

Research Proposal- IARCO - Sarah M..pdf

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Submission date: 13-Oct-2025 11:25PM (UTC+0700)

Submission ID: 2779973740

File name: Research_Proposal_-IARCO_-_Sarah_M..pdf (131.57K)

Word count: 1088

Character count: 6522

IARCO RESEARCH PROPOSAL

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Research Topic: Biodegradable Natural Hydrogels as a Sustainable Solution for Bangladesh's Agricultural Water Crisis: A South-Asian bio-economic perspective

Title: Biodegradable Natural Hydrogels as a Sustainable Solution for Bangladesh's Agricultural Water Crisis: A South-Asian bio-economic perspective

Research Aim

This study aims to explore the feasibility of biodegradable naturally-occurring hydrogel, and how they can help solve Bangladesh's agricultural water crisis by water retention in farming and balancing the costs and benefits for smallholder farms in the country.

Research Problem

Bangladesh is a low-lying delta that faces water crisis due to the growing issue of salinity intrusion, unprecedented seasonal variations, and inability to construct adequate infrastructure [1]. Groundwater depletion still remains a major factor in water insecurity, in addition to growing irrigation costs in coastal regions. Smallholder farmers have resorted to depending on diesel-powered irrigation, which is biologically unsustainable and economically draining. While prior research implies that naturally-occurring polysaccharide-based hydrogels, which are also biodegradable, have the possibility of improving soil water retention and reducing harmful irrigation alternatives, there is little to no research connecting their application to reducing Bangladesh's agricultural and economic uncertainty. This lack of scientific and economic criticism forms a void in the knowledge required to understand whether or not biodegradable hydrogels could be a feasible and sustainable alternative for Bangladesh's agriculture industry.

Research Questions

1. How effective are biodegradable hydrogels in improving soil water retention and reducing irrigation demand in Bangladesh's staple crop systems?
2. What are the economic costs and potential financial benefits for Bangladeshi farmers adopting biodegradable hydrogels?
3. How might hydrogels contribute to mitigating environmental challenges such as groundwater depletion, arsenic contamination, and salinity intrusion in Bangladesh?
4. What policy and institutional mechanisms can support widespread adoption of hydrogel-based solutions in Bangladesh's agricultural sector?

Existing Literature

Previous studies have shown that biodegradable hydrogels contain hydrophilic properties that help retain water, there is little research done on their implications and usage with Bangladesh's economic state in mind. Hydrogels, in general, have been widely

researched on as their contribution in water-scarce regions are noteworthy. Experimental studies in sub-Saharan Africa and arid regions in India have demonstrated that hydrogel-based soils show higher moisture content, and improves seed germination rates, a proof of water retention factor. On the other hand, Bangladesh-based hydrogel research mainly focuses on the production of cellulose-based hydrogels and their alternatives. For instance, Mondal et. al. [2] concentrates primary on the structural characteristics of hydrogels, and the eco-friendly preparation of hydrogels. [3] aligns with the previous research and focuses on using jute sticks for hydrogel preparation. [4] worked primarily on polymer-based hydrogels, whereas [5] scratched the surface and dig deeper into the uses of hydrogels for wastewater treatment. However, there is still a lack of knowledge surrounding hydrogels and their uses in the Bangladeshi context, keeping in mind their feasibility and cost-effectiveness for smallholders in the country.

Research Question

To what extent are biodegradable hydrogels useful in mitigating Bangladesh's agricultural water crisis and being cost-effective in the South-Asian Economy?

Methodology

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This study aims to use a mixed-method approach to assess the potential of hydrogels in Bangladesh's agricultural sector.

Quantitative phase: Experimental field trials would be conducted on soil, comparing hydrogel-treated and untreated soils under controlled irrigation. Key variables measured would include soil moisture retention (gravimetric water content), crop yield and water productivity (g/cm^3 of water used). In addition to this, an economic model regarding the costs and benefits would be constructed to showcase the savings from reduced irrigation and crop yield.

Qualitative phase: There may be structured interviews with around 5-10 smallholder farmers in the Dhaka district about water scarcity, approach to adoption of new technologies, and affordability. This may give further insight into the agricultural market and the possibility of future risks of hydrogel usage.

Data analysis: Regression models would be constructed to display the quantitative data statistically and to identify relationship and trends between hydrogel-treated soil and crop yield. Qualitative interview data would be thematically coded to reveal cultural attitudes and economic concerns. The intersection and integration of both data would allow a better understanding of hydrogel adoption in the Bangladeshi agricultural context.

Safety concerns and practicality: This study will ensure that only biodegradable, non-toxic hydrogels are used, and all soil and crop samples will be monitored for toxic

residues (if any). Researcher and farmer safety will be ensured with protective equipment and training. The research also will include economic cost-benefit model and recommendations for policy or subsidy interventions to make hydrogel adoption feasible for smallholder farmers.

Conclusion

Bangladesh's growing agricultural water crisis, due to groundwater depletion, rising irrigation costs and salinity intrusion is a major threat to the country's food security and smallholder farms. Biodegradable poly-saccharide based hydrogels present a promising solution by improving water-use efficiency and offering a long term solution to sustainability and economic stability in the agricultural sector. This research highlights the urgent requirement for Bangladesh to invest in sustainable natural hydrogels to secure its agricultural future and build resilience against water scarcity and climate change.

References

- [1] T. Bahar Chowdhury, K. Choi, F. Muntaha, and T. Bahar Chowdhury, “View of Evaluating the Water Crisis and Management Strategies in Climate-Sensitive Coastal Areas of Bangladesh: A Focus on Household, Agricultural, and Aquaculture Water Risks,” Cultechpub.com, 2025.
<https://jee.cultechpub.com/index.php/jee/article/view/23/17> (accessed Sep. 29, 2025).
- [2] Md. I. H. Mondal, Md. O. Haque, F. Ahmed, Md. N. Pervez, V. Naddeo, and M. B. Ahmed, “Super-Adsorptive Biodegradable Hydrogel from Simply Treated Sugarcane Bagasse,” *Gels*, vol. 8, no. 3, p. 177, Mar. 2022, doi:
<https://doi.org/10.3390/gels8030177>.
- [3] <https://pubs.acs.org/doi/full/10.1021/acsomega.3c06349>
- [4] A. H. Karoyo and L. D. Wilson, “A Review on the Design and Hydration Properties of Natural Polymer-Based Hydrogels,” *Materials*, vol. 14, no. 5, p. 1095, Feb. 2021, doi:
<https://doi.org/10.3390/ma14051095>
- [5] Md. O. Rahman *et al.* “Modification of Superabsorbent Hydrogels for Industrial Wastewater Treatment,” *Advances in Polymer Technology*, vol. 2022, pp. 1–10, Feb. 2022, doi: <https://doi.org/10.1155/2022/8405230>.

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- 1** Ghada Kadry, Heba A. El-Gawad. "Rice straw derived cellulose-based hydrogels synthesis and applications as water reservoir system", International Journal of Biological Macromolecules, 2023
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