International Journal of Advanced Biochemistry Research

**ISSN Print:** 2617-4693
**ISSN Online:** 2617-4707
IJABR 2024; 8(1): 366-370
www.biochemjournal.com
Received: 18-10-2023
Accepted: 25-12-2023

**Tejas Mangesh Lingavale**
M. Tech. Scholar, Department of Irrigation and Drainage Engineering, CAET, DBSKKV, Dapoli, Ratnagiri, Maharashtra, India

**Sunil T Patil**
Associate Professor, Department of Irrigation and Drainage Engineering, CAET, DBSKKV, Dapoli, Ratnagiri, Maharashtra, India

**Uttam S Kadam**
Director of MCAER (Education), Pune, Maharashtra, India

**Mahanand S Mane**
HOD, IWM, MPKV, Rahuri, Maharashtra, India

**Ganesh G Kadam**
Ph.D. Scholar, Department of Irrigation and Drainage Engineering, CAET, DBSKKV, Dapoli, Ratnagiri, Maharashtra, India

**Corresponding Author:**
**Tejas Mangesh Lingavale**
M. Tech. Scholar, Department of Irrigation and Drainage Engineering, CAET, DBSKKV, Dapoli, Ratnagiri, Maharashtra, India

# Performance evaluation of the energy free water lifting device

**Tejas Mangesh Lingavale, Sunil T Patil, Uttam S Kadam, Mahanand S Mane and Ganesh G Kadam**

**DOI:** https://doi.org/10.33545/26174693.2024.v8.i1e.398

**Abstract**
Indian agriculture is the monsoon-dependent. Frequently, water flows near the fields or from the rooftop, but there is a lack of gadgets and power to lift it to the desired place. Under such circumstances, farmers are using some manually operated or animal-drawn devices to draw the water from the river, channel or naturally impounded water to irrigate their fields in tribal and undeveloped areas. But ithasalot of limitations which will cause loss of energy and time. Therefore, to provide relief and to save energy and time for the farmers, an energy-free water lifting device that will operate 24×7 with little head available was designed and developed. The performance of the designed and developed 32 mm size energy-free water lifting device was worked out by taking 27 combinations such as three supply heads, three diameters of delivery pipes, and three diameters of supply pipes. The supply and delivery combination used for the study was 40/12. 40/16, 40/25, 50/12, 50/16 and 50/25 respectively. It was found from the study that a maximum discharge rate of 2.40lpm was found with the 40/12 mm supply/delivery combination at 2.0 m supply head under 3 m delivery head. Similarly, a maximum discharge rate of 2.07 lpm was found with the 50/12 mm supply/delivery combination at 1.5 m supply head under 2.5 m delivery head. The maximum discharge rate of 1.67 lpm was found with the 50/12 mm supply/delivery combination at 1.0 m supply head under 2.0 m delivery head. The maximum delivery head achieved at supply head of 1.0 m, 1.5 m, and 2.0 m were 3.3, 3.9 and 4.0 m respectively. It was observed that the supply and delivery pipe diameters of 50 mm, 40 mm and 12 mm, 16 mm respectively were found best amongst all the three combinations of supply pipe. From the study, it was revealed that as the delivery head increases, delivery discharge gradually decreases. It was also observed that if the size of the supply pipe increases, discharge rates also increase up toa certain extent. The designed and developed energy-free water lifting device is found helpful for farmers for lifting water without power available.

**Keywords:** Indian agriculture, monsoon, water lifting device

## Introduction
India's economy is based primarily on agriculture. According to Limbore *et. al.* (2015) [19], 10% of the urban population and 70% of the rural population respectively depend on agriculture for their daily needs. Agriculture in India is monsoon dependent. India receives about 1190 mm of average precipitation each year. Out of which 33.8% flow as surface runoff and enter the sea (Gupta *et. al.*, 2016) [13]. Water is accessible during the monsoon and flows from higher elevations to lower elevations in the form of runoff. However, the lack of electricity in hilly and tribal areas and the lack of appropriate equipment to lift runoff water from lower elevations to higher elevations for irrigation prevented the farmers from lifting this flowing water. The market is filled with a variety of mechanical and electrically powered equipment that can raise water from lower elevations to higher elevations.
However, the current state of the Indian economy and marginal farmers' financial status does not allow them to purchase and use these kinds of mechanically propelled lifts or electrically propelled pumps to irrigate their fields. In rural and undeveloped areas, tribal communities, and distant locations, even some populations in hilly terrain struggle to meet their necessities, such as food, shelter, etc. Even it is almost impossible for them to have access to gasoline and energy. To extract the water from water sources like rivers, perennial streams, naturally impounded water, springs, etc., they are thus using some human-driven or animal-drawn devices which are very laborious, time and energy-consuming.

The Konkan region makes up about 10% of the state's total land area but receives 46% of its total precipitation (Mahale *et al.*, 2017) [20]. Most precipitation is turned to surface flow, but some of it also seeps into the soil. Lateritic soil with excellent water drainage is found in the Konkan region. The water is soon drained from it. Energy or electricity availability is the most important issue that arises during the monsoon season. Stakeholders had a variety of pumping equipment, but during a severe monsoon, they were unable to even fill their overhead tanks because of the lack of energy. The Konkan region is home to numerous rivers that flow freely year-round. Therefore, it was deemed necessary to evaluate the performance developed device by designing an energy-free, lightweight, and cost-effective device that can only operate by naturally occurring elevation heads, either of sloping land or rooftops, and lift the water to use it either for irrigation or to fill the overhead tanks installed on the rooftop.

## Materials and Methods

Konkan region is gifted with a naturally available gravity head. It was decided to use the naturally available velocity head of the flowing water to run the proposed device and to lift the water from the lower elevation to the higher elevation. The device of 32 mm diameter PVC pipes was designed and tested with the 12 mm, 16 mm, and 25 mm diameter delivery pipes. The following material is needed to develop the device.

1. PVC pipes, Flow control valves, Non-return valves, and Plastic disposable bottle
2. Supply and delivery pipes, Male Threaded Adapters, and Female Threaded Adapters
3. Elbows, Tees (T), Hose clips, Hose nipples, Reducers, Teflon tape, PVC solution etc.

The 32 mm size energy-free water lifting device was developed for the study and performance evaluation was carried out by taking 27 combinations such as three supply heads, three diameters of delivery pipes, and three diameters of supply pipes. The supply and delivery combination used for the study was 32/12, 32/16, 32/25, 40/12, 40/16, 40/25, 50/12, 50/16, and 50/25 respectively at 1.0, 1.5, and 2.0 m supply head. The designed cost-effective energy-free water-lifting device is shown below in Plate 1. The performance of the designed and developed device in terms of delivery head and quantity of water lifted was determined by changing supply and delivery head, varying supply and delivery pipe sizes, etc. From the study, the maximum discharge was found under 40/12 and 50/12 supply and delivery combination which is presented in this paper.

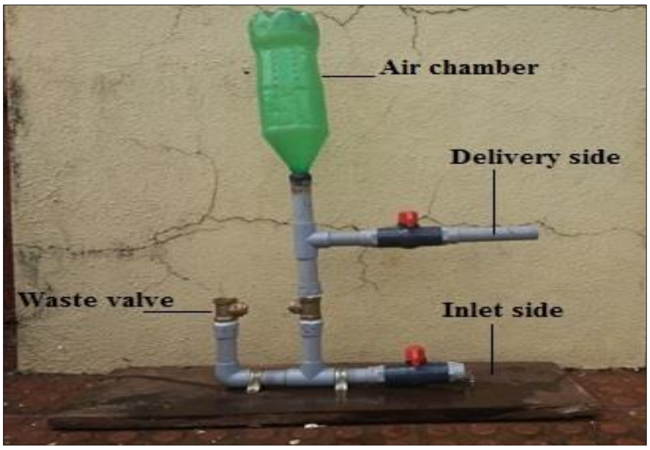


**Plate 1:** Final setup after total accessories assembly

## Results and Discussion

The experiment was conducted during 2018-2020 at the Instructional Farm and in the Laboratory of the Department of Irrigation and Drainage Engineering, College of Agricultural Engineering and Technology, Dapoli (M.S.), India.

### Effect of supply pipe diameters, supply heads, and delivery pipe diameters on delivery discharges

The 32 mm size energy-free water lifting device was developed for the study and performance evaluation was carried out by taking 27 combinations such as three supply heads, three diameters of delivery pipes, and three diameters of supply pipes. The supply and delivery combination used for the study was 32/12, 32/16, 32/25, 40/12, 40/16, 40/25, 50/12, 50/16, and 50/25 respectively at 1.0, 1.5, and 2.0 m supply head. The performance of the designed and developed device in terms of delivery head and quantity of water lifted was determined by changing supply and delivery head, varying supply and delivery pipe sizes, etc.

The developed device was tested for 27 combinations as enlisted above and most efficient operating performance of the developed device is presented in Table 1.

**Table 1:** Effect of supply pipe diameters, supply heads, and delivery pipe diameters on delivery discharges

| Supply pipe diameter, mm | Obtained delivery discharges (lpm) with the corresponding delivery heads (m) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1.0 m supply head, 12mm Delivery pipe | | | | | | | | |
| | 2.0m | 2.5m | 3.0m | 3.1m | 3.2m | 3.3m | | | |
| 50 | 1.67 | 1.13 | 0.82 | 0.79 | 0.72 | 0.60 | | | |
| 1.5 m supply head, 12mm Delivery pipe | | | | | | | | | |
| | 2.5 m | 3.0 m | 3.1 m | 3.2m | 3.5m | 3.6m | 3.7m | 3.8m | 3.9m |
| 50 | 2.07 | 1.39 | 1.05 | 1.03 | 0.90 | 0.88 | 0.68 | 0.51 | 0.22 |
| 2.0 m supply head, 12mm Delivery pipe | | | | | | | | | |
| | 3.0 m | 3.5m | 3.6m | 3.7m | 4m | | | | |
| 40 | 2.40 | 1.48 | 1.09 | 0.91 | 0.39 | | | | |

The developed device was tested for 1.0 m head, 32, 40, and 50 mm supply pipe diameters, and 12, 16, and 25 mm delivery pipe diameters. The study observed that the best performance at a 1.0 m supply head was obtained for a combination of a 50 mm diameter supply pipe and at 12 mm diameter delivery pipe. From Table 1 and Fig. 1, it is revealed that for the supply head of 1.0 m and the diameter of the delivery pipe was kept at 12 mm, the maximum discharge was found at 2.0 m head i.e. 1.67 lpm. The discharge of 0.60lpm could be lifted upto3.3 m maximum supply head.

Similarly, the developed device was tested for 1.5 m head, 32, 40, and 50 mm supply pipe diameters and 12, 16, and 25 mm delivery pipe diameters. The best performance at a 1.5 m supply head was obtained for a combination of a 50 mm diameter supply pipe and a 12 mm diameter delivery pipe. From Table 1 and Fig. 2, it is revealed that for a supply head of 1.5 m and the diameter of the delivery pipe was kept at 12 mm, the maximum discharge was found at 2.5 m head i.e. 2.071 pm. The discharge of 0.22 lpm could be lifted up-to 3.9 m maximum supply head.

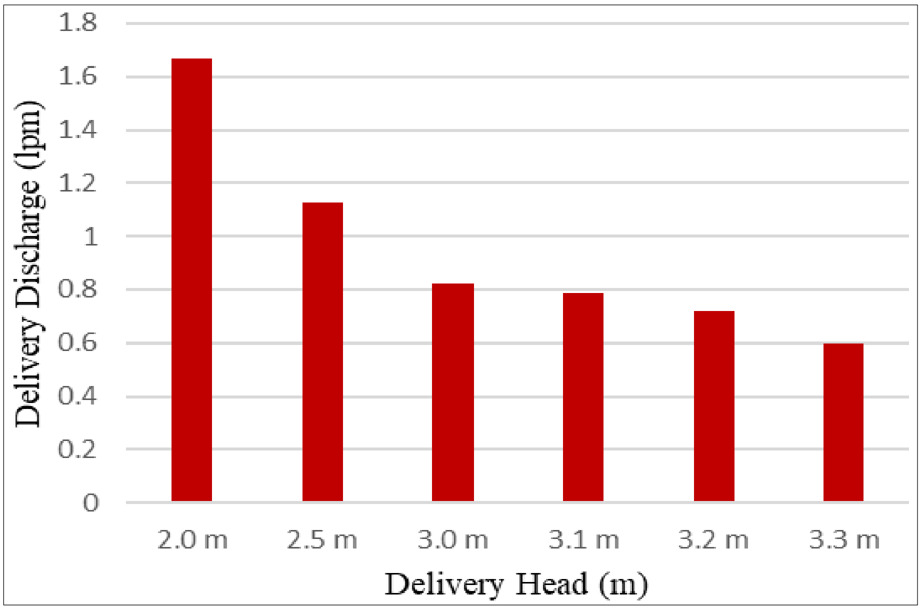


**Fig 1:** Delivery discharges (lpm) at 1.0 m supply head

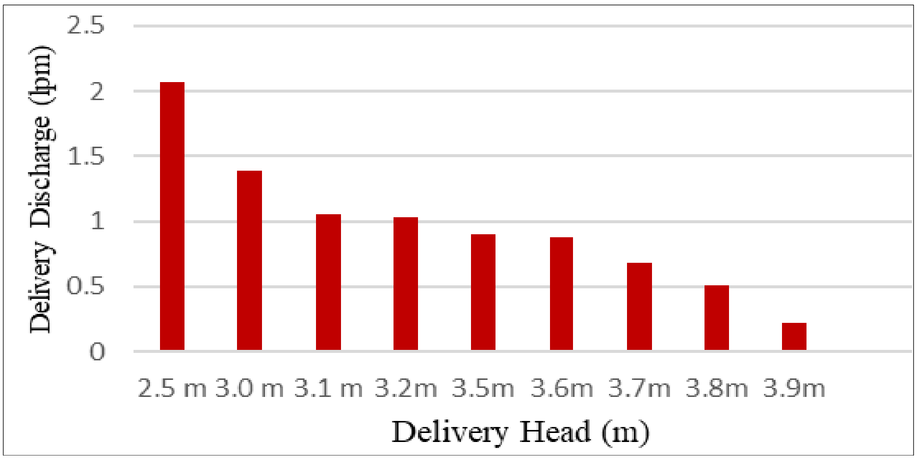


**Fig 2:** Delivery discharges (lpm) at 1.5 m supply head

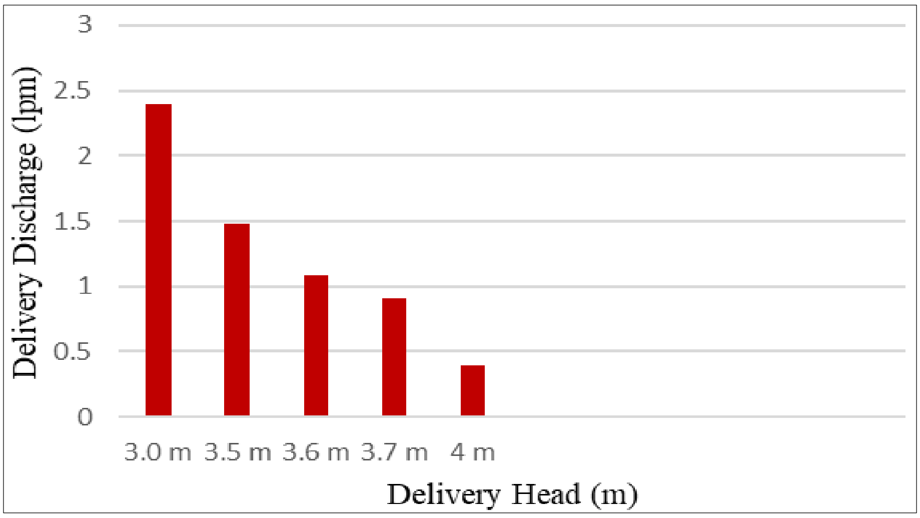


**Fig 3:** Delivery discharges (lpm) at 2.0 m supply head

The developed device was tested for 2.0 m head, 32, 40, and 50 mm supply pipe diameters and 12, 16, and 25 mm delivery pipe diameters. The best performance at a 2.0 m supply head was obtained for a combination of a 40 mm diameter supply pipe and a 12 mm diameter delivery pipe. From Table 1 and Fig. 3, it is revealed that for a supply head of 2.0 m and the diameter of the delivery pipe was kept at 12 mm, the maximum discharge was found at 3.0 m head i.e. 2.40 lpm. The discharge 0f 0.39 lpm could be lifted up to 4.0 m maximum supply head.

It is also very interesting to state that as the diameter of the supply pipe increases, the discharge at the delivery side increases up to a certain extent, however decreases by increasing the delivery head.

## Conclusion

It was found from the study that as the delivery head increases, delivery discharge gradually decreases. It is also observed that if the size of the supply pipe increases, discharge rates also increase up to a certain extent. The supply pipe with diameters of 50 mm and 40 mm and the delivery pipe of 12 and 16 mm diameters were found best among all selected combinations. The 50/12 supply delivery pipe combination at 1.0 m supply head can develop maximum discharge and head of 1.67 lpm and 3.3 m. The 50/12 supply delivery pipe combination at 1.5 m supply head can develop maximum discharge and head of 2.07 lpm and 3.9 m. The 40/12 supply delivery pipe combination at 2.0 m supply head can develop maximum discharge and head of 2.40 lpm and 4.0 m. The developed device is useful for lifting water without power in remote areas of the Konkan region.

## References


1. Arude H, Bhojane A, Dhamale A, Walunj A, Shinde S. Hydraulic Ram Pump. International Journal of Advance Engineering and Research Development (IJAERD) Technophilia-2018; c2018, 5(04).
2. Asvapoositkul W, Juruta J, Tabtimhin N, Limpongsa Y. Determination of Hydraulic Ram Pump Performance: Experimental Results. Hindawi Advances in Civil Engineering. 2019;2019:9702183.
3. Balgude R, Rupanavar S, Bagul P, Ramteke M. Designing of Hydraulic Ram Pump. International Journal of Engineering and Computer Science. 2015;4(5):11966-11971.
4. Cararo D, Damasceno F, Griffante G, Alvarenga L. Hydraulic ram pump manufacturer features using alternative materials. Rev. bras. eng. agríc. ambient; c2007, 11(4).
5. Carvalho J, Saad J, Silva D, Cunha F, Teixeira M, Campos M, *et al*. Performance of water ram built with disposable bottles. African Journal of Agricultural Research. 2016;11(34):3197-3202.
6. Choudhary S, Shende P, Ninawe A. Design and Analytical Calculation for a Hydram using Individual Head Losses. International Journal of Science Technology & Engineering. 2015;2(02):107-111.
7. Filipan V, Virag Z, Bergant A. Mathematical Modelling of a Hydraulic Ram Pump System. Journal of Mechanical Engineering. 2003;49:137-149.
8. Gaikwad V, Gholap M, Kadus R, Gaikwad M, Padekar A, Mali P. Recycled Hydro-power plant using hydraulic Ram Pump. IJARIIE; c2017, 3(2).
9. Ghosh S, Sinha P, Halder B. Scope for using underutilized Hydraulic sources a Re-emphasis on the role of Hydram. Int. Journal of Engineering Research and Application. 2018;8(7):42-47.
10. Gilbert S. Water-lifting devices, Linking Technology Choice with Operation and Maintenance. Available from: https://silo.tips/download/4-water-lifting-devices; c2016. p. 43-63.
11. Girish L, Naik P, Bhanu Prakash H, Sunil Kumar M. Design and Fabrication of a Water Lifting Device without Electricity and Fuel. International Journal on Emerging Technologies. 2016;7(2):112-116.
12. Grygo D. Effect of the Height of the Delivery Water on Performance of Water Ram. Technical Sciences. 2016;19(2):139-149.
13. Gupta P, Chauhan S, Oza M. Modelling surface run-off and trends analysis over India. J Earth Syst. Sci. 2016;125(6):1089-1102.
14. Hamid Z, Zain M, Hung F, Halim M, Bidin W, Chatta I, *et al*. Performance Testing on Ram Pump – An Alternative Sustainable Water Supply System for Rural Communities in Malaysia. Malaysian Construction Research Journal. 2016;19(2):57-73.
15. Kadlowec J, Dmitruck K, Everett J, Ketcho K, Zhang H, Pillion K, *et al*. Rope Pump Modifications to Reach Greater Depths: A Service Project for Clean Water in The Gambia. International Journal for Service Learning in Engineering. 2013;8(2):8-23.
16. Kimaro S. The Influence of Air Vessel Volume on the Delivery Flow Rate and Efficiency of a Hydram Water Pumping System. International Research Journal of Engineering and Technology (IRJET). 2018;05(05):1312-1320.
17. Kumar H, Temesgen, Beyene T, Ofgaa G, Kaso M, Shemellis, *et al*. Pollution Free Design and Manufacturing of Hydraulic Ram Pump for Villages in Hill Areas. International Journal of Mechanical Engineering Research and Technology; c2016, 2(2).
18. Lee S, Yoon H, Kim D, Shin E, Kim Y, Ko K, *et al*. Evaluation of Field Feasibility and Efficiency of Hydraulic Ram Pump. Korea Institute of Geoscience and Mineral Resources. Daejeon 305-350, South Korea, University of Science and Technology, Daejeon 305-350, South Korea; c2016.
19. Limbore N, Khillare S. An Analytical study of Indian Agriculture Crop Production and Export with reference to Wheat. Review of Research; c2015, 4(6).
20. Mandale V, Mahale D, Nandgude S, Gharde K, Thokal R. Spatio-Temporal Rainfall Trends in Konkan Region of Maharashtra State. Advanced Agricultural Research & Technology Journal. 2017;I(I):61-69.
21. Maratos D. Technical feasibility of wave power for seawater desalination using the hydro-ram (Hydram). Desalination. 2003;153:287-293.
22. Maw Y, Htet Z. Design of 15 meter Head Hydraulic Ram Pump. International Journal of Scientific Engineering and Technology Research. 2014;03(10):2177-2181.
23. Shende P, Choudhary S, Ninawe A. Analysis and Enhancement of Hydraulic Ram Pump using Computational Fluid Dynamics (CFD). International Journal for Innovative Research in Science & Technology. 2015;2(03):109-133.

24. Suarda M, Ghurri A, Sucipta M, Kusuma G. Investigation on the characterization of waste valve to optimize the hydraulic ram pump performance. AIP Conference Proceedings 1984, International Conference on Thermal Science and Technology (ICTST); c2017. 2018;PN:020023-1-020023-9.
25. Verspuy C, Tijsseling A. Hydraulic ram analysis. Journal of Hydraulic Research. 2010;31(2):267-278.
26. Viccione G, Immediata N, Cava R, Piantedosi M. A Preliminary Laboratory Investigation of a Hydraulic Ram Pump. Proceedings 2018. 2018;2:687.
27. Waghmare S, Prabhavalkar M. Design and Fabrication of Gravity-Assisted Free Energy Pump. Journal of Engineering Research and Studies. 2013;4(2):12-15, 05-08.
28. Yang K, Li J, Guo Y, Guo X, Fu H, Wang T. Design And Hydraulic Performance Of A Novel Hydraulic Ram Pump. China Institute of Water Resources & Hydropower Research, Beijing/100038, China, City University of New York (CUNY), CUNY Academic Works, 11th International Conference on Hydroinformatics HIC 2014, New York City, USA. 2014.
29. Zaman A, Khan T. Design of a Water Wheel for a Low Head Micro Hydropower System. Journal Basic Science and Technology. 2012;1(3):1-6.