations. Water resources are plentiful in the Northern Ganga River Basin, but groundwater and surface water in the Southern River Basin are severely polluted. Both urban and rural regions are seeing a rise in the need for water, mostly for irrigation, due to population growth and changing lifestyles. Even though it only accounts for 4% of the world's fresh water, 80% of it goes toward farming, India is home to 18% of the world's population. The annual precipitation total for India is around four billion cubic meters. Surface and underground water sources in India only consume 48% of it. Only 18% to 20% of the water is actually used due to insufficient storage procedures, inadequate infrastructure, and improper water management. Seventy-five percent of India's yearly rainfall—roughly 1,118 millimeters—falls during the monsoon season (July through September). The outcome is water that runs off during the monsoon and necessitates irrigation investments throughout the year. There will be a greater need for electricity, water, and food as India's population is projected to reach 1.6 billion by the year 2050. We need to expand our infrastructure and make better use of our resources for this.

Water Availability in Different Regions of India

There are considerable regional differences in both the supply and demand for water resources across India. The distribution and use of water is both unfair and inefficient. In parts of India, when food production is low or water is scarce, over 90% of the population survives. Across much of India, groundwater has been plentiful. But it's quickly rising to the top of the list of resource crises in some areas.

IV. WATER AND AGRICULTURE

Groundwater and Surface Water Use for Agriculture

Global groundwater development (groundwater draw as a percentage of total availability) is 62%, however there is a great deal of regional variation. The groundwater table has dropped significantly, particularly in northwest India, due to human over-reliance on groundwater beyond sustainable level consumption. A total of 6,607 assessment units (Blocks, Mandals, or Talukas) have been classified as by the Central Groundwater Board, making up 16.2% of the total. Excessively used. Another fourteen percent have been classified as being in a "critical" or "semi-critical" condition. The northwest part of the nation is home to the majority of the blocks that have been overused. In order to increase water usage efficiency in the agriculture sector, demand control and supply augmentation techniques are necessary due to the unsustainable use of groundwater. However, there is more room to take use of groundwater consumption to boost agricultural yields in the eastern area, where it is used less extensively. Linking canals (using surface water): constructing storage reservoirs on rivers and linking them to other regions of the nation can reduce regional imbalances and offer numerous benefits, such as increased irrigation, water supply for homes and businesses, hydropower generation, improved navigation, and more.

Groundwater Utilization for Irrigation

Worldwide, groundwater supplies around 40% of irrigation water; in India, that number is projected to exceed 50%. Groundwater is notoriously difficult to monitor and control, particularly in underdeveloped nations, because to its common pool character and the difficulties of directly seeing it. Unsustainable extraction levels are surpassing natural recharge rates, leading to the depletion of groundwater supplies. Approximately 42 million hectares, or over half of India's irrigated land, is watered via underground sources. Central, state, and municipal administrations in India work together. Through the application of cutting-edge technology and the skilful coordination of all relevant parties, the Central Water Commission aspires to advance the integrated and sustainable development and administration of India's water resources. Their current projects include a system to track reservoir levels, monitor water quality in real-time, predict floods, manage river basins, build watersheds, and tackle significant problems, among others. The Central Ground Water Board was established with the goal of creating and sharing tools for the scientifically sound management of ground water resources, including their extraction, evaluation, conservation, enhancement, protection from contamination, and equitable and efficient use of both the natural and financial resources. As a result of collaboration between the two agencies, "General Guidelines for Water Audit and Water Conservation" was drafted. All of the state governments, relevant federal ministries, and other utilities have received these recommendations and are now working on their own unique sets of regulations.

Punjab, a state in northern India, is one of few that provides free power to pump groundwater. Solar pumps can be subsidised to a large extent in western Indian states like Maharashtra and Gujrat. There has been a significant subsidy on water sprinkler and drip irrigation systems in an effort to increase water consumption efficiency. Acute water stress is a persistent problem in several parts of the nation. Some of these regions in India are: South and North Interior Karnataka in the south, Andhra Pradesh's Rayalseema on the southeast coast, Maharashtra's Vidarbha and Marathwada in the west, Northern India's Bundelkhand region and Western Rajasthan in the north, and Madhya Pradesh in the centre. These regions have seen little and unpredictable rainfall for several years running, which has left water-harvesting infrastructure dry and conservation efforts almost non-existent. There is now a severe lack of potable water since reservoirs have run dry. Most of these regions have moisture indices between -85% and 50%, meaning that the amount of precipitation that falls naturally is insufficient to sustain agricultural production. Punjab, Uttar Pradesh (80%), and Uttarakhand (67%), among others, rely heavily on groundwater for irrigation (79% of the irrigated land is via tube-wells and wells). The Panchayati Raj system (PRC) was established in 1992 as the basis for local administration in India. There are elected bodies at the village, taluk, and district levels under the Panchayati Raj system. Policies at the federal and state levels have proposed a variety of programs to encourage efficient irrigation and water usage. Some members of the state administration were too excited, which led to inflated water costs and excessive water use. At the regional level, they fulfil a number of crucial roles in agricultural growth, including making decisions on irrigation services.

V. IRRIGATION AND AGRICULTURAL DEVELOPMENT

Donors and governments have long used concerns about food insecurity and rural development to rationalise water provision to farms. Following an analysis of these, this section provides a synopsis of key points of the new global agreement on water management policy.

Food Security

Compared to rainfed agriculture, irrigation allows for higher agricultural output. Global and, for certain nations, national food security depends on the increased agricultural output made possible by irrigation. Either achieving national food security (i.e., satisfying demand through local production) or achieving it through a mix of domestic production and imports are viable options. Maintaining one's own food supply was formerly a common goal, and it remains so for several countries today. It helps to save money in the currency market, shields local producers and consumers from the ups and downs of global markets, guarantees food supply in rural areas, and boosts political confidence in national security. Nevertheless, there are drawbacks to it. The overexploitation of groundwater resources is a potential consequence of self-sufficiency policies in dry nations, which involve increasing water allocations to agriculture at the cost of industrial and domestic water consumption. In addition, food supplies are susceptible to natural disasters, and when supplies are inadequate, imports are needed to fill the gap, which depletes already scarce foreign currency. Many nations have made food security a priority, with some assistance from imports, in response to issues including rising water shortages, shrinking arable land, and rapid industrialisation. To guarantee imports under fair trade conditions, however, sufficient control of international commerce in foodstuffs is essential to the achievement of this goal.

As the world's population and standard of living rise, so does the need for food. The developing world is bearing the brunt of the demand pressure, with projections showing a 2% annual growth in the demand for agricultural goods between 1999 and 2030. Dietary changes brought about by rising incomes, more urbanisation, and evolving tastes are significantly impacting food consumption in emerging nations. Livestock products, fruits, and vegetables are becoming increasingly popular among developing-world populations, whereas grains are becoming less popular. The expected rise in meat consumption per capita in developing nations from 1997/99 to 2030 is 44%. This, together with the inefficiency of the meat industry and the trend toward intensive animal production methods that rely on cereals rather than grazing, is driving up the need for grains like maize. The demand for grains is expected to expand by 70 percent in developing nations between 1997/99 and 2030, with half of that growth going toward animal feed. Producing grains relies heavily on irrigation. In 1997–1999, for instance, irrigated land accounted for over 60% of developing nations' cereal output. But it helps with other food items that are in high demand as well.

Nationally, improved agricultural production will mitigate, to varying degrees, the rising demand for food in developing nations. Between 1997–99 and 2030, yearly grain output is predicted to rise by 61%. The majority of this growth will come from irrigated crops, with the possibility of rainfed crops playing a larger role in regions like Latin America and sub-Saharan Africa. In addition to reducing or preventing agricultural water stress, irrigation boosts yields through the synergistic effects of using it in conjunction with high-yielding cultivars, fertilisers, and pesticides (the so-called "green revolution" technology). In 1995, the cereal yields in developing nations were 135 percent higher than the rainfed yields, while in sub-Saharan Africa and West Asia/North Africa, the difference was 150 percent. While developing-world irrigated grain yields are rising, it's a slower rate of 1.2% per year compared to the 1.9 percent per year increase from 1982 to 1995.

We anticipate that between 1997–1999 and 2030, irrigated cereal yields in developing nations would rise at a rate comparable to rainfed cereal yields (0.9 percent vs. 0.8 percent, annually, respectively). Absolute increases will be larger for irrigated grains due to their higher beginning yields. Developing nations as a whole may anticipate a 1.4 tonne/ha rise in irrigated cereal output between 1997/99 and 2030, compared to a 0.5 tonne/ha increase for rainfed cereals. High and growing crop yields are two reasons why irrigation is expected to play a major role in future food production.

A further benefit of irrigation is that it allows for the growth of the cultivated area, which in turn increases production. While there was a lot of regional variances, in 1997–1999, 21% of developing nations' arable land was irrigated. As a percentage of total arable land, irrigation covered 39% in South and 31% in East Asia, 30% in the Near East and 30% in North Africa, and a meagre 2% and 9% in sub-Saharan Africa and Latin America (including the Caribbean), respectively. It is anticipated that emerging nations would account for the majority of the additional irrigated land. The most significant projected gains in irrigated arable land area from 1997/99 to 2030 are expected to occur in Asia, with South and East Asia each seeing an increase of 14 million hectares. Despite substantial percentage increases (of 40 and 22 percent, respectively), the projected expansion of the irrigated arable land in sub-Saharan Africa and Latin America is quite modest (an extra 2 and 4 million hectares, respectively). There was a 100 million hectare increase in irrigated land in developing nations between 1962 and 1998, an increase of 2 percent annually. Nevertheless, compared to the net growth attained between 1960 and 2000, the rise in irrigated land in developing nations from 2000 to 2030 is projected to be 60% smaller. A third of the growth rate attained between 1960 and 2000 will be accomplished in the irrigated area in the next years, at 0.6% per annum. Collectively, emerging nations will be able to offset the slowdown in irrigated arable land development to a certain degree by increasing the amount of arable land used for rainfed crop production. So, compared to 1997–1999, the proportion of total cereal land irrigated in 2030 will be rather stable. Irrigation will cover 22% of the total arable land in emerging nations.

Warming deserts will decrease agricultural production potential and more climatic variability will increase the frequency and severity of crop water stress, two ways in which climate change is anticipated to impact agricultural output in developing nations. The national susceptibility to food insecurity will rise, and there will be more localised variations in crop output and food supply, which will have a disproportionate impact on low-income households' food budgets and food supplies. The consequences may not fully materialise for certain areas until well into the future. With everything else held equal, this would put an additional 10 million people in danger of going hungry.

In many developing nations, food imports are necessary to varied degrees since native production cannot meet the demand for food. Producing cereals met 91% of developing nations' grain demand in 1997–1999, which was 1,026 million metric tonnes. Regional extremes are, however, concealed by this aggregate. The demand for cereal in the Near East and North Africa was met by producing 63% of what was needed. It accounted for 82% of demand in Latin America (including the Caribbean) and 82% in sub-Saharan Africa, while output fulfilled 95% and 102% of demand in East and South Asia, respectively. There will likely be a greater reliance on imported goods. Forecasts indicate that by 2030, grain imports will have increased from 9 percent of demand in developing nations in 1997/99 to 14 percent.

Poverty Alleviation

Investment in irrigation projects may stimulate the rural economy and, indirectly, reduce poverty if done in the right setting and with the right planning (such as the provision of training and loans). Food security and poverty alleviation goals, rather than immediate financial gain, were at the heart of many Asian Green Revolution-related large-scale projects. There are still this idea and this practice. As the IFAD "Report on Rural Poverty 2001" makes very apparent, under the right policy and institutional conditions, impoverished people may reap the direct advantages of irrigation projects. Irrigation boosts the rural economy's agriculture sector in a roundabout way, even if it isn't deliberately aimed at low-income beneficiaries. This is because irrigation increases demand for agricultural inputs, such as agricultural labour, the services of local artisans who make tools and equipment, seed, and fertiliser, and the marketing of more produce. Many non-agricultural products and services, including as meat, processed foods, clothing, and bicycle maintenance, are sold only locally and can be provided by resource-poor individuals. This means that as wages in farming communities increase, demand for these goods and services might rise as well. As a result, if the current asset distribution is not excessively unequal, the stimulation of non-farm earnings can help alleviate relative poverty and, eventually, absolute poverty in rural regions.

The local populace, farmers' families, and farmers themselves may all reap the nutritional benefits of greater food production through irrigated agriculture. Through the use of irrigation, it is possible to cultivate more than one crop at a time, which helps to even out food supply fluctuations caused by the seasons and promotes the growth of foods that are better for human health. Better nutrition has several positive effects, including raising life expectancy, decreasing sickness rates, increasing productivity in the workplace, and boosting academic achievement in children. The urban poor can also gain from irrigation agriculture as it helps to keep food prices down even as population increases. The impoverished would be hit the hardest by this trend since they spend a disproportionate amount of money on food. If irrigation investment continues to fall, global grain prices might rise.

Parasitic illnesses and diseases carried by water-related vectors, such malaria, can negatively affect the health of rural families due to irrigation. This is especially true in relation to canal distribution systems and flood irrigation. The economic advantages of irrigation might end up going to affluent farmers in an unfair setting, for example one where land is not divided equitably, which would just serve to exacerbate existing wealth and resource disparities. The extent to which irrigation benefits low-income communities is highly dependent on the policy and institutional settings.

International Consensus in Water Policy: Water as An Economic Good

A worldwide agreement on water management has developed as a result of increased environmental consciousness, dissatisfaction with previous attempts, and rising worries about the effectiveness of the allocation of public and donor funds. One example of a policy that reflects these concerns is the European Community's water policy, also known as the Water Framework Directive. This directive emphasises the need to incorporate economics into planning and decision-making processes and advocates for the use of water pricing and charging to reduce resource depletion. There has been a shift in the development cooperation agenda, which has affected the policy consensus. This shift has led, among other things, to a closer look at institutional reform, participation, and the role of the private sector and civil society.

At the heart of the water policy consensus are three agreements: (i) the "Dublin Principles," a set of important recommendations reached at the International Conference on Water and the Environment in 1992; (ii) the freshwater resources chapter of Agenda 21, an action plan agreed upon at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, which included adoption of the Dublin Principles for rural water resource management; and (iii) the 2002 World Summit on Sustainable Development in Johannesburg, which reaffirmed the 1992 "Dublin Principles" and emphasised water availability as a key concern and objective.

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Everyone agrees that water resources should be considered holistically and that water consumption should be seen from several sectors, at least on a watershed scale. All of these factors—economic efficiency, environmental preservation, sustainability, and the needs of the poor and marginalized—are taken into account when thinking about water management. The requirements of the community should drive decision-making, which should engage users—especially women—and their participation. It is imperative that water sector investments be fiscally sound, socially acceptable, and long-term viable.

Water policy is widely agreed upon, but how exactly to put such changes into action is a hotly contested topic. It is acknowledged that the primary obstacle facing managers is not an idealised picture of integrated water resource management, but rather a "pragmatic but principled" strategy that acknowledges the highly political nature of water resource management and calls for the formulation of prioritised, sequential, realistic, and patient interventions in order to bring about change.

A crucial component of water management decisions is sustainability, as mentioned before. But there are a variety of ways to operationalise sustainability because the phrase is subjective. The two approaches, weak sustainability and strong sustainability, are differentiated by the degree to which they allow for some wiggle room in the definition of sustainable.

For a system to be sustainable, the amount of capital accessible to future generations must be equal to the amount available to us now. In this context, capital is the total amount of resources (both physical and digital) that may be mobilised to produce commodities and services that improve people's standard of living. Here are the several ways capital may be categorised based on whether it is used up in the creation of products or services:

- Human-caused capital, such as buildings, roads, and industries. You have the freedom to adjust this to your liking.
- The ozone layer, biodiversity, and water are examples of essential natural capital. This is fundamental to human survival and cannot be supplanted or replaced by capital that humans have created.
- Non-essential natural capital, which comprises a portion of renewable and a portion of finite mineral resources. Capital created by humans can supplant or even completely replace this.

Weak sustainability presupposes that natural and human-induced capital are interchangeable and calls for the maintenance of the complete stock of both. An increase in price when a resource's supply decreases motivate people to utilize it more wisely, find alternatives, and develop better technologies. There are some types of capital for which there are no suitable alternatives (such as crucial natural capital) or which are inadequate (like in the case of complex ecosystems), therefore full replacement may not be feasible or even feasible.

The overall pool of natural capital must not be drained in order for there to be strong sustainability. Both natural and human-induced capital are seen as complementary rather than interchangeable, and it is necessary to keep both types of stock. As a result, environmental protection measures are necessary, or else' shadow projects will have to be implemented to make up for any losses. Most development initiatives have some kind of impact on the environment, hence using a high sustainability criterion would probably lead to their complete rejection. The use of project suites intended to contain components that produce net environmental advantages, however, can circumvent this rejection. By embracing this strategy, market-oriented decision-making may continue even in the face of strict sustainability regulations. One program that exemplifies a significant necessity for sustainability is the United States' wetland mitigation strategy. In the event of a wetland's loss, the policy mandates its replacement with a wetland of comparable physical quality. Nevertheless, the policy's implementation has been fraught with difficulties. Some examples of these include problems specific to the area and its interactions with the environment, as well as the need for a reliable metric to assess the physical condition of wetlands.

VI. CONCLUSION

The agricultural industry in India is currently feeling the effects of the country's diminishing water supplies. Water scarcity is a problem in several parts of the nation. The nation may face water shortage in the next one to two decades unless water usage efficiency is improved. Making the most of existing technology and resources to improve water usage efficiency is crucial for the agricultural sector to help stop the problem from getting worse. It is important to think about ways to improve water usage prevention policies, methods, and regulations. In the face of water shortage, the nation may benefit by raising awareness and orienting agricultural water users to adopt more water-efficient production practices.

REFERENCES

1. Abdel-Qader, A., Zidan, A., Abdel-Elah, H., Qassem, D., & Ali, S. (2021). The role of efficient use of water resources in achieving agricultural development and food security in Iraq. Al-Noor International Conference for Science and Technology, 2(8), 2–15.
2. Chartzoulakis, K., & Bertaki, M. (2015). Sustainable water management in agriculture under climate change. Agriculture and Agricultural Science Procedia, 4(8), 9–16.
3. Ingrao, C., Strippoli, R., Lagioia, G., & Huisingh, D. (2023). Water scarcity in agriculture: An overview of causes, impacts and approaches for reducing the risks. Heliyon, 9(1), e12345.
4. Kalogiannidis, S., Kalfas, D., Giannarakis, G., & Paschalidou, M. (2023). Integration of water resources management strategies in land use planning towards environmental conservation. Sustainability, 15(21), 15242.
5. Kariznovi, A., Jafari, H., & Alizadeh, K. (2021). The role of water resources management in reducing the production costs of agricultural products. Propósitos y Representaciones, 9(8), 2–15.

6. Mahato, A., Upadhyay, S., & Sharma, D. (2022). Global water scarcity due to climate change and its conservation strategies with special reference to India: A review. Plant Archives, 22(1), 1–10.
7. Makanda, K., Nzama, S., & Kanyerere, T. (2022). Assessing the role of water resources protection practice for sustainable water resources management: A review. Water, 14(19), 3153.
8. Maurya, D. K., Maurya, S. K., Kumar, M., Chaubey, C., Gupta, D., Patel, K. K. & Yadav, R. (2024). A review on precision agriculture: An evolution and prospect for the future. International Journal of Plant & Soil Science, 36(5), 363–374.
9. Mishra, S., Kumar, R., & Kumar, M. (2023). Use of treated sewage or wastewater as irrigation water for agricultural purposes: Environmental, health, and economic impacts. Total Environment Research Themes, 6, Article 100051.
10. Molden, D., Frenken, K., Barker, R., De Fraiture, C., Mati, B., Svendsen, M., & Giordano, M. (2007). Trends in water and agricultural development. In Water for food, water for life: A comprehensive assessment of water management in agriculture 3(2) 122-125.
11. Molossi, L., Hoshide, A. K., de Abreu, D. C., & de Oliveira, R. A. (2023). Agricultural support and public policies improving sustainability in Brazil's beef industry. Sustainability, 15(6), 4801.
12. Nikolaou, G., Neocleous, D., Christou, A., Kitta, E., & Katsoulas, N. (2020). Implementing sustainable irrigation in water-scarce regions under the impact of climate change. Agronomy, 10(8), 1120.
13. Piñeiro, V., Arias, J., Dürr, J., Elverdin, P., Ibáñez, A. M., Kinengyere, A., ... & Torero, M. (2020). A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes. Nature Sustainability, 3(10), 809–820.
14. Raimondi, A., Quinn, R., Abhijith, G. R., Becciu, G., & Ostfeld, A. (2023). Rainwater harvesting and treatment: State of the art and perspectives. Water, 15(8), 1518.
15. Rastogi, M., Kolur, S. M., Burud, A., Sadineni, T., Sekhar, M., Kumar, R., & Rajput, A. (2024). Advancing water conservation techniques in agriculture for sustainable resource management: A review. Journal of Geography, Environment and Earth Science International, 28(2), 41–53.
16. Russo, T., Alfredo, K., & Fisher, J. (2014). Sustainable water management in urban, agricultural, and natural systems. Water, 6(12), 3934–3956.
17. Shang, M., & Xie, J. (2024). Agricultural sustainable development: Soil, water resources, biodiversity, climate change, and technological innovation. Advances in Resources Research, 4(8), 181–204.
18. Upadhyaya, A. (2016). Water management and agriculture development. Irrigation & Drainage Systems Engineering, 5(8), 9–15.
19. Zaman, A., Zaman, P., & Maitra, S. (2017). Water resource development and management for agricultural sustainability. Journal of Applied and Advanced Research, 2(5), 73–79.