The Rower Pump

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manufactured by:
Mirpur Agricultural Workshop and Training School (MAWTS)
Mirpur Section 12, Pallabi
Dacca-16, BANGLADESH

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REPORT 1: THE ROWER PUMP

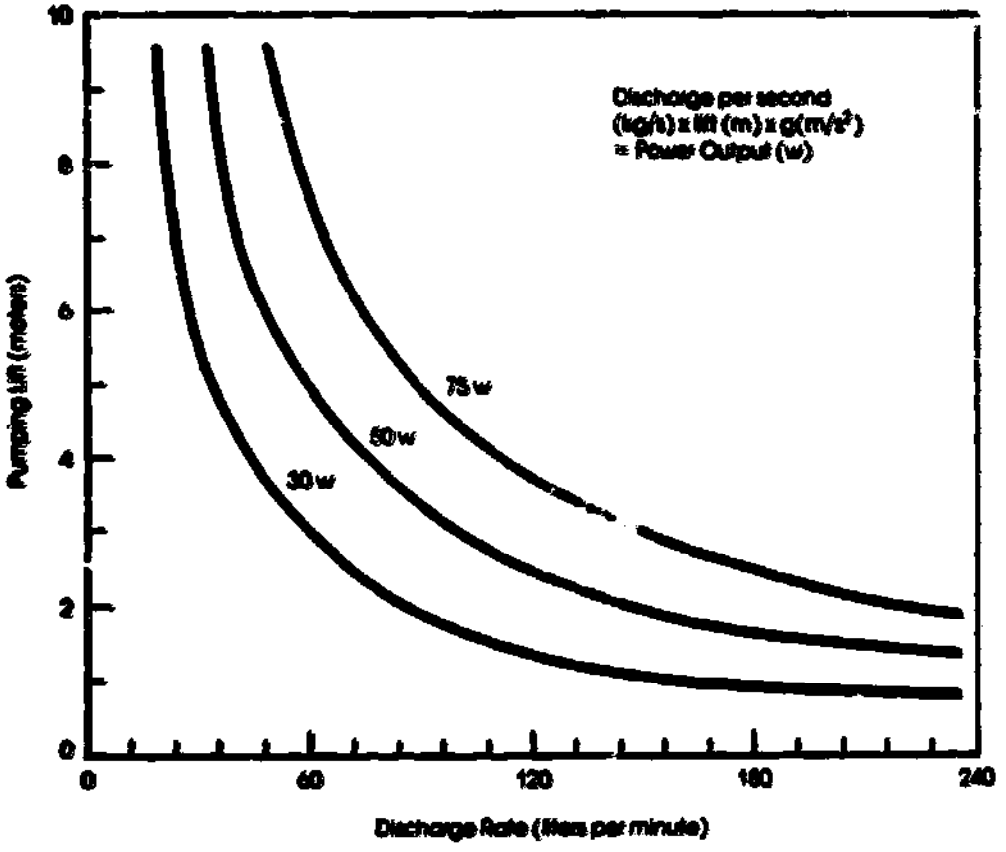
1. DESCRIPTION

The Rower pump is a manually operated reciprocating pump with a 2 inch nominal diameter PVC pipe as the pump cylinder. The piston inside the cylinder is operated by pulling and pushing directly on a T-handle at the end of the piston rod. The pump is installed at an inclined angle of 30° from the horizontal to the well in the ground through a "Y" connector piece. Moving the "T" shape handle in a rowing motion the farmer/operator thrusts the piston back and forth in the cylinder and draws water out of the tube well by means of suction. Use of a suction chamber is made to compensate for the velocity variation produced by the water column traveling in the well pipe, which provides a steadier upward flow of water in the ground pipe enabling the operator to make easier and smoother strokes. Compared with the conventional metal body lever pumps a person can pump significantly more water in a given time with the Rower pump at a suction lift of 15 to 25 feet (5 to 8 meters). The output difference increases with the increased lift, however, at 20 feet lift the output is about 0.8 liters per second (12 GPM) depending on the aquifer condition. The pump is easy to install and operating comfort is remarkable. The pump is being used for small scale irrigation by the farmers for various types of crops. Several types of the Rower pump have been produced and tested for various lifting height and cylinder sizes. Another successful version is the 3 inch diameter Rower pump suitable for low lifting of surface water up to a lift of 10 feet (3 meters) giving an output of about 2 liters per second.

2. TYPES OF ROWER PUMPS

Types	Maximum Lift	Recommended Maximum Working Lift	Discharge at Recommended Lift	Suitability
Rower pump 2 inch	26 ft (7.9 m)	20 ft (6.1 m)	0.8 liters/sec 13 gal/min	Tube well
Rower pump 2.5 inch	18 ft (5.5 m)	12 ft (3.7 m)	1.5 liters/sec 20 gal/min	Lifting water from dug well & tube well
Rower pump 3 inch	12 ft (3.7 m)	9 ft (2.7 m)	2.0 liters/sec 30 gal/min	Surface water lifting from pond, canal, river, etc.

Figure B-1
Water Discharge Versus Depth



3. PERFORMANCE CHARACTERISTICS

During field trials carried out in various parts of Bangladesh, the performance of the two inch Rower pump has been found as indicated in the discharge graph shown for various power inputs by individuals while operating the pump. However, for an average healthy person operating the pump output over a period of eight hours of continuous operation in turn by two persons operating and resting is as indicated in the table:

2 Inch Rower Pump

Lift Height	Discharge
10 feet (3.0 m)	23.0 gpm (1.5 liters/sec)
15 feet (4.6 m)	20.0 gpm (1.3 liters/sec)
18 feet (5.5 m)	17.0 gpm (1.1 liters/sec)
20 feet (6.0 m)	12.5 gpm (0.8 liters/sec)

4. OPERATIONAL INSTRUCTION

4.1 Well

The well normally consists of 1-1/2 inch nominal diameter galvanized iron (G.I.) pipe or PVC pipe as found suitable, depth of the well would vary according to the ground condition from place to place. A screen/filter length of 12 feet (3.7 m) at the bottom of the well is generally recommended. In certain cases 6 foot (1.8 m) length may be sufficient. Fine sand condition would necessitate a gravel packing around the screen. Gravel packing must be well mixed and consist of required sand sizes. A cap is required at the bottom of the screen. The top end of well casing should be installed at a proper point so that the pump outlet will be 20 to 24 inches (51 to 61 cm) above the surface where the operator stands. This height assumes an adult operating the pump. For final placement of the well, pack the top of the casing pipe tightly, to prevent movement of the well during pumping action.

4.2 Installation of Pump

a) Inspect all the pump parts so that they function properly:

Foot valve seal should seat tightly inside the tapered end of the cylinder.

- Piston locking nut moderately tightened and lock ring correctly attached, assembly in correct order.

- Surge chamber collar properly sealed with rubber mounting coupler. Check coupling for required rigidity.

b) Installing pump cylinder to "T" function piece:

- Use paint on the threads.

- Use pipe wrench to moderately tighten the cylinder to the junction "T" piece.

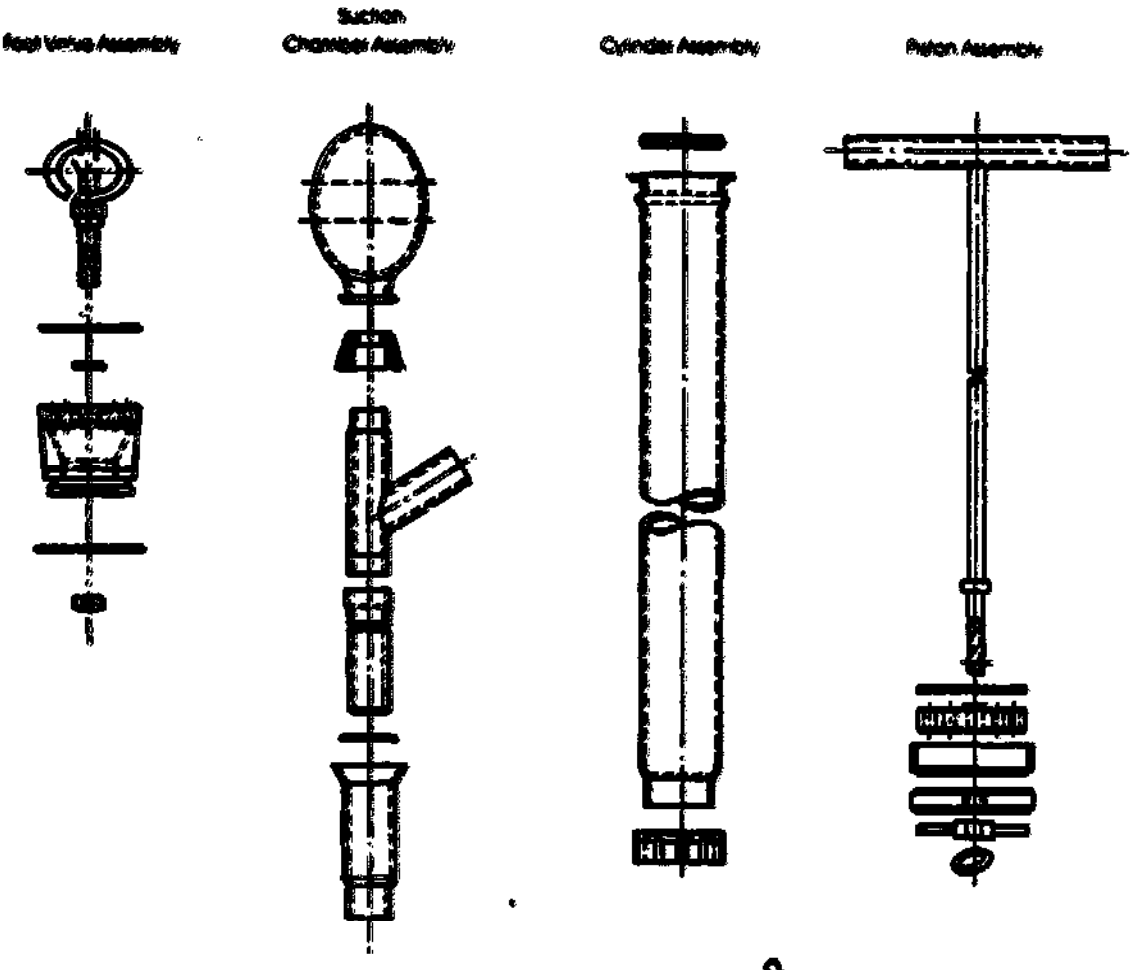
- Turn the pump in the direction the farmer wishes to operate the pump.

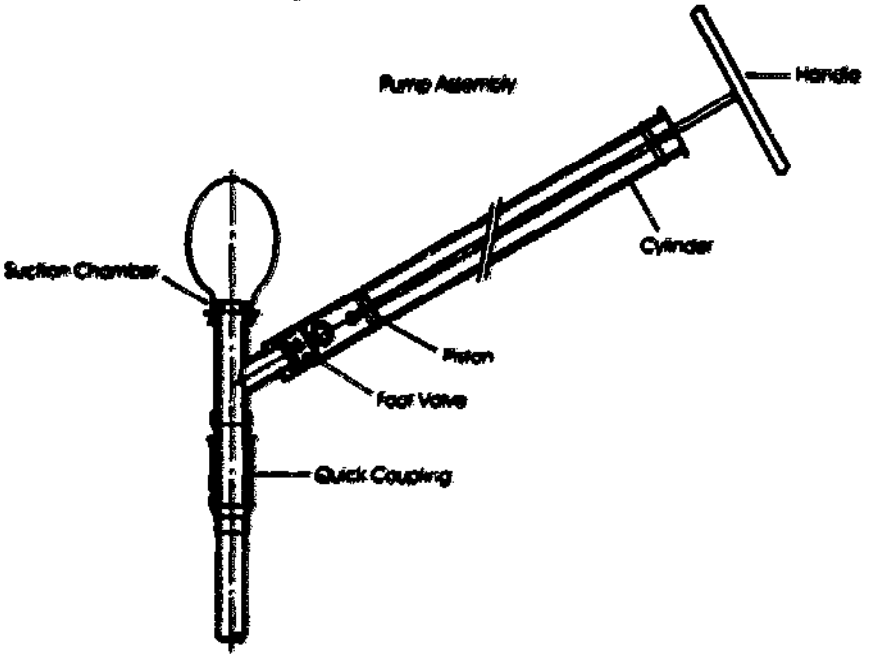
- Check the angle of the pump against the horizontal ground and the comfortable angle should be about 30^{0}.

c) Support for the inclined pump cylinder:

- Split a bamboo and tie it around the outside of the PVC pipe for sunlight protection and for stable support. Also fashion a bamboo or branch of tree to act as a vertical support directly under the pump cylinder about 1 foot from the end of the delivery spout. With wire or rope fasten these together. For additional rigidity and stability the pump can be completely buried in an earth mound.

Figure B-2
Sub-Assemblies of the Rower Pump





d) Make a proper receiving area for water to fall. Approximately 3 foot (1 m) diameter area with small dike around the perimeter. If the user wishes the water can be conveyed by various means found suitable for different areas. Efforts should be made to prevent soil erosion around the pump specially at the delivery end.

4.3 Developing the Well

In order to lengthen the useful life of the well and the pump and allow for easy operation of the pump the following procedures are recommended:

Once the pump and well are completely installed begin to operate the pump, when water appears, stop and quickly remove the surge chamber from the pump allowing the water column to rush down into the well.

Repeat this procedure two to three times. Next start pumping water from the well with Rower pump till all dirty water ceases to come out. When water appears clean remove the surge chamber as before, as many times as necessary, till no more dirty water is discharged from the well. This procedure may have to be repeated several times before the well is satisfactorily developed.

4.4 Tools Required for Installation of the Pump

Pipe wrench and hacksaw blade (if PVC well is used). For normal operation hardly any tools are required.

5. REPAIR AND MAINTENANCE

The merit of the Rower pump lies in the very simple design used for its manufacture. The pump during its normal operation hardly requires any maintenance, and the components are very simple and spares may be easily replaced without use of any tools. Simplified maintenance is an important feature of this pump. Access to both piston and foot valve is quick and simple. They can be removed without dismantling the pump. The piston with the leather cup seal in the cylinder can be easily removed by pulling out the piston rod. A rod with a hook at one end and a ring at the other is used to both draw out the foot valve and slide it back again. If the pump looses its prime then the foot valve seals and sealing of the suction chamber around the coupling rubber piece should be checked for leakage. Different rubber seals used in the pump can be made from ordinary inner tubes and replaced. Other maintenance points are:

5.1 Leather Bucket

If the action of the piston becomes stiff usually it is found that the leather bucket has swollen and needs "shaving" to make it an easy slip fit.*

5.2 Rubber Piston Valve

If a replacement valve is required it must be tight fit around the piston rod, and cover all the holes in the aluminum plate.

5.3 Over Tightening of Locking Nut

Over tightening of the locking nut can result in cracking the aluminum plates. For this reason a washer is provided to facilitate tightening.

5.4 Bending of Piston Rod

If the piston rod is bent, it will result in excessive wear of the piston guide or the leather bucket. This condition must be avoided.

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* Editor's comment: This statement has been included here because it is part of the original document provided by the Mennonite Central Committee. However, elsewhere, with other types of pumps, it has been found that the practice of "shaving" oversized leather buckets (leather cup seals) has drastically shortened their working life. The outside of the leather is its strongest part, and once shaven the remainder deteriorates rapidly. It is therefore important to provide original leather buckets which are undersized and will not need shaving. Buckets with a diameter about 1/16 inch (about 1.5 mm) smaller than the inside diameter of the cylinder have been found to work well elsewhere, with different pumps.

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REPORT 2: ROWER PUMP INFORMATION
(Two-Inch Model)

INTRODUCTION

Groundwater conditions in many parts of Bangladesh are good enough to allow successful operation of above-ground, reciprocating piston handpumps. However, other parts of Bangladesh are not suitable. In those areas, the water level drops to 25 feet (8 m) or more in the dry season, not allowing traditional hand irrigation pumps to operate easily for irrigation.

The Rower Pump is designed to meet unfavorable groundwater conditions. This manually operated handpump produced in Bangladesh has features of relatively high water output, easy field maintenance, and low cost.

PUMP DESCRIPTION

The Rower Pump is simple, consisting of 15 disassembleable parts. The pump cylinder is a two inch PVC pipe mounted on the tubewell at 30 degrees from horizontal. The water flows through the upper end of the body as the piston rod is pushed and pulled. A one-directional "foot valve" is at the lower end of the body, by use of a suction chamber attached below the foot valve, water flows steadily, enabling a relatively easy and smooth pumping effort.

INSTALLATION

Necessary to pump operation is a proper installation. A good installation will increase pump life, enable efficient water output, and give the operator reasonable comfort. Two basic positions are recommended, but many variations from them are possible. The sitting position is suitable for prolonged operation. The pump is completely buried in the soil, leaving the mouth only a few inches above ground level. This installation is the least expensive, most resistant to theft, and can be covered for protection during seasonal flooding.

The second position, operating while standing can be used for irrigation as well as home purposes. The support under the cylinder is quite sufficient to prevent movement at the pump's base. The cylinder should be wrapped with bamboo. It is recommended to make the water receptacle and standing ramp of concrete. The two inch Rower Pump is installed with 1-1/2 inch nominal diameter tubewells. It can be used with galvanized iron (GI), plastic or bamboo pipe. Rural well drillers setting the pump in Comilla and Noakhali are required to take a 3 day training course including theory and practice, to bring their skills up to necessary levels.

IRRIGATION SUITABILITY

The Rower Pump is designed for irrigation. While it is especially useful for winter vegetables and wheat, many other crops can be irrigated. Given good conditions and high labor input, rice can be irrigated. With its field-

tested output (described below), the Rower Pump can produce in eight 5 hour days more than one inch of water over one acre of crop land.

PUMPING CHARACTERISTICS

The pump has been operated without cavitation at a 28 foot (8.5 m) water level. Irrigation can be done at 25 foot (7.6 m) water level. At more than 25 feet (7.6 m), the strength of the operator is the limiting factor.

Recent testing has illustrated the pump's advantages at higher water lifts. At water levels between five feet (1.5 m), the output varied from 15 to 10 US gallons per minute (0.9 to 0.6 liters/sec) respectively. These pumping capacities verify the pump's usefulness for manual irrigation in many areas of Bangladesh. The range of lift capacity is approximately eight feet (2.4 m) more than any other manual pump being manufactured in Bangladesh. Surveys of fielded pumps in Comilla and Noakhali, where the water levels occurred between 10 and 15 feet (3 to 4.5 m) and sand layers varied from coarse to fine, substantiated these test results. Actual pumping outputs there ranged from 11 to 12 U.S. gallons per minute (0.69 to 0.76 liters/sec).

PUMP MAINTENANCE

One important feature of the Rower Pump is its ease of maintenance. Tools are not needed for disassembly of the piston or foot valve. These can be repaired by hand. The piston assembly is attached to the bottom of the piston rod, and may be reached by pulling the piston completely out of the cylinder. To disassemble the piston, the support plate is unscrewed. The individual parts can then be slipped off the bolt.

The foot valve can be retrieved by use of a hooked rod supplied with the pump head. Both the rubber flap valve and the ring seal can be replaced by stretching them in and out of position. The PVC cylinder pump body is glued into place on the metal "T" piece and should not be removed.

FIELD OPERATION RESULTS

During the 1980-81 rabi season, 500 pumps were marketed. These were marketed with PVC tubewells through local businessmen. The rate was subsidized at about 19 percent of actual cost. In the 1981-82 rabi season an additional 650 pumps were marketed, mostly through local businessmen, but this year at cost. The retail price was marked up to give the businessman a profit margin.

Following up on each season's sales were two surveys. First, an installation survey was conducted with each farmer immediately after his pump was fielded. Second, utilization surveys were conducted approximately on a

monthly basis with about 30 percent of the rower pump purchasers.* Below is a summary of some pertinent data from those surveys:

The pump was sold as an irrigation pump. Immediately after purchase over 90 percent of pump purchasers reported an intention to use the pump for irrigation. More than 80 percent of the pumps sampled were reported to have actually been used for irrigation. Over half of the sampled pumps were used significantly for domestic purposes (drinking, washing), a few of the users reported innovative uses such as for fish culturing, brick fields, and restaurant.

Installation surveys showed that two-thirds to three-fourths of the pump operators questioned were able to show that they could, in fact, carry out routine maintenance procedures on their pumps. Repeat visits showed over 95 percent being able to do so. Thus, the pump appears to be designed well for simple maintenance.

Good installation procedures did not appear to be conscientiously followed by the tubewell mistories as is suggested by several criteria. From the previous paragraph one reason can be deduced. Another: the water receiving area was not properly constructed. This indicates a need to pay much attention to the mistories training and the process by which they are made accountable for good work.

These sampled pumps used for irrigation during 1981-82 rabi season covered an average land area of one-half acre in the Noakhali and Comilla areas. A major crop was potato. However, many other crops were irrigated. In 1981, 27 different crops were discovered to have been irrigated by the Rower pump. A common practice noted is for a farmer to plant two or three short duration crops in succession on the same plot throughout the rabi season and early summer.

AVAILABILITY

The Rower Pump is manufactured by Mirpur Agricultural Workshop and Training School of Mirpur, Dhaka. Marketing inquiries should be directed to: Project Manager, Mirpur Agricultural Workshop and Training School, Section 12, Pallabi, Dhaka-16.

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* Copy of Survey results available at Mennonite Central Committee, Box 785, Dhaka-2.

August 1982
Mennonite Central Committee, Dhaka
MAWTS, Mirpur, Dhaka

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REPORT 3: TECHNICAL MANUAL - Two Inch Rower Pump

1. DESCRIPTION

The Rower Pump is a manually operated, reciprocating pump with two inch diameter PVC plastic pipe as the cylinder. The piston inside the cylinder is operated by pushing and pulling directly on a T-handle at the upper end of the piston rod. The pump is attached to the tube well at an angle of 30° from horizontal. Moving the piston back and forth in a rowing motion the farmer/operator draws water out of a tubewell by suction. Use is made of a vacuum chamber to damp the velocity variation in the moving water column that occurs due to the reciprocating piston. This damping effect makes it possible also to reduce stress on the operator since the water column accelerates at the beginning of each stroke at a lower rate than the piston.

The Rower pump is very simple. No extra tools are required for inspection and maintenance of the pump. Furthermore, maintenance is a simple task so that a farmer can easily check and service his own pump as needed. Primary maintenance would be expected on the piston on which a leather cup seal and a rubber valve flap are fixed, on less frequent occasions the foot valve may need to be examined. This has a rubber flap valve which is removed and replaced quite easily. The foot valve is extracted through the discharge end of the cylinder by the use of a retriever rod supplied with the pump.

2. PERFORMANCE CHARACTERISTICS

The Rower pump operates without cavitation up to about a 28 foot (8.5 m) pumping head where the pump is used for irrigation, a maximum 22 feet (6.7 m) pumping head is recommended due to limitations of operator strength and endurance. In locations where the source of water is an open well or where better tubewell conditions occur, the allowable water level under which the pump could operate satisfactorily for irrigation would be 25 feet (7.6 m). But if the tubewell does not produce water so easily this maximum water level would be proportionately less.

Assuming average conditions of a medium to fine sand layer, an adult operator and about a 15 foot (4.6 m) water level, one can expect this Rower pump to produce approximately 12 US gal/min (0.76 m liters per second) over extended period of operation. This output capacity would vary, of course, depending on the ground water conditions and development of the well. Depending on the type of installation the pump can be operated in a standing or sitting position.

The characteristic, nearly constant velocity of water in the tubewell with a Rower pump creates a favorable condition for the tubewell filter. When using the Rower pump the danger of damaging the tubewell filter is very small, even with especially fast pumping. Thus, it is not likely that the well will produce sand if the tubewell has been installed properly.

3. INSTALLATION PROCEDURE

WELL

The source of water for the two inch Rower pump is a tubewell. For this the pipe and filter/screen can consist of PVC plastic, galvanised iron (G.I.), bamboo or a combination of these. The tubewell should be installed by an experienced well driller using the best methods available within the financial means of the pump purchaser. In areas where the tapped aquifer consists of fine sand, it will be advantageous to bore a hole larger than the well pipe, allowing for oversized sand or gravel to be packed around the outside of the filter.

Proper installation of the Rower pump requires the top of the tubewell pipe to be positioned at the correct depth from ground level. Figures B-4 and B-5 show the dimensions for two alternative installation methods.

After the tubewell is positioned properly the top end should be packed very tightly with soil so that it will not move during the pumping operation.

PUMP

Push the surge chamber with the seal onto the Y-piece carefully so that it seals tightly, when fitted not more than 1/2 inch of the rubber seal will be visible. Attach the pump to the tubewell taking care to prevent any air leaks. The desirable direction of the pump with respect to the tubewell is one that considers the angle of the sun, location of irrigation fields, any available shade and other relevent factors.

INSTALLATION

Option - 1

Sitting Position: for irrigation purpose. If the pump will be used mostly for irrigation purposes and is not placed at a farmstead (bari) then the pump should be installed by the very simple, cheap and relatively secure method shown in Figure B-3. The dimensions indicated show that only a few inches of the discharge of the pump remain visible above ground level. Soil that is packed around the cylinder will prevent its movement during the pumping and will keep the cylinder positioned at the proper angle. A small amount of soil can be shaped to form a seat for the operator.

Option - 2

Standing Position: for irrigation and household uses. If the pump will have a significant amount of domestic use (drinking, cooking and washing) in addition to irrigation, the Rower pump should be installed according to the dimensions given in Figure B-4. For such uses, it will be important to have the pump placed at the correct height for a person to stand while operating. The platform on which the operator stands, and the receptacle where the water

Figure B-3
Rower Pump Installation for Irrigation

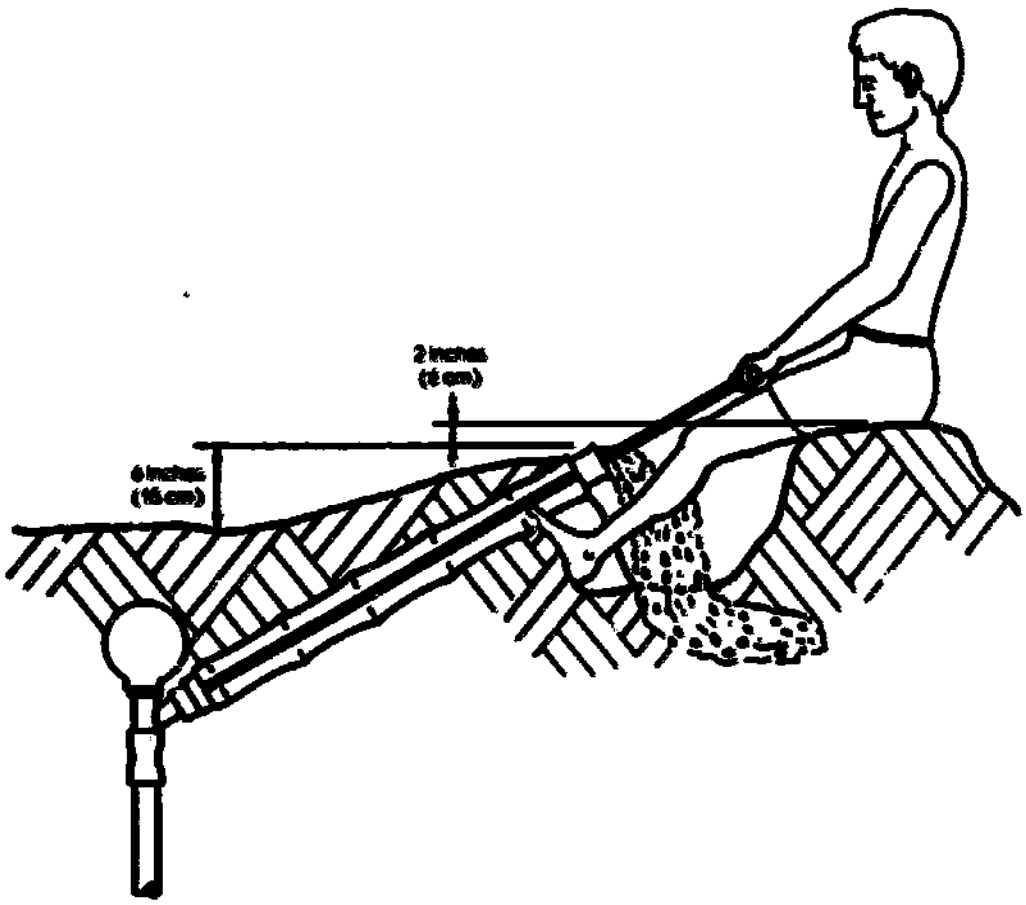

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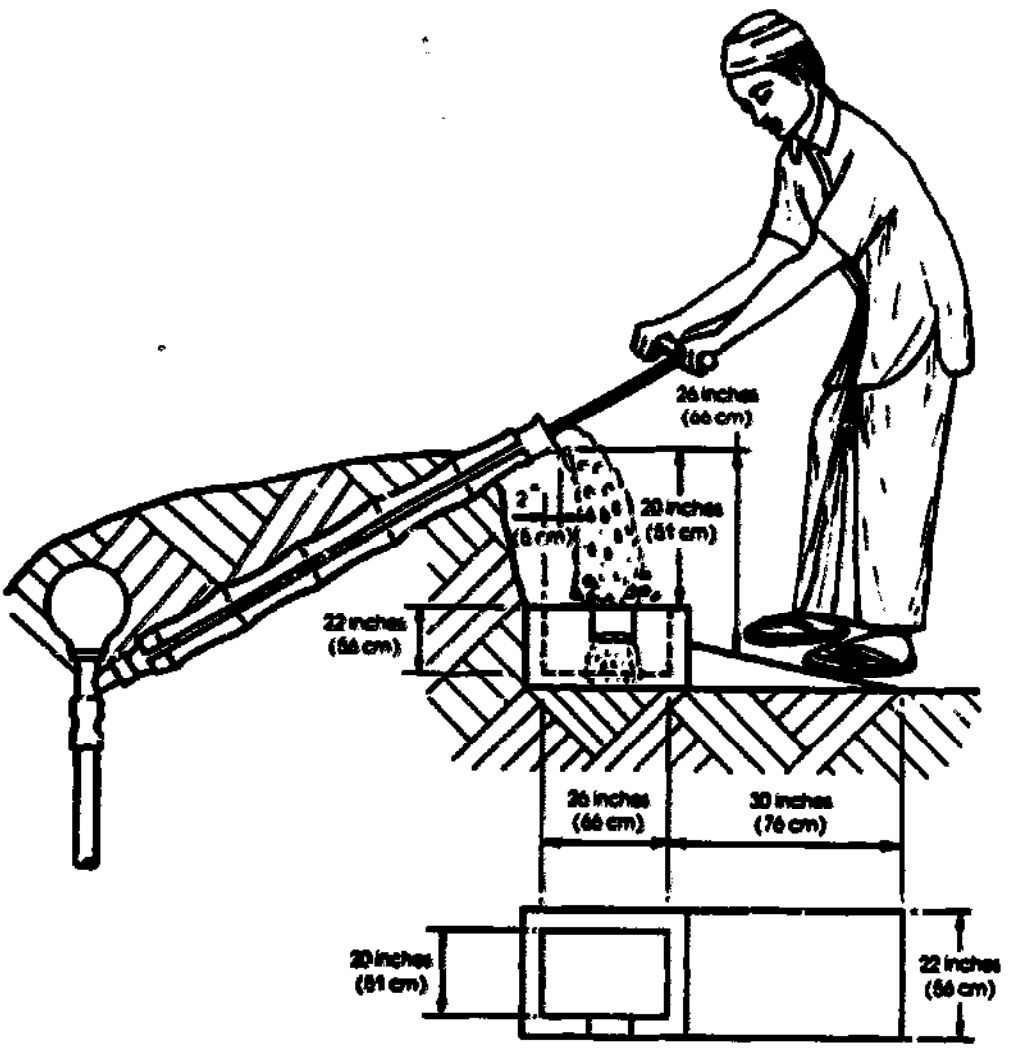
Figure B-4
Power Pump Installation for Domestic Water Supply



falls should be of such construction as to prevent erosion. Soil should be packed around the complete pump as near to the discharge end as possible.

For both installation options, the operator platform should be positioned so that when the pump is being operated the piston rod does not rub the edges of the cylinder. Long-term exposure of the PVC cylinder to direct sunlight will damage the plastic. Any exposed parts of the cylinder should be wrapped loosely with bamboo strips or other suitable material.

A very important step in installing the well comes after placement of the pump head. The well must be cleaned out and developed properly. If the well driller has no method of his own, then use the following procedures; pump for five minutes, then remove the foot valve. After the water has drained, place the foot valve back in the cylinder. Repeat this until the water becomes clean. This procedure often requires up to an hour of pumping.

4. REPAIR AND MAINTENANCE

The piston has a leather cup seal that may need occasional replacement. This is easily accomplished by removing the locking pin and unscrewing the assembly from the piston rod. If the rubber valve is worn, it can also be easily replaced at this time.

The foot valve will rarely need to be removed from the cylinder. In case water does not stay in the cylinder very long it may be useful to examine the foot valve seals. The foot valve is removed by the use of the hook on the end of the retriever rod provided with each pump. Pull the valve out of the cylinder slowly. If either of the two rubber seals is damaged or for any reason needs to be replaced just slip off the old ones and fit the new one in place. The ring seal needs to sit flat and uniformly around the valve body.

If air bubbles come out of the cylinder together with the water after several minutes of pumping, there is probably an air leak that should be plugged. The most likely source of air leaks is improperly sealed threads. A damaged surge chamber could also give this problem. For threaded components use of quality paint will serve as a good sealant.

If the surge chamber must be removed for any reason, it is again installed easily by the use of soap and water on the rubber seal and the metal surface against which it will slide. First, place the rubber seal firmly and squarely in the mouth of the surge chamber. Then, with the two mating surfaces soapy and wet, push the chamber and the seal together completely onto the Y-piece while twisting the chamber in only one direction.

5. MECHANICS RESPONSIBILITIES

The Rower pump is designed so that the owner of the pump can accomplish his own repair and maintenance. Therefore, the mechanic who installs the pump has the responsibility to clearly instruct the pump owner or user in all aspects of the pump use and maintenance. The farmer needs to know how to use his pump, how to do any routine repair, where he can obtain spare parts, and where he can obtain general advice about irrigation methods with the use of the Rower pump.

The Rower pump is developed and manufactured by:

MIRPUR AGRICULTURAL WORKSHOP AND TRAINING SCHOOL, (MAWTS)
Mirpur Section 12, Pallabi
Dacca-16, Bangladesh
Telephone No. 38 25 44

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1/1, Block "A" Mohammadpur
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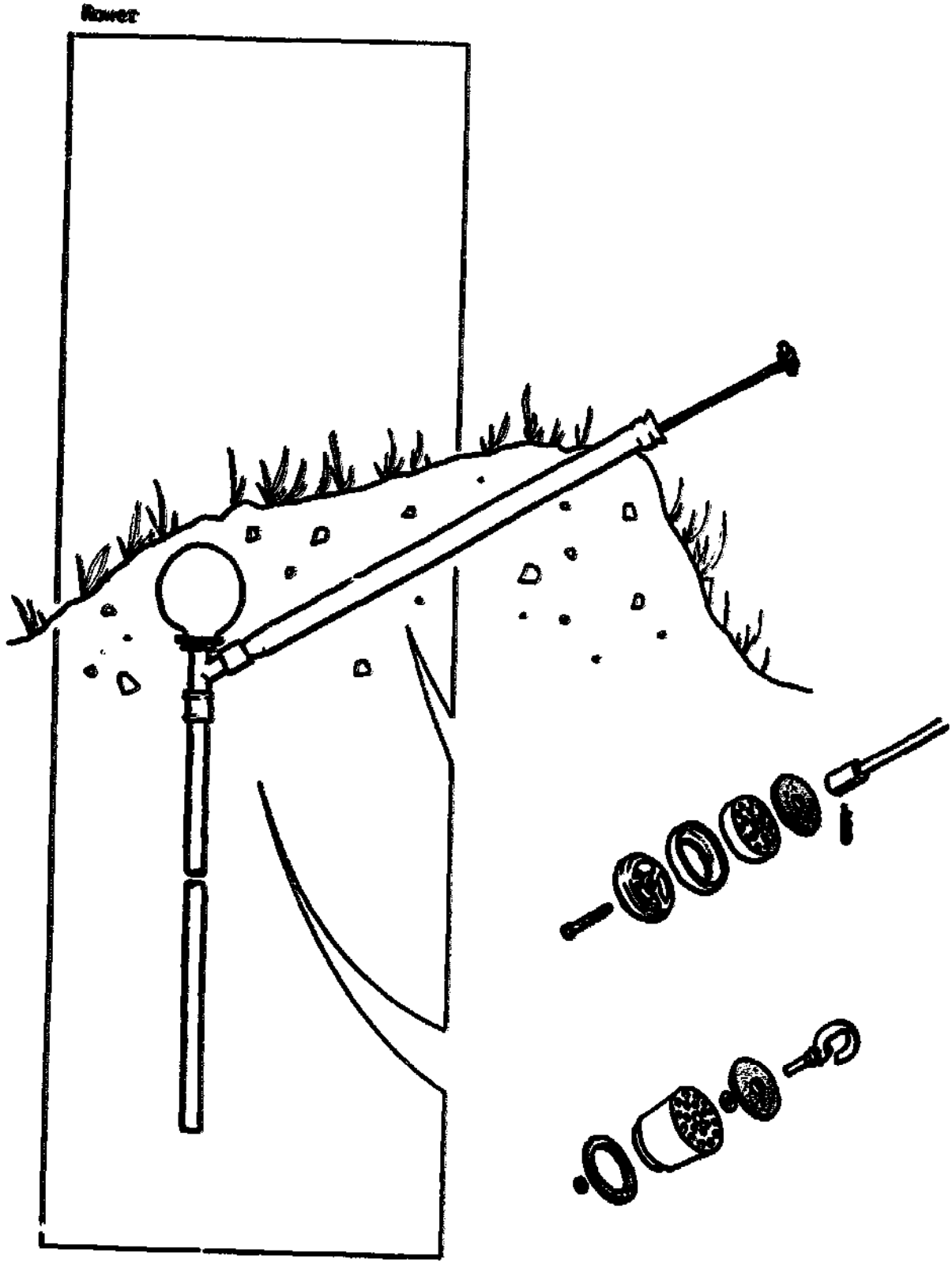
Rower

ROWER

1.1	Manufacturer	Mirpur Agricultural Workshop Training School
	Address	c/o The World Bank, 222 New Eskaton Road PO Box 97, DHAKA, Bangladesh.
1.2	Description	The Rower pump is a high capacity low-lift pump designed for irrigation, made in Bangladesh. The pump is fitted with a surge chamber. The cylinder is a single length of extruded uPVC tube with heat swaged ends. The operator pulls directly on the plunger rod by means of a T-handle. The plunger is fitted with a single leather cup washer and simple rubber flap valves cut from tyre inner tubes are used for both the plunger valve and check valve. The pump is normally embedded in earth for support and protection, as shown, or alternatively may be supported by a smaller earth bank and protected by strips of bamboo bound around the cylinder. It is usually operated in a seated position.
1.3	PRICE	$13.50, local price in Bangladesh.
2.	INSPECTION	
2.1	Packaging	The pumps were packed in a hessian sack and cardboard box. The two pump units were tied together with spare parts inside the pump cylinder. The surge chamber was packed in a cardboard box. The samples were delivered by hand, and we cannot therefore comment on the suitability of packaging for export and for crude overland transportation.
2.2	Condition as Received	Both pumps were received in good working order.
2.3	Installation & Maintenance Information	Engineering drawings were supplied with the test samples: these were useful but not suitable as an alternative to an installation and maintenance manual.

3. WEIGHTS & MEASURES

3.1 Weights — Pumpstand complete : 3.5 kg

3.2 Dimensions

Nominal cylinder bore:	54 mm
Actual pump stroke (max):	980 mm
Nominal volume per stroke:	2.24 litres
Drop pipe size:	1.5 inch
Maximum outside diameter of below-ground assembly:	59 mm

3.3 Cylinder Bore — No significant taper or ovality was found in either of the two samples.

The surface roughness average (R_a) was measured in three places in a direction parallel to the cylinder axis.

SAMPLE	CYLINDER BORE	ROUGHNESS AVERAGE (μm) TEST 1	TEST 2	TEST 3	MEAN
1	Extruded uPVC	0.55	0.50	0.60	0.55
2	Extruded uPVC	0.60	0.55	0.60	0.58

Measured at 0.25mm cut-off

3.4 Ergonomic Measurements

HANDLE HEIGHT MAX(1) (mm)	HANDLE HEIGHT MIN(1) (mm)	ANGULAR MOVEMENT OF HANDLE (deg)	HEIGHT OF SPOUT (mm)
1225	840	0	790

(1) Measured without compressing any bump stops

The pump is normally buried in an earth mound to provide support and protection.

4. ENGINEERING ASSESSMENT

4.1 Materials of Construction

COMPONENT	MATERIAL(S)
Handle	Fabricated steel with injection moulded plastic spacers.
Angled Connector	Galvanised steel pipe
Cylinder	uPVC water pipe with heat-swaged ends
Plunger assembly	Aluminium with rubber valve
Cup Seal	Leather
Check valve	Moulded polyethylene with rubber valve flap
Surge chamber	Aluminium

4.2 Manufacturing Techniques

The techniques required to manufacture the pump are listed below:

Steel cutting and welding
Simple machining
Plastics moulding
Sheet leather and rubber work
Manipulation of uPVC tube
Spinning (of aluminium)

The Bower pump has been designed for manufacture in a developing country. Most of the components are easy to make, though some skill is required in heat forming uPVC tube. Care is needed in machining, and spinning the surge chamber is a skilled process.

4.3 Ease of Installation, Maintenance and Repair

4.3.1 Ease of Installation

The Bower pump should be easy to install, particularly if plastic pipe is used. The most important tool may well be a spade or shovel to construct the earth bank. Care must be taken to achieve airtight joints in the drop pipe as any leaks will significantly affect the efficiency of the pump.

4.3.2 Ease of Maintenance and Repair

Pumpstand maintenance is very straightforward and will require only the simplest hand tools.

4.4 Resistance to Contamination and Abuse

4.4.1 Resistance to Contamination

The position of the outlet and the need to prime the pump make the Rower particularly susceptible to contamination. It is not recommended as a pump for drinking water supply.

4.4.2 Likely Resistance to Abuse

Buried in an earth bank the pump cylinder is well protected from accidental damage. The pump rod might be easily bent but would be easy to straighten also.

4.5 Potential Safety Hazards

None

4.6 Suggested Design Improvements

A standard 30° branch connector could replace the fabricated component between the pump and rising main.

In cutting valve discs from old inner tubes, care should be taken to avoid the joint lines. On the reverse side of the joint line, the rubber is distorted out of flat which may reduce the efficiency of the valve.

The metal parts of the plunger should be in direct contact to control the compression of the leather. Adding a spigot to the upper of the two aluminium parts would achieve this and also prevent incorrect assembly.

Any rigid ready-made container of appropriate size could be used in place of the aluminium surge chamber. Alternatively, a second length of uPVC pipe could be used but blocked off at the top. This avoids the use of a skilled manufacturing process.

5. PUMP PERFORMANCE

5.1 Volume Flow, Work Input and Efficiency

The description of the method can be found in the Test Procedure.

Results - with surge chamber

HEAD	7 m		
Pumping Rate (strokes/min)	11	15	19
Vol/stroke (litres)	1.63	1.80	1.72
Work input/stroke (J)	168	192	180
Efficiency (%)	66	64	65

Results - without Surge Chamber

HEAD	7 m		
Pumping Rate (strokes/min)	11	14	19
Vol/stroke (litres)	1.62	1.70	1.72
Work input/stroke (J)	179	194	210
Efficiency (%)	62	59	56

5.2 Leakage Tests

HEAD (m)	VOLUME (ml) in 5 min.	LEAKAGE RATE (ml) per minute
7	34	6.8

The endurance test later showed that leakage in the joints of the drop pipe had contributed to this.

6. USER TRIAL

Details of the organisation of this trial can be found in the Test Procedure.

Once instructed in the appropriate method of operation, only small children found the pump difficult to use: the height and angle of the handle made it difficult for them to apply a straight pull with sufficient force. The lack of an upper stop caused problems - some stronger, larger users pulled the plunger right out of the cylinder. Everyone liked the very high rate of delivery, though some objected to getting wet when water spurted out of the pump at the start of the return stroke.

7. ENDURANCE

General Comments

The pump was tested at 19 strokes/minute at a suction head of 7 metres.

The Rower completed the full endurance test without failure. In the early stages of the test however, the pump seemed to lose its prime more rapidly than had been indicated by the leakage test on the check valve, sometimes within a few minutes. A contributory cause was found to be air leaking into joints in the drop pipe, emphasising the need to ensure airtight joints on installation.

At the end of the test the plunger and check valve remained in good condition. The cylinder bore was worn and there was a 2 mm step in the bore at the top of the swept area. The volume delivered per stroke was somewhat lower than in the original performance test but still remained well over 1 litre.

Breakdown Incidence

Hours: 0	1062	2112	3127	4169
Inspection and full performance test	Inspection and volume flow	Inspection and volume flow	Inspection and volume flow	Inspection and final performance test

No breakdowns occurred.

Details of the Endurance Test

HOURS

1062 Inspection after 1st 1000 hours:

a) Check valve in poor condition - rubber valve flap loose on centre spindle - new check valve fitted
b) Leaking joint between top of drop pipe and surge chamber - sealed
c) No significant corrosion

2112 Inspection after 2nd 1000 hours:

a) Some joints in drop pipe found to leak, which would have contributed to the apparent leakage from the check valve observed in earlier tests. Threaded joints were replaced by solvent cemented joints.
b) Some rust on plunger rod

3127 Inspection after 3rd 1000 hour stage:

a) Cylinder bore locally scratched, polished elsewhere
b) Further rust on plunger rod

4169 Final Inspection

1	Footvalve	In good condition
2	Plunger	Valve and seal in good condition, but part of the plunger body had scored the cylinder bore
3	Cylinder	Worn on the lower side, with a step between the used and unused areas of approximately 2 mm
4	Corrosion	Surface rust on check valve and plunger body fixings; slight pitting of plunger rod; all parts still serviceable
Note		If the pump had been operated in the field for a similar period, it is likely that wear of the plunger rod and of the steel reinforcing ring at the mouth of the cylinder body would be apparent. (We were informed that the manufacturer has subsequently replaced the steel reinforcing ring with a flared steel tubular insert.)

Estimated Total Amount of Water Pumped in 4000 hours.....7.1 million litres

Mower Pump

	Volume Flow Tests at 7 m (litres)			Leakage Tests at 7 m (ml/min)
Strokes/min	10	20	30	
New	1.63	1.72	-	6.8
After 1000 hours	1.63	1.47	1.54	14.5 *
After 2000 hours	1.38	1.45	1.32	33 *
After 3000 hours	1.27	1.32	1.52	8.5
After 4000 hours	1.27	1.47	-	2.6

* Part of this leakage was later found to be due to leaky joints in the rising main.

Pump Performance after Endurance

HEAD	7 m		
Pumping Rate (strokes/min)	11	15	20
Vol/stroke (litres)	1.27	1.29	1.47
Work input/stroke (J)	201	203	213
Efficiency (%)	43	43	47

NB. Tested with surge chamber - not re-tested without the surge chamber because the earlier test had shown that the pump was more efficient when the surge chamber was in operation.

Both volume flow and efficiency were reduced by 4000 hours of endurance testing, because of wear in the cylinder. However the pump continued to deliver a substantial volume of water per stroke.

8. ABUSE TESTS

8.1 Impact Tests

Not applicable

8.2 Handle Shock Test

Not applicable

9. VERDICT

A commendably simple pump, easy to install, maintain, and repair. A true VLOM pump, very suitable for low-lift irrigation, but not for drinking water because contamination is almost inevitable. Likely to wear, with consequent reduction in delivery, but all wearing parts are easy to replace.

Rower Pump