WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Water Scarcity in India Related to Agriculture

Tandle V. H.[1*], Laxmi R. Dubey[2] and Khushboo Kumari[3]

[1*]P.G. Scholar, College of Agri Business Management, SDAU, Sardarkrushinagar -385 506
[2]Assistant Professor, College of Agri Business Management, SDAU, Sardarkrushinagar-385 506
[3]P.G. Scholar, College of Agri Business Management, SDAU, Sardarkrushinagar-385 506
Email ID:laxmirani.d@gmail.com, ksandilyaa@gmail.com, vtandale29@gmail.com

ABSTRACT

Water scarcity is a critical challenge in India, significantly affecting agriculture, which accounts for approximately 90% of the country's freshwater usage. Factors such as climate change, groundwater depletion, inefficient irrigation methods, and river pollution exacerbate the issue, leading to reduced agricultural productivity and threatening food security. The uneven distribution of freshwater resources further intensifies water stress, particularly in arid and semi-arid regions. Government interventions, including the National River Linking Project and watershed management programs, aim to improve water availability and agricultural resilience. Additionally, technological solutions like drip irrigation, climate-smart agricultural practices, and IoT-based systems offer promising pathways to optimize water use. However, addressing water scarcity requires a holistic approach that integrates community participation, policy innovation, and sustainable practices. This paper explores the causes, impacts, and potential solutions for water scarcity in Indian agriculturePlacing a premium on the necessity of adaptive perspectives.. These strategies guarantee long-term water security.. They also ensure Sustainable agricultural development.. The water security situation is becoming dire .Climate Change exacerbates issues around water scarcity .It's vital to address this immediately. The current methods of water management are unable to support the evolving needs. They are Not Equipped to handle changing climates.

Water scarcity is A global issue .It's a Challenge that needs to be confronted. Not just in India. It affects every country ,no matter how rich or poor .It's imperative for every nation to adopt sustainable Water management .This will ensure that water is not over-extracted. It will be available for everyone .These adaptive Strategies should be put in Place now. Groundwater Depletion is a common challenge. It's a symptom of global water scarcity. Without water there's no agriculture. It is time To face this reality. It is Time to act.The water crisis is not an isolated issue. Agriculture is a major contributor to water pollution. It's a primary water user too. The two are interlinked. The problem is one of Cyclical nature. The solutions to tackle water pollution are often intertwined with those for agriculture. Thus the urgency of optimizing agricultural practices .The goal is to reduce the water footprint of agriculture .The need is to transform the current agricultural system .This will make it more sustainable.The challenge is immense. Yet, the solution lies In cooperation. The call to action ,is now. The necessity is to Act on adaptive strategies, and to Do It with urgency .The time For change is now .The change is not optional. The change is indispensable. It is essential To recognize the interdependence of both Water and agriculture. It is necessary to heed the call to action.This is a reality. .A crucial reality That needs to Be addressed.. We need a new era of water security We need to ensure the future of agriculture It is time To act Time to embrace change..

Keywords: Water Scarcity, Agriculture, Groundwater Depletion, Sustainable Water Management, Climate Change Impact

1. Introduction

Water scarcity is a pressing issue in India. It has a significant impact on the country's agricultural productivity .Likewise it affects food security and rural livelihoods. The agricultural sector relies heavily on water resources. However it faces challenges. The challenges are due to an uneven distribution Of freshwater. There is also climate change .And there is an increasing demand For irrigation.In India agriculture uses about 90% of all freshwater. This highlights the critical need .There is a need for efficient water management practices .This Is to sustain agricultural output. The output ensures food security .Kumari ,2023 stresses The importance of it. National Water Policies show that too. The Policies emphasize the need for improving water use efficiency. It's a vital goal for sustainable agricultural growth. This was noted by Katyaini & Barua In 2017.

Climate-smart agricultural practices are a strategy. It's a strategy that India is employing. The practices include the Use Of drought-resistant crop varieties .Also innovative irrigation techniques are in use. These tactics help mitigate the adverse effects of water scarcity. For example the introduction of climate-resilient rice varieties has been successful. They have shown promising results. These results were shown in maintaining stable yields .They Were even tested in drought-prone regions .Meher, 2024 and Dar et al. ,2020 Provide these examples.Moreover ,there are practices like intermittent flooding In Paddy fields. These can significantly reduce water usage .There is no compromise on crop yields .Meher, 2024 also writes about this. Climate change has some impacts on water scarcity. One such Impact is The increased frequency and intensity of droughts. It further worsens water scarcity in India.Historical data Tells us About drought years.. Approximately 17% of years from 1901 to 2010 were drought years.. They had severe implications for Agriculture And Water resources. .They are discussed by Udmale et al., 2014 The Ministry of Water Resources expects irrigation needs

to rise by 56. It's expected by 2050 This highlights the urgency of addressing water scarcity. The detail Is provided by Kaur et al. ,2013 .Then there is the over-extraction of groundwater in India. It's a significant problem .India is the largest groundwater user in the world. Agricultural Demand is The main reason for depletion. This Fact is also provided by Kaur et al., 2013.To address these issues we need to look at innovative solutions. The National River Linking Project (NRLP) is one such project. NRLP aims To improve Irrigation coverage. It also intends to enhance water accessibility .This is mentioned by Higgins et al., 2018 .However ,not large-scale interventions are enough .We need to Complement these with localized water management strategies. These include watershed management. They also include decentralized water infrastructures. They have been found effective in reducing water demand. Particularly in semi-arid regions.Technology might also lead to A solution .IoT-based irrigation systems might help optimize water usage. They may also enhance agricultural productivity. Technology can Integrate With These strategies to Make an enormous impact on water use. The Journal ,2022 has mentioned this point.

2. Importance of irrigation in India

Irrigation plays a crucial role in Indian agriculture. It significantly affects food production and economic stability .About 90 Million households in India depend on irrigation. They primarily utilize groundwater. This is used to manage the risks associated with rainfall variability. The importance of Irrigation is significant .It is shown by the fact that irrigated crops yield. This Yield is at least twice that Of rainfed crops .Average yields of irrigated Crops are 3.3 tons per hectare .Rainfed Crop yields, in contrast ,are 1.5 tons per hectare. This disparity highlights The necessity of irrigation. The process enhances agricultural productivity. It ensures food security in a Nation where agriculture is A major Economic driver.Reliance on Groundwater for irrigation is substantial. Estimates suggest that over 50% of irrigation requirements in India are met Through groundwater. However sustainability of groundwater resources Is under threat .This is due to over-extraction. It is also due to declining water tables. This threat is Particularly notable in regions Like Punjab And Rajasthan.As climate change exacerbates water scarcity demand for irrigation is projected to rise. By 2050 The demand for irrigation Is likely to rise significantly. This Stresses the need for efficient Water Management practices .Modern Irrigation technologies are necessary like drip and sprinkler systems. They can optimize water use and enhance agricultural resilience

3. Water Scarcity related to agriculture

Water scarcity in India is intricately linked to agricultural practices. There are significant implications for food security. There are also implications for rural livelihoods The uneven distribution of freshwater Resources is a challenge. Especially in arid and semi-arid regions .This Situation is not favorable for agricultural productivity (Kumari ,2023. The competition for water among Various sectors is growing The impacts of climate change also play a role.Heightened water stress Is evident in agricultural areas (Hiremath & Makadia, 2021). Depletion of groundwater is a critical concern. Many regions Have declining aquifer levels (Alkon ,2024) .This Makes it increasingly difficult for farmers to access enough irrigation water.There are consequences of water scarcity. The issue goes Beyond immediate Agricultural output. It threatens the livelihoods of millions who rely on farming. These are individuals seeking sustenance. Efficient strategies For water management are important. The adoption of high-efficiency irrigation systems is also important .Another key factor is drought-resistant Crop varieties .They are vital To address these challenges (Nasir Et al. ,2021).

Furthermore ,the implementation of policies is important.. These policies promote sustainable water usage.. These policies should implement conservation practices. .This is necessary to mitigate the impacts of water scarcity on agriculture (Adhikari et al., 2021). When agricultural sector faces these issues focus turns To innovative solutions and adaptive strategies They become crucial.. They ensure sustainability of water resources and resilience of farming communities in India.. Developing farming communities in India also depends on sustainability of water. .Therefore these strategies are of great importance.Innovative solutions are being adopted By many farmers .They have realized that traditional methods are not effective anymore. Change is necessary. Some farmers are turning to sustainable farming techniques. The government has introduced schemes to promote these techniques.Rapidly Depleting water levels have forced many Farmers To rethink their strategies Many are moving towards water-efficient crops These crops need less water for irrigation Adaptive Strategies are also being used. Water harvesting ,Drip irrigation are some of these strategies. Water harvesting helps in utilizing rainwater to increase water resources. Drip irrigation is a technique that distributes Water directly to The plant root. This minimizes water wastage .It is a Boon for Regions facing water scarcity.Farmers are also changing their Crop patterns. They are Choosing drought-resistant crops .These crops require lesser water For growth. They are sustainable in times of water scarcity.When farmers adopt these strategies ,Not only their income increases. It also benefits the environment. Sustainable farming practices reduce pressure on water resources. They also Maintain Soil fertility. This ensures that future generations can also rely On these resources for their survival . Innovation and adaptation are the need Of the hour in the agricultural sector.The government has also Introduced policies to promote water conservation in agriculture .The Water Conservation Bill is one such policy. It encourages collective investment in water conservation projects. There are Also several governmental and non-governmental organizations working towards promoting water-efficient practices.Innovation without adaptation Is futile. To ensure sustainability of water resources both need to Be used in coherence. Innovation Leads to new efficient solutions .But adaptation is what ensures sustainable utilization of these solutions. The balance between innovation and adaptation is crucial in achieving sustainable agriculture and resource management in India.

4. Reasons for Water Scarcity

Water scarcity is profound issue In India .This is Especially true for agriculture. It's driven By multiple interconnected factors. The primary causes for this scarcity bring forth A multifaceted array. They encompass climate change .They involve river contamination And overuse of groundwater. Wastage is also a concern. Each of these elements contributes significantly. They all influence challenges Met by Indian agriculture.

4.1 Climate Change

Climate change is a severe issue .It's exacerbating water scarcity in India. More importantly, it's a critical factor. A factor that's resulting in The worsening of water scarcity. There is a noticeable increase in variability of rainfall patterns. This is Causing major shifts .Alongside this we have rising temperatures. It's leading to large scale alterations in water availability. Changes ,that are altering ability to Cater To agricultural demands.Studies suggest that by 2080 an approximate 600 million people might Experience food shortages .The research also shows that a Similar number of individuals may have Water scarcity issues .The report estimates this 18 Billion globally In India, the problem is particularly acute. There is heavy dependence on monsoon rains for agriculture. This Puts the agriculture sector At high vulnerability to climate changes. The changes frequently Lead to droughts. Weakened crop Yields are the result (McDonald et al., 2011) .Indeed, the Ministry of Water Resources look ahead .They Project that demand for agricultural irrigation will escalate. It could rise by 56% by 2050. So ,this puts a significant strain on an already constrained water reserve. (Kaur et al., 2013. Climate change isn't the only player. A similar role is played by the irrational use of water.

4.2 River Pollution

River contamination is a major factor Behind water scarcity in India .It hampers the supply of water for agricultural purposes. Industrial discharge is one reason. Agricultural runoff too. Urban waste doesn't help. They pollute rivers .All of this creates issues. Contamination in Rivers is severe .It's serious Enough to impede the availability of clean water. A water supply crucial for irrigation. The National River Linking Project is notable. This project's aim is to lessen water scarcity. It Underscores the need for better water management systems .These Systems could curb pollution and improve Water quality. The degradation of river ecosystems Brings additional problems. It doesn't only affect water supply .It also threatens the existences of communities. Lots of communities depend on these river ecosystems .They depend on these for their agriculture work and for fishing.

4.3 Groundwater Extraction and Irrigation

Groundwater extraction for irrigation is common in India. About 230 km³ of groundwater is used annually. It is used for agricultural goals. Heavy use of groundwater has brought about significant depletion of aquifers. This is true particularly in states like Punjab And Rajasthan. These states have seen decline In water tables due to over-extraction .The trend is worrisome because it's a response to limited availability of surface water .The response is not sustainable and Carries long-term risks for agricultural productivity and water safety.When groundwater Levels drop farmers face more substantial challenges.. Challenges include sustaining crop yields.. This leads to economic trouble in rural areas.. All this is a big problem for water tables .But the tables may restore if use of groundwater is decreased. The Decrease in use has to happen in a Planned and strategic way.

4.4 Wastage of Water

The wastage of water could exacerbate water scarcity .This Occurs due to the inefficient irrigation practices in India. The traditional irrigation methods cause significant water losses. This is Based On estimates. These estimates show that vast quantities of water used in agriculture are wasted.Modern irrigation techniques have been Proposed as a solution. Techniques like drip irrigation and rainwater harvesting are part of this solution .They can enhance water efficiency. However the Transition to these practices is slow. This Is mainly due to a lack of awareness and financial constraints Among smallholder farmers.

Addressing water wastage is crucial Necessary for improving water availability. It is also essential for ensuring sustainable agricultural practices. These Face growing demands. Therefore ,to tackle these issues awareness and Educational campaigns are essential . Hence a balance between Traditional and modern methods is crucial. This will ensure both effective water usage and productivity in agriculture

5. Efforts to Control Water Scarcity

Water scarcity in India is a grave situation This is especially true in the agricultural sector Its major problem that requires Thorough Strategies for management and mitigation.Not only it requies But also it needs exploration .Exploration of both governmental and non-governmental efforts aiming to control water scarcity.Following this will be a SWOT analysis.. This analysis will assess the current situation.. The SWOT analysis will consider the strengths, weaknesses ,opportunities, and threats. .All these factors play crucial roles in addressing water scarcity In India.

5.1Government Efforts

The Indian government has been implementing different policies and initiatives targeting the issue of water scarcity In agriculture.. One such significant strategy is the National River Linking Project (NRLP). .It has the objective to interlink Rivers to increase irrigation and water supply across The nation.. If successful ,the NRLP could potentially boost irrigated areas by an area of 350,000 square kilometres (Higgins et al., 2018). Furthermore it also promotes the construction of small-scale water storage interventions. Interventions like check Dams and farm bunds are the Focal point .They have been proven to enhance local water security (Horan Et al., 2021).

The National Water Policy (NWP) has evolved too. It now Considers water scarcity in economic planning .The significance of water scarcity is recognized in agricultural productivity and rural livelihoods It Is considered To play a pivotal role in both aspects (Katyaini & Barua, 2017). Moreover watershed

development programs have been rolled out. The goal is to Increase water resources And improve land use The impacts have been positive Both Surface and groundwater availability have shown improvement attributable to such programs (Mondal et al. ,2018).On the other hand, the government has also put emphasis on increasing Water productivity in agriculture. The main Idea is to enhance crop yields. However, there is a Need to minimize non-productive water Use (Mekonnen & Hoekstra, 2016) .Such an approach aligns With wider efforts for sustainable practices in water management. Government is trying to ensure that these practices can handle the pressures of increasing Population and climate change (Mahato et al. ,2022).

5.2 Non-Governmental Efforts

NGOs Have played an important role in mitigating water scarcity.. They often concentrate on grassroots efforts. .These promote sustainable agricultural practices like Rainwater harvesting.. They also promote efficient irrigation techniques such as Drip irrigation (Moin & Kamil 2018). These technologies have been Shown to significantly Boost agricultural yields and farmer incomes. This is particularly true in regions facing severe water shortages (Passarelli et al. ,2018).Various NGOs have also adopted integrated watershed management practices. These aim to enhance public health And agricultural productivity This is done through better management of water resources (Nerkar et al ,2015) .Such initiatives frequently Include community participation. This enhances ownership and sustainability of local water management practices.Researchers also underscore role of virtual water trade .Water-intensive crops are traded. This allows Regions with water scarcity to import food instead of growing it locally (Katyaini et al. ,2021). Although this can reduce pressure on local water resources it still ensures food security.

6. SWOT Analysis of Water Scarcity in India

6.1 Strengths

• Government Initiatives: Indian government has proactive stance .They execute large-scale projects like NRLP. This government also endorses effective irrigation technologies. This is Valuable strength (Higgins et al. ,2018, Horan et al., 2021).

• Community Engagement: Involvement Of NGOs and local communities in water Management is beneficial .It fosters innovative ,customized solutions For local needs. This furthers the need for community involvement. It's important For sustainable development (Nerkar et al., 2015).

6.2Weaknesses

• This point highlights uneven distribution of water resources. Water scarcity is worsened by uneven distribution of freshwater resources This primarily Impacts Arid and semi-arid regions .Problem is not uniformly distributed (Kumari 2023)

• Overexploitation of Groundwater: Reliance on groundwater for irrigation has Led to significant depletion .It is A threat to long-term sustainability (Garg & Wani ,2013).

6.3Opportunities

Technological Advancements: Innovations in irrigation technology are present. Water management Practices offer a wonderful opportunity. opportunities for improving water use efficiency (Angom, 2023).Policy Integration: Integrating water management into broader agricultural and economic policies can enhance resource allocation and sustainability (Katyaini & Barua, 2015).

6.4Threats

- Climate Change: Increasing variability in rainfall patterns and extreme weather events pose to Water availability and agricultural productivity (Mahato Et al .2022; Khetwani & Singh 2018). Population Growth: The rising demand for Water Due to population growth and urbanization intensifies competition for limited water resources (Hanjra & Qureshi 2010).

7. Conclusions

- Water scarcity poses a significant threat to Indias agricultural sector influencing productivity food security and rural livelihoods .Climate change ,groundwater depletion inefficient Irrigation practices and river pollution exacerbate These challenges.
- Water scarcity threatens India's agricultural sector. This issue Affects Productivity and food security .The problem also impacts rural communities. Water shortage is a global issue.
- Scarcity of this resource Is a Consequence of climate changes .Climate alterations result in more Extreme weather These weather events lead to water scarcity in many regions This scarcity endangers food production
- Groundwater depletion is another issue .The misuse of irrigation practices worsens this. Overuse of certain agricultural methods also contribute. It is a complex issue.

- Water pollution is a significant factor. Industrial waste ,agricultural runoff and household products are to blame .Animal Waste also contributes.
- Addressing these issues requires Concerted effort. Policy changes are necessary. Sustainable allocation of resources Is vital too .Reducing waste and pollution is key.
- We also need to take longterm planning seriously Education about sustainable practices is crucial The task may seem daunting. .However concerted action can mitigate this crisis..
- The consequences of inaction are dire .We are at a Critical juncture. The time to act is now. Even as we grapple with complexity of water scarcity we must act. Remember our actions today Will. Addressing these issues requires integrated efforts, including the adoption of modern irrigation technologies, climate-resilient crops, and sustainable water management policies. Government initiatives like the National River Linking Project and localized interventions such as watershed management have shown promise. However, community participation, technological innovations, and policy coherence are crucial to ensuring long-term water sustainability. Collaborative efforts between stakeholders can build a resilient agricultural system, mitigating the impacts of water scarcity and enhancing the livelihoods of millions dependent on farming. Sustainable solutions must prioritize resource efficiency and equitable water distribution.

References

Acharya, S., George, B., Aye, L., Nair, S., Nawarathna, B., & Malano, H. (2015). Life cycle energy and greenhouse gas emission analysis of groundwater-based irrigation systems. *Irrigation and Drainage*, 64(3), 408-418.

Adhikari, B., Prasad, S., Praveena, P., Sagar, G., & Reddy, B. (2021). Socio-personal and communication characteristics of pradhan mantri krishi sinchayee yojana (pmksy) beneficiary farmers in uttarakhand. *Asian Journal of Agricultural Extension Economics & Sociology*, 11-19. https://doi.org/10.9734/ajaees/2021/v39i1130715

Alkon, M. (2024). High resolution prediction and explanation of groundwater depletion across india. *Environmental Research Letters*, 19(4), 044072.

Angom, J. (2023). Irrigation technology interventions as potential options to improve water security in india and africa: a comparative review. *Sustainability*, 15(23), 16213.

Balachandran, S., Lakshmi, S., & Rajendran, N. (2020). Irrigation system using hyperspectral data and machnie learning techniques for smart agriculture. *Journal of Computer Science*, 16(4), 576-582.

Chinnasamy, P., Maske, A., Honap, V., Chaudhary, S., & Agoramoorthy, G. (2021). Sustainable development of water resources in marginalised semi-arid regions of india: case study of dahod in gujarat, india. *Natural Resources Forum*, 45(2), 105-119.

Dar, M., Waza, S., Shukla, S., Zaidi, N., Nayak, S., Hossain, M., … & Singh, U. (2020). Drought tolerant rice for ensuring food security in eastern india. *Sustainability*, 12(6), 2214.

Garg, K. and Wani, S. (2013). Opportunities to build groundwater resilience in the semi-arid tropics. *Ground Water*, 51(5), 679-691.

Gupta, A., Singh, R., Kumar, M., Sawant, C., & Gaikwad, B. (2021). On-farm irrigation water management in india: challenges and research gaps. *Irrigation and Drainage*, 71(1), 3-22.

Hanjra, M. and Qureshi, M. (2010). Global water crisis and future food security in an era of climate change. *Food Policy*, 35(5), 365-377.

Higgins, S., Overeem, I., Rogers, K., & Kalina, E. (2018). River linking in india: downstream impacts on water discharge and suspended sediment transport to deltas. *Elementa Science of the Anthropocene*, 6. https://doi.org/10.1525/elementa.269

Hiremath, D. and Makadia, J. (2021). Growth and instability of area under drip method of irrigation in south gujarat- a district-wise analysis. *International Journal of Agricultural Sciences*, 17(1), 9-14.

Horan, R., Wable, P., Srinivasan, V., Baron, H., Keller, V., Garg, K., … & Rees, H. (2021). Modelling small-scale storage interventions in semi-arid india at the basin scale. *Sustainability*, 13(11), 6129.

Journal, I. (2022). Sustainable irrigation for enhancing the water usability in agriculture using iot. *Interantional Journal of Scientific Research in Engineering and Management*, 04(05). https://doi.org/10.55041/ijsrem16420

Katyaini, S. and Barua, A. (2015). Water policy at science–policy interface – challenges and opportunities for india. Water Policy, 18(2), 288-303. https://doi.org/10.2166/wp.2015.086

Katyaini, S. and Barua, A. (2017). Assessment of interstate virtual water flows embedded in agriculture to mitigate water scarcity in india (1996–2014). *Water Resources Research*, 53(8), 7382-7400.

Katyaini, S., Mukherjee, M., & Barua, A. (2021). Water–food nexus through the lens of virtual water flows: the case of india. *Water*, 13(6), 768.

Kaur, S., Lubana, P., & Aggarwal, R. (2013). Groundwater management for adaptation under changing climate conditions in indian punjab. *Journal of Water and Climate Change*, 4(1), 38-51.

Khetwani, S. and Singh, R. (2018). Assessment of hydrological drought in marathwada region: a spatio-temporal analysis. *Journal of Geography Environment and Earth Science International*, 17(1), 1-10.

Kumari, V. (2023). Statistical analysis of growth and installation cost of sprinkler irrigation system in bikaner district of rajasthan, india. *Asian Journal of Agricultural Extension Economics & Sociology*, 41(10), 294-302.

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*, 64-69.

McDonald, R., Green, P., Balk, D., Fekete, B., Revenga, C., Todd, M., … & Montgomery, M. (2011). Urban growth, climate change, and freshwater availability. *Proceedings of the National Academy of Sciences*, 108(15), 6312-6317.

Meher, S. (2024). Performance of climate smart rice (var. cr dhan 801): a case study from western undulating zone of odisha, india. *International Journal of Environment and Climate Change*, 14(4), 80-85.

Mekonnen, M. and Hoekstra, A. (2016). Four billion people facing severe water scarcity. *Science Advances*, 2(2). https://doi.org/10.1126/sciadv.1500323

Moin, K. and Kamil, A. (2018). Drip irrigation in india: prospects, potential and challenges. *Journal of Geography Environment and Earth Science International*, 17(4), 1-14.

Mondal, B., Singh, A., Singh, S., Kalra, B., Samal, P., Sinha, M., … & Kumar, S. (2018). Augmentation of water resources potential and cropping intensification through watershed programs. *Water Environment Research*, 90(2), 101-109.

Nasir, J., Ashfaq, M., Baig, I., Punthakey, J., Culas, R., Ali, A., … & Hassan, F. (2021). Socioeconomic impact assessment of water resources conservation and management to protect groundwater in punjab, pakistan. *Water*, 13(19), 2672.

Nerkar, S., Pathak, A., Lundborg, C., & Tamhankar, A. (2015). Can integrated watershed management contribute to improvement of public health? a cross-sectional study from hilly tribal villages in india. *International Journal of Environmental Research and Public Health*, 12(3), 2653-2669.

Nerkar, S., Tamhankar, A., Johansson, E., & Lundborg, C. (2013). Improvement in health and empowerment of families as a result of watershed management in a tribal area in india - a qualitative study. *BMC International Health and Human Rights*, 13(1). https://doi.org/10.1186/1472-698x-13-42

Passarelli, S., Mekonnen, D., Bryan, E., & Ringler, C. (2018). Evaluating the pathways from small-scale irrigation to dietary diversity: evidence from ethiopia and tanzania. *Food Security*, 10(4), 981-997.

Rastogi, M. (2024). Advancing water conservation techniques in agriculture for sustainable resource management: a review. *Journal of Geography Environment and Earth Science International*, 28(3), 41-53.

Udmale, P., Ichikawa, Y., Kiem, A., & Panda, S. (2014). Drought impacts and adaptation strategies for agriculture and rural livelihood in the maharashtra state of india. *The Open Agriculture Journal*, 8(1), 41-47.

Wada, Y., Wisser, D., & Bierkens, M. (2014). Global modeling of withdrawal, allocation and consumptive use of surface water and groundwater resources. *Earth System Dynamics*, 5(1), 15-40.

Zaveri, E., Wrenn, D., & Fisher-Vanden, K. (2020). The impact of water access on short-term migration in rural india. *Australian Journal of Agricultural and Resource Economics*, 64(2), 505-532.