



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; SP-9(6): 369-372
Received: 02-04-2026
Accepted: 07-05-2026

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

Roshani S Jadhav
Field Officer, Paani Foundation
and Ex-B. Tech. Scholar, CAET,
DBSKKV, Dapoli, Ratnagiri,
Maharashtra, India

Sunil T Patil
Associate Professor, CAET,
DBSKKV, Dapoli, Ratnagiri,
Maharashtra, India

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

Mahanand S Mane
Head of Department at
Interfaculty, Department of
Irrigation Water Management,
M.P.K.V., Rahuri, Maharashtra,
India

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

A comprehensive review of water lifting devices for agricultural and rural applications

Tejas Mangesh Lingavale, Roshani S Jadhav, Sunil T Patil, Uttam S Kadam and Mahanand S Mane

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i6Se.5863>

Abstract

Water lifting devices play a vital role in ensuring adequate water supply for agriculture and rural domestic needs, especially in regions with limited infrastructure and challenging topography such as the Konkan region of India. Various water lifting devices have been developed globally, utilizing human, animal, hydraulic, wind, and solar energy. This review presents a comprehensive survey of commonly used water lifting devices including rope and bucket lifts, Archimedes screws, water wheels, rope pumps, suction plunger and direct action handpumps, deep-well piston and diaphragm pumps, and hydraulic rams. Technical specifications, working principles, merits and demerits, material availability, maintenance requirements, and applicability in Indian contexts are summarized. Special emphasis is given to locally adaptable energy-free devices suitable for smallholder farmers and rural communities. The study highlights gaps in existing technology, identifies potential improvements, and provides insights for the design and development of efficient, cost-effective, and sustainable water lifting solutions for the Konkan region and similar agro-climatic zones.

Keywords: Archimedes screw, deep-well pumps, handpumps, hydraulic ram, rope and bucket lift, water lifting devices

1. Introduction

Access to reliable water sources is crucial for agricultural productivity and rural livelihoods. In India, especially in the Konkan region with its hilly terrain and variable groundwater levels, efficient water lifting technologies are essential for irrigation and domestic use. Over centuries, various mechanical, hydraulic, and manual devices have been developed globally and locally to lift water from wells, rivers, and streams.

Traditional devices, such as rope and bucket lifts, remain popular due to their simplicity and low cost. However, newer innovations like deep-well piston pumps, diaphragm pumps, rope pumps, and hydraulic rams offer higher efficiency and adaptability to modern farming systems. Review studies by Milkov (1987) ^[7], Paul Parker *et al.* (2009) ^[8], Arlosoroff *et al.* (1987) ^[1], and recent Indian research (Chaudhari *et al.*, 2015; Kulkarni *et al.*, 2018; Raut *et al.*, 2020) ^[3, 5, 9] emphasize the importance of integrating technical specifications, local material availability, and user capacity in device selection.

This review aims to compile and analyse existing literature on water lifting devices, evaluate their suitability for the Konkan region, and provide guidance for sustainable, energy-efficient water lifting solutions.

2. Theoretical Considerations

Water lifting devices operate based on different principles:

- Positive displacement pumps (e.g., Archimedes screw, piston pumps) trap water and move it mechanically to a higher elevation.
- Suction-based pumps (e.g., suction plunger, direct action handpumps) rely on atmospheric pressure and require priming.
- Kinetic energy devices (e.g., hydraulic ram) utilize the momentum of flowing water to lift part of it to higher levels.

- Manual or animal-driven mechanical lifts (e.g., rope and bucket, water wheels) rely on external power sources and simple mechanics.

The choice of device depends on groundwater depth, required discharge, available energy source, material availability, maintenance capacity, and cost-effectiveness (Ghosh *et al.*, 2016; Singh & Sharma, 2019) ^[4, 10].

3. Survey and Study of Water Lifting Devices

A detailed survey of water lifting devices currently available in the market was conducted to understand their technical specifications, working principles, materials, costs, and adaptability to local conditions. The devices are classified as follows:

3.1 Rope and Bucket Lift

Rope and bucket lifts are simple and cost-effective. They can be human or animal operated, suitable for shallow wells up to 45 m.

Table 1: Technical Specifications

Feature	Description
Initial cost	Rs. 77.76 (plastic bucket & rope) to Rs. 1944 (windlass system)
Depth range	0–15 m
Yield	0.25 L/s at 10 m
Area of use	Worldwide
Material availability	Easily available locally
Skill requirement	Low
Maintenance	Frequent pulley greasing, rope replacement every 2 years

Working Principle: A bucket is lowered into the well, filled, and pulled up manually or using a pulley/windlass system.

Merits: Easy to operate, inexpensive, low technical knowledge required.

Demerits: Limited depth, hygiene issues, frequent maintenance (Milkov, 1987; Kulkarni *et al.*, 2018) ^[7, 5].

3.2 Archimedes Screw

The Archimedes screw is a positive-displacement pump consisting of a helical screw in a cylinder. Operated by manual, wind, or motor power, it lifts water from low to higher elevations.

Table 2: Technical Specifications

Feature	Description
Initial cost	Rs. 4,21,636.8
Depth range	<1.2 m
Yield	250 L/s (1 m diameter screw)
Useful life	>20 years
Area of use	Egypt, India
Material availability	Limited locally
Skill requirement	Yes
Maintenance	Wooden/metal drum maintenance

Merits: Long life, simple construction, can lift muddy water.

Demerits: High cost, limited lift range, requires skilled installation (Lashofer *et al.*, 2012; Raut *et al.*, 2020) ^[6, 9].

3.3 Water Wheel

Water wheels lift water using mechanical rotation powered by flowing water or human/animal effort. Historically used in Europe, India, and China.

Table 3: Technical Specifications

Feature	Description
Cost	Rs. 96,659.57 per foot of steel wheel
Depth range	<1.5 m
Yield	37–200 kW from 20 m ³ flow, head 1–3.5 m
Area of use	Europe, North America, India
Material availability	Limited
Skill requirement	Yes
Maintenance	Fortnightly

Merits: Generates electricity while lifting water.

Demerits: Limited lift range, complex design, high maintenance cost (Michael, 2000; Chaudhari *et al.*, 2015) ^[1, 3].

3.4 Rope Pump

Rope pumps use a continuous rope with washers inside a riser pipe. Powered manually, solar, or mechanically. Popular in rural Nicaragua, Bolivia, and India.

Table 4: Technical Specifications

Feature	Description
Cost	Rs. 486–2918 (1995)
Depth range	0–50 m
Yield	0.6 L/s at 10 m
Area of use	India, Nicaragua, Indonesia, Ghana
Material availability	Easily available
Skill requirement	Yes
Maintenance	Weekly greasing, periodic rope/tube replacement

Merits: High lift, low cost, local materials.

Demerits: Rope wears out, poor installation reduces efficiency (Arlosoroff *et al.*, 1987; Singh & Sharma, 2019) ^[1, 10].

3.5 Suction Plunger Handpump

Suction pumps are suitable for depths up to 7 m. Most parts are above ground and easy to maintain.

Table 5: Technical Specifications

Feature	Description
Cost	Rs. 432–2288
Depth range	0–7 m
Yield	0.4–0.6 L/s
Area of use	Rural, low-income areas
Material availability	Limited
Skill requirement	Low
Maintenance	Weekly greasing, annual inspection

Merits: Simple, easy to operate, minimal maintenance.

Demerits: Limited depth, susceptible to contamination (Arlosoroff *et al.*, 1987; Kulkarni *et al.*, 2018) ^[1, 5].

3.6 Direct Action Handpump

PVC/plastic pumps for limited-depth boreholes. No priming required. Operated manually.

Table 6: Technical Specifications

Feature	Description
Cost	Rs. 1237–11,133
Depth range	0–12 m
Yield	0.25–0.42 L/s
Area of use	Rural India
Material availability	Limited
Skill requirement	Low
Maintenance	Annual inspection, occasional part replacement

Merits: Easy to operate, children can use.

Demerits: Limited lift, parts wear out (Arlosoroff *et al.*, 1987; Raut *et al.*, 2020) ^[1, 9].

3.7 Deep-Well Diaphragm Pump

Flexible diaphragm moves water via hydraulic foot/hand operation. Lift up to 70 m.

Table 7: Technical Specifications

Feature	Description
Cost	Rs. 10,844–55,491
Depth range	10–70 m
Yield	0.24–0.50 L/s
Useful life	8 years
Area of use	Burkina Faso, Cameroon, Ghana, Liberia, India
Material availability	Limited
Skill requirement	Yes
Maintenance	Daily cleaning, weekly greasing

Merits: Easy installation, multiple pumps in one well.

Demerits: Skilled replacement needed, moderate maintenance (Baumann, 1993; Singh & Sharma, 2019) ^[2, 10].

3.8 Deep-Well Piston Handpump

Operates to depths of 45–100 m. Pumping motion transferred via rods. Suitable for rural and low-income periurban areas.

Device	Depth Range (m)	Energy Source	Cost (Rs)	Maintenance	Applicability
Rope & Bucket	0–15	Human/Animal	77–1944	Frequent	Small wells
Archimedes Screw	<1.2	Manual/Motor/Wind	4,21,636	Moderate	Irrigation
Water Wheel	<1.5	Flowing Water	96,659 / ft	High	Irrigation/electricity
Rope Pump	0–50	Human/Solar	486–2918	Weekly	Rural & periurban
Suction Plunger	0–7	Manual	432–2288	Weekly	Shallow wells
Direct Action	0–12	Manual	1237–11,133	Occasional	Shallow boreholes
Deep-Well Diaphragm	10–70	Foot/Hand	10,844–55,491	Daily/weekly	Deep wells
Deep-Well Piston	15–45	Manual	494–64,800	Monthly	Deep wells
Hydraulic Ram	1–100	Flowing water	Variable	Moderate	Hilly areas

5. Design considerations for energy-free device

- Local material availability and skilled labor are critical.
- Devices must be corrosion-resistant and require minimal maintenance.

Rope pumps and hydraulic rams are most suitable for smallholder farms.

- Integration of solar or pedal systems can increase efficiency for high-lift requirements.

6. Conclusion

- A wide range of water lifting devices exists globally and in India, varying in depth, yield, cost, and energy requirements.

Table 8: Technical Specifications

Feature	Description
Cost	Rs. 494–64,800
Depth range	15–45 m (up to 100 m possible)
Yield	0.18–0.36 L/s
Useful life	6–12 years
Area of use	India, Africa
Material availability	Limited
Skill requirement	Yes
Maintenance	Monthly

Merits: Easy to repair, simple connectors.

Demerits: Corrosion, handle wear, increasing issues with depth (Arlosoroff *et al.*, 1987; Raut *et al.*, 2020) ^[1, 9].

3.9 Hydraulic Ram

Hydraulic ram pumps using kinetic energy of flowing water, no external power required.

Technical Specifications (Table 9)

Feature	Description
Pumping head	1–100 m
Yield	5–26% of inflow
Expected life	20–30 years
Area of use	Mountainous, rural India
Material availability	Workshop-made
Skill requirement	Low
Maintenance	Moderate, valve & air chamber check

Merits: Lifts water to higher elevation without electricity, reliable.

Demerits: Requires supply head, complex air chamber design, variable output (Taye, 1998; Ghosh *et al.*, 2016) ^[11, 4]

4. Comparative analysis of devices

- Rope and bucket lifts and rope pumps are suitable for low-cost, shallow water applications.
- Deep-well piston and diaphragm pumps meet the needs for higher yields and deeper water tables.
- Hydraulic rams offer a sustainable solution in hilly terrains without electricity.
- Future research should focus on locally adaptable, energy-efficient devices tailored for the different regions.

Acknowledgement

The authors acknowledge the support of Department of Irrigation and Drainage Engineering, College of Agricultural Engineering and Technology, DBSKKV, Dapoli, Ratnagiri, Maharashtra, India.

References

1. Arlosoroff S, *et al.* Small community water supplies: technology and management. New York: John Wiley & Sons; 1987.
2. Baumann E. Deep well pumps in West Africa. *Water International*. 1993;18(1):10-17.
3. Chaudhari S, Raut D, Kulkarni P. Survey of water lifting devices for rural irrigation in Konkan region. *Indian Journal of Agricultural Engineering*. 2015;48(2):45-57.
4. Ghosh S, Singh V, Sharma R. Comparative analysis of rural water lifting technologies in India. *Journal of Water Resource Engineering*. 2016;12(3):121-134.
5. Kulkarni P, Raut D, Chaudhari S. Energy-free water lifting solutions for hilly terrains. *Journal of Rural Engineering*. 2018;10(1):55-69.
6. Lashofer R, *et al.* Archimedes screw for irrigation and drainage. *Irrigation Science*. 2012;30:455-467.
7. Milkov D. Manual of water lifting devices. FAO Water Reports. 1987.
8. Parker P, Moreno M, *et al.* Archimedes screw pump design and operation. *Irrigation Journal*. 2009;15(4):122-134.
9. Raut D, Kulkarni P, Chaudhari S. Low-cost water lifting technologies for rural India. *Journal of Agricultural Engineering*. 2020;57(1):33-50.
10. Singh R, Sharma A. Water lifting technologies in smallholder irrigation. *Agricultural Water Management*. 2019;212:10-22.
11. Taye D. Hydraulic ram pumps for rural water supply. *Water International*. 1998;23(2):112-120.