Innovations

Groundwater Depletion, Food Security and Power Utility in Saharanpur District of Western Uttar Pradesh in India – A Study of Water-Energy-Food Nexus

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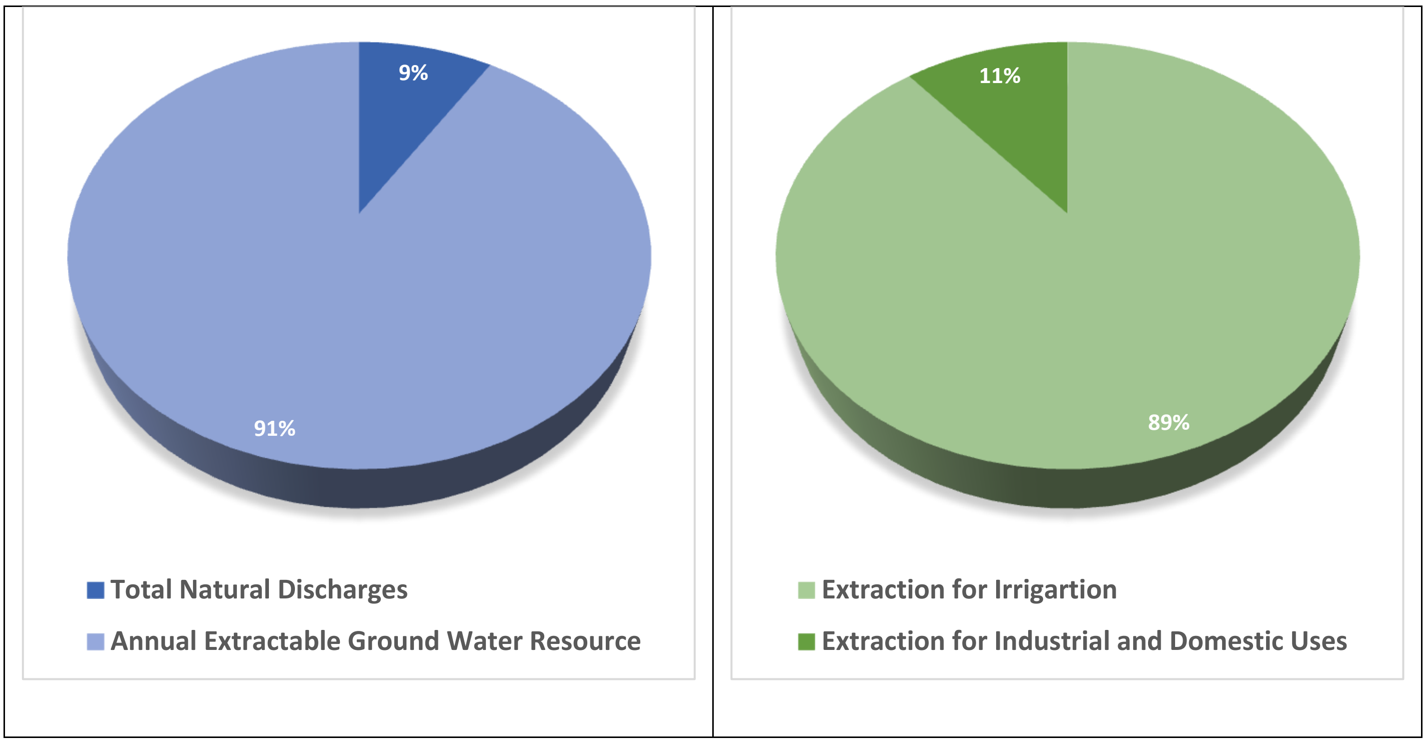
Abstract: *Groundwater depletion has become a serious issue in India as it is the greatest consumer of groundwater in the world. Irrigation in agriculture is a major reason for groundwater extractions in India. The increase in food production due to intensive groundwater pumping and energy usage is linked with treadmill of production theory. Hence, the core objective of the paper is to examine the interlinkages between groundwater depletion, food security, and power subsidies in western Uttar Pradesh through water-energy-food nexus approach.This study sheds light on the problems in the irrigation system and suggests possible solutions which can be carried out by the government and the individual farmers at ground level. The mix of quantitative and qualitative methods such as interviews of farmer and stakeholders were conducted along with Case Studies, Cases, Focused Group Discussions, and Participatory Rural Appraisal to make the studyevidence-based.*

Keywords: *Groundwater depletion, food security, power, treadmill of production, water-energy-food nexus*

Introduction

Groundwater has become essential for sustenance and drinking water in India. The agriculture sector is the major consumer of underground water in India. The estimated total annual groundwater extraction for the complete nation in 2020 was 244.92 billion cubic metres from which about 89 percent of total annual ground water extraction, was used for irrigation (Central Ground Water Board, 2020).India accounts for 17 percent of the world's population with a share of 2.4 percent of land and 4 percent of the water resources (Jain et al., 2020). As a result, effective consumption of present water resources is vital for India. In addition, the per capita availability of water in the country will decrease from 1434 cubic metres in 2025 to 1219 cubic metres in 2050 falling into water constrained category[1](Central Water Commission, 2021). Thus, there are substantial social and economic repercussions that could result from ongoing poor or nonexistent groundwater management. The relationship between deteriorating groundwater and food production is inversely related and groundwater extraction for irrigation purposes has been increasing continuously with increased production.

Figure 1: Ground Water Resourcesand Extraction PercentageinIndia (2020)



Source: Central Ground Water Board (2020)

India is the world's greatest consumer of groundwater (Garduño et al., 2011). In the past few decades, tube wells have become substantially more popular than tanks, canals, and other types of wells. This expansion is driven by insufficient public irrigation, new pump technologies, the adaptability and reliability of groundwater supply, and government subsidies for electricity. In the agricultural sector, the increased use of tube wells for groundwater extraction is accompanied by decreased

1 . *The per capita water availability is determined by dividing the average amount of water available each year by the number of people. If the per capita availability is less than 1700 cubic metres (cum), then it is called a water stressed condition. If the amount of water per person drops below 1000 cum, then it is called a water scarcity condition.*

surface water usage and increased electricity consumption. In 1960-1961, when the green revolution was established, nearly 29 percent of the land area was irrigated with groundwater through tube wells which has increased to nearly 62 percent in 2019-2020 (Directorate of Economics & Statistics, 2023). Population growth and food security have increased the pressure on water resources. Also, power subsidies have a significant impact on agricultural production and groundwater. This has a negative impact on agricultural production, but power subsidies are still in existence because political parties exploit them to gain local electoral control (Chaudhuri & Roy, 2018). Nevertheless, removing electricity subsidies or enforcing stringent groundwater rationing could cause food shortages (Zaveri et al., 2016). Consequently, the issues of food security, water conservation, and energy subsidies must be addressed collectively to assure optimal social outcomes.

Understanding Groundwater Exploitation in Western Uttar Pradesh through Treadmill of Production Theory:

The usage of groundwater for irrigation purposes is a concern in Uttar Pradesh. It is the most populated state in the nation, which is in the fertile plain of Indo Gangetic region. The economic backbone of the state is agriculture. It is divided into four zones namely, Bundelkhand, Central, Eastern, and Western zone. These four zones have varying levels of rainfall, groundwater supply, and other issues depending on their environment. The land composes of alluvial deposits which makes the state a good reservoir of aquifer systems (Deo et al., 2015). But still, it faces the increasing extent of groundwater depletion as groundwater is easily accessible to people. The state's agriculture relies on groundwater to a greater extent. Groundwater supplies most of the state's drinking water and industrial water, resulting in rising abstraction and declining water levels in rural and urban regions. Hence, Uttar Pradesh is considered as an important site for studying groundwater depletion in agriculture.

The treadmill of production theory provides a framework in analyzing and understanding the role of technological modernization resulting into groundwater depletion. The treadmill effect is supported by an income-subsidy relation (Sanderson & Hughes, 2019). Expanding irrigation technologies such as water pumping machines, for which farmers receive subsidies has a major impact on the resource depletion. Despite extensive awareness of the issue and significant financial commitments towards it, the unsustainable use of groundwater for such a long duration raises significant concerns about the mechanisms driving groundwater depletion. According to the treadmill of production theory, capital owners compete with one another for profits through ecological consumption (groundwater use) (Schnaiberg,1980). Capital owners are driven by competition to apply capital-intensive technology, which in turn drives up demand for natural resources (Gould et al., 2004). In western Uttar Pradesh, the capital owners are the farmers who are driven by the market to produce more yield (majorly sugarcane) by using pumping machines resulting into more demand of groundwater use and its exploitation. Hence, resulting into treadmill of increase in capital intensity, production, and depletion of the environment.

Table 1: Groundwater Resources in Different Regions of Uttar Pradesh (2011 Data)

Region	Annual groundwater availability (Ham)	Groundwater draft for irrigation (Ham)	Draft for industrial/ domestic water use (Ham)	Gross groundwater draft (Ham)	Net Groundwater available (Ham)	Groundwater development (%)
Bundelkhand	4.55	2.08	0.21	2.29	2.01	50.35
Central	15.10	9.85	0.67	10.52	3.63	69.69
Eastern	26.48	16.45	1.92	18.37	6.01	69.36
Western Uttar Pradesh	**25.53**	**20.36**	**1.24**	**21.60**	**3.21**	**84.60**
Total	**71.66**	**48.64**	**4.04**	**52.78**	**14.86**	**73.65**

Source: (Sinha et al., 2016)

As compared to other areas of the state, western Uttar Pradesh has high development of irrigation facilities and high cropping intensity (Rehman & Lata, 2022). Farmers in the western region of the state largely cultivate sugarcane which lowers the proportion of cultivated area for food grains. The state experiences less rainfall than the national average, but western Uttar Pradesh saw a bigger drop than other parts of the state (Deo et al., 2015). The cropping intensity is high due to usage of canal water and groundwater which is resulting into rapid groundwater depletion. The reason for choosing Saharanpur district in Uttar Pradesh as a field of study is the high usage of private tube wells and increased cropping intensity in the area. More than 75% of the reporting area in Saharanpur district has been under cultivation, which is higher than the percentage of net cultivated area at the state level (Central Ground Water Board). The district's total irrigated area is 375604 acres, with ground water resources providing irrigation for around 84 percent of that area (Central Ground Water Board). The groundwater levels are declining at an alarming rate due to the current trend of overexploitation brought on by the increasing population, industrialization, irrigation, and less rainfall.

Objective and Methodology

Objective:

Agriculture in western Uttar Pradesh, is charactarised by intense cropping and major exploitation of groundwater. In this context, the present paper assesses the relationship between groundwater depletion, food security, and power subsidies. This article uses water-energy-food nexus approach to look at the current issues holistically in the Indian agriculture at district level in western Uttar Pradesh and identifies the possible gaps in its approach. The main objectives of this research are: firstly, to highlight the major issues that are currently faced in agriculture sector of western Uttar Pradesh; second, to analyse the relationship between groundwater irrigation and cropping pattern; and third, to examine linkages between groundwater usage and power utility. The paper draws attention on the great paradox of agricultural practices in western Uttar Pradesh along with the power subsidies which is leading to groundwater depletion. Further, there are some insights drawn from the site of field study based on the objectives mentioned above. The last section of the paper presents discussion on possible solutions required in the region and suggests the way forward in order to have an effective water management through water-energy-food framework in agriculture sector.

Methods:

Saharanpur district was intentionally picked from among the thirty districts in Western Uttar Pradesh. The area has a system of canal network, privately owned tube wells, sugar plants, and regulated markets. In the district of Saharanpur, groundwater irrigation governs 85.66 percent of the area (Central Ground Water Board). The district's most significant cash crop is sugarcane, followed by wheat, rice, and mustard. In general, the district has a high level of groundwater depletion, as evidenced by the fact that out of 11 blocks, five blocks are classified as over-exploited, four as critical, one as semi-critical, and only one as safe[2]. The district currently and in future will be vulnerable to several environmental threats which will affect the level of water, such as depletion of groundwater, reduction in the output of bore wells, failing of shallow wells, resulting into increase in the cost of withdrawing water from wells with greater depths. Increase in depths of the wells will also result in increasing the power consumption for pumping water to greater heights.

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2 . *The status of groundwater extraction is generally classified by percentage. It is calculated as the ratio of annual groundwater extraction to annual extractable groundwater resource. Based on the state of extraction, the assessment units are categorized as Safe (<= 70 %), Semi-Critical (>70 % and <=90 %), Critical (>90 % and <=100%) and Over-Exploited (>100 %).*

Agriculture in Western Uttar Pradesh: Issues:

Western Uttar Pradesh is an area with major agricultural importance, making a large contribution to the agrarian economy of the nation. This region faces crucial agricultural problems, which limits its potential for development and sustainability. The issue of water scarcity and poor management is one of the biggest issues that the region's agriculture must deal with. Due to its heavy reliance on groundwater for irrigation water tables are declining fast which will eventually affect agricultural production. Inadequate irrigation systems and an inequitable allocation of water resources makes the issue worse and results in uneven agricultural yields. Also, there is issue of land fragmentation (Singh & Singh, 2003). The fragmented plots make efficient use of mechanisation,constraining the potential for greater productivity and profitability. The major issue of groundwater exploitation in western Uttar Pradesh exists due to several reasons. Groundwater is easily accessible and more productive than surface water. Groundwater irrigation is replacing the surface irrigation due to large electricity subsidies and groundwater pump set funding which is leading to water table depletion (Smilovic et al., 2015). Hence, a multifaceted strategy is required to solve these problems.

Table 2: Groundwater Resource Availability in Uttar Pradesh and Assessment for Future

Year	1975	1990	2000	2009	2013	2025	2050
Total Groundwater Recharge (mhm)	7.05	6.41	8.08	6.85	7.16	7.00	7.00
Total Groundwater Draft (mhm)	2.63	2.64	4.22	4.94	5.28	6.55	9.20
Total Groundwater Availability (mhm)	4.42	3.77	3.86	1.91	1.88	0.45	-2.20

Source: (Singh, 2020)

Further, the Indian property rights combine groundwater ownership with land ownership, turning the groundwater resource into private property and giving landowners substantial authority over groundwater and barring landless users (Subramanian &Bhalachandran, 2013). This arrangement favors wealthy landowners who can drill deeper wells or pollute groundwater. Climate change is the other factor which affects rainfall frequency and local ecology impacting the groundwater (Shah, 2009). These changes increase the risk of floods and droughts for crops. Also, the legal framework related to groundwater is complex in India. The State List manages within state water resources, while the Union List manages interstate water resources. The law considers groundwater as part of irrigation or water distribution.

Groundwater becomes a state concern, making interstate aquifer management difficult. The Easement Act of 1882 states groundwater as a private property (Subramanian &Bhalachandran, 2013).

Furthermore, the 1986 Environment (Protection) Act established groundwater management to monitor groundwater and surface water resources, encouraging rainwater collection, etc. (Pandey et al., 2022). Later, the Central Ground Water Authority (CGWA) was founded. The State governments usually adopted the central government groundwater management model bills which was passed in 1970 and revised in 1992, 1996, 2005, and 2011 (Pandey et al., 2022). Presently, each state governments have their own groundwater management laws and policies. The state government of Uttar Pradesh adopted water policy in 1999 that placed a large emphasis on irrigation related water utilization to increase food production (Verma &Dimri, 2020). This resulted in decrease of underground water significantly in the state. To address the state's ongoing water conservation challenges, the policy for groundwater management, rainwater harvesting, and groundwater recharge was promulgated in 2013. Further, the Groundwater (Management and Regulation) Act was created in 2019 in the state to ensure effective groundwater management involving the coordination of panchayat and municipalities (Verma &Dimri, 2020). Hence, the management of groundwater becomes very difficult in India.

Groundwater Irrigation in Western Uttar Pradesh:

Irrigation is an essential component of modern agriculture. The utilization of groundwater has resulted in numerous benefits for people but is damaging the environment. Its development has led to significant increases in farm incomes, including for impoverished farmers (Smilovic et al., 2015). Groundwater can be tailored to specific crops, thereby conserving irrigation water and minimize distribution losses in the form of evaporation and seepage. Also, small scale farmers can develop groundwater systems at a lower cost than surface water systems. Hence, groundwater development through contemporary water extraction mechanisms has received increased attention. This is noticed in western Uttar Pradesh where sugarcane is the most important cash crop grown which requires intensive irrigation (Sinha et al., 2016). The fixed cropping pattern of cash crops in the area is the major reason for groundwater depletion. Thus, there is a direct relation between groundwater exploitation and food production which is adversely affecting the environment.

Almost one-fifth of the nation's total production of food grains (cereals, millets, and pulses) is contributed by Uttar Pradesh (Department of Economics and Statistics, 2019). The flow rates of tube wells are decreasing due to groundwater depletion.

Hence, farmers need to run their wells for longer periods of time to supply crops with water. The decline in dependance on centralized surface reservoir and the growth of the independent peasant, often known as the Bera of atomistic irrigation, are the main reasons of increasing dependency on tube wells (Shah, 2009). It is noticed that over the past few decades, irrigated area has grown steadily. India pumped 245 billion cubic meters (bcm) of groundwater for irrigation in 2011, which is equal to 25 percent of the entire amount drained worldwide that year (National Aeronautics and Space Administration, 2017). Population strain on Indian farmland increased steadily in the 20th century, and growing the cropping intensity was the one way to improve carrying capacity. This demanded irrigation for the whole year.

Hence, the tube well technology was discovered by the British engineers in the Indo-Gangetic basin. United Provinces (now Uttar Pradesh) intensively promoted groundwater irrigation in the 1930s (Kahnert& Levine, 1993). Between 1964 and 1966, India suffered three consecutive droughts and became dependent on US food aid (Shah et al., 2012). Irrigation was a key component of the Green Revolution technology to increase agricultural output. The ability to cultivate more than one crop each year was made possible by improvements in irrigation infrastructure (Jain et al., 2020). Governmentspromoted tube well irrigation and subsidized the capital cost of power supplyin the Indo-Gangetic plains. But the private ownership of the tube wells and water extracting devices became primarily restricted to large farmers (Singh & Singh, 2006). Smallfarmers, purchase irrigation water from wealthy landowners. This has led to emergence of informal groundwater markets which is advantageous for both parties, as the buyer purchases water from the proprietor at half the cost, but leads to severe groundwater depletion.

Groundwater and Power Utility:

The current increase in groundwater use for agriculture in India is primarily due to the availability of power subsidies for affordable groundwater pumping devices. The initial goals of the power subsidies were to boost agricultural production, lessen the poverty, and ward off the threat of famine. The strong foundation of the Green Revolution in India has been attributed to the subsidies and groundwater usage (Bhamoriya& Gandhi, 2011). But as the economy has changed, the subsidies have not, which has resulted in groundwater exploitation and burden on the exchequer.During the 1960s and 1970s, centrifugal pumps engines running on diesel were broadly used throughout India (Shah et al., 2012). Diesel pumps, however, ceased to function as the depth of the groundwater level increases, farmers electrify their wells as after a certain depth, diesel engines become ineffective (Shah, 2009). This increased the need for more electricity connections. Particularly in the months leading up to

assembly elections, political leaders catered to this need which resulted in depletion of aquifers (Dubash, 2007).
Deepening of the tube wells and increasing horse power of the water extracting machines above the approved load became the norm in the western Indian alluvial aquifers of Rajasthan, North Gujarat, Haryana, Punjab, and Western Uttar Pradesh, favoring rich farmers and excluding the poor (Sarkar, 2011). For farm power supply, the switch from a metered tariff to a flat tariff sparked a significant domino effect that radically altered the irrigation system in India (Mukherji, 2022). The flat power rate has decreased the low cost of pumping groundwater to almost zero, making farmers relying on the subsidies and expecting waiver off with each election.There are 20 million wells in existence out of which 73 percent runs on electricity, accounting for almost 18 percent of all electricity used in India (Government of India, 2017). Agriculture in Uttar Pradesh now receives power at a flat rate after a revision in September 2019 under Uttar Pradesh Power Corporation Limited (UPPCL) (Kishore et al., 2021). There are two alternatives available to farmers for electricity payment in Uttar Pradesh, either a fixed cost or the installation of a metre for agricultural electricity use.
Inefficient distribution and inadequate voltage supply causes motor and transformer burnouts in result of which, the farmers install larger motors which increases the maintenance cost. This affects the revenues of State Electricity Board's (SEB) declining their financial performance and reducing funds for new initiatives, maintenance, and distribution (Shah et al., 2012). Growing power shortages started to have an adverse effect on the expansion of the industrial and service sectors influencing the entire economy. To make up for agricultural losses, SEBs raised electricity prices for non-farm clients (Mukherji, 2022). Thus, to reduce overall farm power use, SEBs started lowering the number of hours for which three-phase power was available while still retaining single-phase or two-phase electricity for the rest of the day (Shah et al., 2012). It was assumed that while household users could run their appliances on single- or two-phase power, electrical pumps for irrigation could not be operated on anything below a three-phase power source. Hence, this had a negative effect on other institutions which depended on three phase power.

Observations and Findings from the Study:

The insights from the field in Saharanpur district from western Uttar Pradesh are aligned based on the three objectives discussed before in the article. Firstly, the major issue that farmer's face is that the production costs are high and returns are low. Due to this, many farmers are in debt. They depend on cash crops, especially sugarcane, because there is a sugar factory in the district to sell their produce. At the grassroot level, politics affects voting and other social, cultural, and political events. Under the government subsidies, farmers have adopted drip or sprinkle method of irrigation. However, due to the high water needs of sugarcane and rice, only some farmers employ it at the ground level. Further, the agricultural practices in the district are leading to stressful situations for the environment as the government sources of canal are not enough to fulfil the irrigation demand. The minor canals are not updated and levelling of land is disrupted. Therefore, people are shifting towards private tube wells for irrigation.Presently, the wells must be dug up to 210 feet in the area to avail groundwater.

It is noticed that previously tube wells were restricted to few rich farmers but now due to subsidy and low cost, most of the farmers are shifting towards private tube wells. Further, the farmers who do not have tube wells and due to lack of canal irrigation take water through rent from the tube well owners. Thus, there is existence of informal water markets in the area. The informal water trade rate varies from Rupees 30 to 50 per hour. There is existence of power relations and asymmetries which are built due to water usage and trade. Secondly, in the last 40 years, the cultivation practices have changed totally as earlier there was subsistence agriculture practice with mixed and diversified cropping pattern. They were mostly dependent on rain water and up to some extent canal water in the command area for irrigation. Use of chemical fertilisers and pesticides was almost negligible. But with time these crops have reduced into four major crops i.e., sugarcane, wheat, rice, and mustard. Also, there is a practice of deep irrigation done overnight rather than surface irrigation in the area. This highly affects the groundwater level and there is a need to change the mindset of the farmers in terms of utilisation of water for irrigation.

Thirdly, the subsidized rates of electricity in agricultural practices affect the electricity companies. The charge of electricity is Rupees 5.54 per unit in the area but for farmers it is highly subsidized costing less than 1 Rupees per unit. The approximate bill for farmers is Rupees 650 per month but if not paid on time it leads to 18% surcharge, totaling to approximately 20,000 Rupees annually. It was observed that most farmers were unaware that their electricity bill is generated monthly and the monthly bill payers receive a 50 percent refund. The farmers usually pay their bills in March because the power department runs a bill submission campaign and waives interest. Also, farmers obtain sugarcane mill payments in this month after selling their sugarcane yield, making March bill payment easier. The bill payment is not done by many as there is a mindset that the bills will get waived off for political vote bank during the time of elections. This has resulted in high interest on the electricity companies.

But the farmers are also stuck in this situation as the cost of production is high and many times even the crops get destroyed due to heavy rainfall, insects, etc. Hence, they are also in loss and cannot pay their bills for electricity. If the production cost is reduced and farmer gets good returns for their crops then the situation can be balanced. There is need of crop rotation and shift from cash cropping and double cultivation to save the environment. Further, the interdependency of sectors is not reflected in the policies. There is 60% subsidy on Solar Pump under the Kusum Yojana scheme which is helpful for energy sector in future but its effect on groundwater is still questionable. The problematic situation occurs in context of water and energy in India. The farmers are also struggling, the electricity companies are also in debt, and the groundwater is also depleted. Hence, it can be said that the agriculture sector is stuck in great paradox and it is very difficult to come out of it if proper measures are not reflected in the policies by government.

Stimulating Solutions for Sustainable Agriculture Practices:

The management of water resources have faced problematization by the state through different periods in the past and present. Water management has been a very tricky affair due to many socio-economic-political and ecological reasons. The management of water resources can be traced down from the pre-colonial times where the state promoted small water harvesting structures and encouraged building irrigation structures by giving grants to increase state revenue (Naz & Subramanian, 2010). Thus, traditional Indian society had decentralized institutional arrangement with well-defined local water rights. The indigenous methods prevented floods, soil erosion, run-off, conserving local and global ecosystems. Groundwater management in India is challenging since it concerns human livelihood and the environment. Today's competing water and energy scenario needs a rational groundwater and energy management in an integrated and holistic manner, with its link to the environment which can be understood through water-energy-food nexus approach.

Nexus framing can be understood as interdependence between sectors of water, energy and food (WEF) through the sustainability lens. It focuses on security of resources through cross-sectoral integration showing interdependence in use of resources and their availability (Biggs et al., 2015). Security of resources also involves socio-economic-political factors such as access to resources, social power relations, power asymmetries and social inequalities. Food security is mainly dependent on water and energy resources which can be very well understood in the irrigation system for agriculture in India. Thus, food production, groundwater usage, and power use are linked together.In western Uttar Pradesh the fixed cropping pattern requires huge amount of water for irrigation. There are several initiatives taken by government to break this cycle like providing subsidies for drip- and sprinkler irrigation methods. Another initiative which was launched by the Prime Minister Narendra Modi is of Amrit Sarovar Yojana for developing and rejuvenating 75 water bodies in each district. Through this scheme, there will be increase in biodiversity and water can be provided to the nearby areas reducing groundwater exploitation.

Figure 2: Rejuvenation of Old Pond under Amrit Sarovar Yojana in Deoband Block of Saharanpur District

Source: Author's Field Photograph

Further, more initiatives can be taken by the farmers themselves at the ground level to change the current situation of agriculture. There can be adoption of innovative agriculture practices of mixed and diversified farming through intensified integrated farming system. This method is a way for sustainable income for small farmers and will be a motivation for many farmers. Energy and water efficiency require firm rules and productive pricing. To minimize shortages, agriculture needs demand and price management (Mukherji, 2022). Thus, a smart tariff with intelligent power supply rationing to the farm sector may reduce water and electricity wastage. For instance, Jyotigram Yojana enhanced Gujarat's power sector and rural development (Shah, 2009). Thus, governments must collaborate with key stakeholders to address needs of the poor. Hence, well targeted subsidies and minimum support price (MSP) which is at least 50 percent higher than the cost of production for their cultivation is required (Narayanamoorthy& Suresh, 2013). Thus, water resource management requires strong local institutions and higher-level expertise.

Conclusion and Policy Implications:

India is the world's largest consumer of groundwater and groundwater depletion has become a severe problem in this country. The main cause of groundwater withdrawal is irrigation for agricultural purposes. Food production and declining groundwater are inversely correlated, and groundwater extraction for irrigation has been steadily rising. This is clear from the fact that current food production practises, including growing sugarcane and rice, have greatly accelerated the depletion of groundwater. This results into growing use of tube wells for groundwater extraction in the agricultural sector which is accompanied by decreased use of surface water irrigation and increased use of electricity. Power subsidies also have a big impact on groundwater and agricultural output. Prior to subsidies, few wealthy farmers had access to tube wells, but now most farmers are switching to private tube wells. Also, the Indian property rights integrate land and groundwater ownership.

Western Uttar Pradesh has a significant development of irrigation facilities and a high agricultural intensity compared to other parts of the state. The district of Saharanpur was chosen for its canal networks, privately owned tube wells, sugar mills, and regulated markets. Sugarcane is the major cash crop in the district for which huge amount of water is used in irrigation. Despite the negative effects on groundwater, power subsidies still remain because political parties utilise them to win local elections. Farmer's major issues are the high cost of production and low returns. As a result, many farmers are in debt trap. The schemes like subsidy on different water conserving methods for irrigation are doubtful and implementations are not effective because grassroot conditions are different. There is no nexus approach in the schemesin relation to groundwater in long run. But there are several initiatives taken by the government like Amrit Sarovar Yojana for rejuvenation of water bodies which is a step forward. On ground level there is a need to shift from cash cropping to mixed and diversified cropping system to reduce water usage. In conclusion, to find comprehensive solutions, the interdependency between different sectors should be considered to look for holistic solutions.

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