TECHNICAL ASSISTANCE TO THE BOLGATANGA COMMUNITY WATER AND SANITATION MANAGEMENT PILOT PROJECT

TECHNICAL REPORT

GHANA WATER AND SEWERAGE CORPORATION

UNITED NATIONS DEVELOPMENT PROGRAM

WORLD BANK

Bipin Joshi
Project Advisor
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BACKGROUND:

Handpumps can be classified according to the depth from which they draw water - low-lift and high-lift pumps. The conventional handpumps are reciprocating single action positive displacement pumps; but Diaphragm Force pumps and Rotary Screw pumps are also common.

a. Low-lift Pumps can further be divided into suction pumps and direct action pumps.

Suction Pumps draw water from depths up to 7 meters by creating a partial vacuum in the rising main thereby bringing water to the surface by utilizing atmospheric pressure. The main advantage of suction pumps are their low cost and ease of installation and repair, as all the moving parts are above ground. The main disadvantages are the limitation in pumping lift and the need of priming in case of a defective plunger seal. Because of its simplicity and low cost there are many more suction pumps in the world than any other type of handpumps.

Direct Action Pumps are suitable for lifting water up to 12 meters of pumping lift. The primary identifying feature of this type of pump is the elimination of a lever or fly-wheel to create a mechanical advantage, which restricts the depth from which water can be drawn. Because of the use of light-weight manufacturing materials for the pump the maintenance is reasonably simple. It does not require priming as do suction pumps and has a high discharge rate.

b. High-lift Pumps must have the pumping elements submerged below the water table. With this type of pump water can be lifted up to 45 meters or more, depending on the effort the users are willing to extend for progressively less water. In general handpumps are not appropriate for lift beyond 45 meters.

Reciprocating Pumps, as the name implies, lift water by the reciprocating action of the plunger. The mechanical advantage needed to balance the force on the handle to the level that can be applied manually is provided by a lever or fly-wheel. The main disadvantages have been the difficulty of repairing below ground components and the wearing of bearings above ground. A minor repair such as replacement of the plunger seal also calls for major efforts involving disconnecting the rising main and cylinder. Because of amount of effort required, minor repairs such as this are ignored until a major problem arises.

Progressive Cavity Pumps lift water by turning an accurately machined rotor within a rubber stator. The pump is operated by two rotary handles whose motion is transmitted to the pump rods through a gear box in the pump head. The rotary motion of rotor pushes water trapped within the pockets

formed by the rotor and the stator. Like reciprocating pumps, the repair of this type of pump has also proved difficult.

Diaphragm Pumps lift water through alternate stretching and relaxing of an elastic diaphragm placed inside a rigid cylinder and submerged below the water table. When the diaphragm expands the water inside the cylinder is forced into the discharge pipe and when it contracts, water is drawn into the cylinder through inlet check valve. The operating force is provided by a pilot piston and cylinder at ground level that forces water into the diaphragm through a pilot pipe. The main advantage of this type of pump is that the below ground components can be removed easily. Their disadvantages is the high cost of diaphragm and frequent maintenance of pilot plunger.

NEW APPROACHES:

Replacement of the plunger seals is one of the normal major repairs on reciprocating pumps. Traditional handpumps have a big diameter cylinder and smaller diameter rising main. This type of arrangement means all below ground components must be extracted from the well in order to have access to the plunger. Efforts have been made to redesign the pumps such that the plunger can be extracted without disturbing the rising main. The use of large diameter PVC rising main have made this possible.

The introduction of quick disconnect type rod connectors and open top cylinders have revolutionised maintenance systems. Adoption of such modifications have made the handpumps simple enough to be maintained by less skilled village mechanics with minimum tool requirements.

Traditional handpumps use a fixed mechanical advantage and change the cylinder diameter to achieve optimum the combination of handle force and discharge rate. Various components are also designed for the maximum load taken by them. This requires stocking different sizes of components. Keeping simplicity in mind, the alternate approach taken is to keep the diameter of cylinder fixed and vary the mechanical advantage and to use the same size of parts at different places even if they are over sized in some places. This minimises stocking different size of components.

It has been learnt from different water supply projects that installing a system is not as difficult as keeping it operational. The current handpump maintenance system in Ghana is heavily supported by external donors. This type of centralised maintenance system can be effective but requires considerable sum of money to operate and cannot be sustained once the donors pull out. A major area of concern in the rural water sector involves the identification of a sustainable means of maintaining the systems which have been installed.

It is also well recognised that the communities should be involved in all aspects of planning, implementation, operation, and in the management of maintenance of rural water supply projects. As long as the communities do not feel responsible for their water point these systems will not remain operational for very long. If the system is made simple and easy there is more chances of sustainability.

To make the systems simple the handpumps have been redesigned so that they can be repaired with simple tools by village mechanics. This new generation of handpumps are designed keeping VLOM concept in mind.

The UST handpump made in Ghana has adopted some of these new concepts to make it simple to repair. This handpump is one step simpler than the traditional handpumps as the plunger can be extracted without removing the rising main. The rods are threaded and it needs various tools to work on it. The footvalve is not extractable.

AFRIDEV HANDPUMP

The Afridev is a lever-action deep well handpump suitable for pumping lift of up to 45 meters.

The pumpstand is available in two forms - a galvanised all steel fabrication which makes a replacement of old handpumps easier and a concrete pedestal which should be constructed during the construction of the apron. In both the cases the handpump is supplied with a T-bar handle which can be fixed to one of the three positions according to the pumping lift to minimise the force on the rods and bearings to make the operation easy.

The use of single size of bolts and nuts has minimised the number of tools required for maintenance. The bolt on the pump head and the nuts on the hanger and fulcrum pins are free to rotate by hand but cannot be removed thus eliminating accidental loss during maintenance. The same spanner can be used to support the weight of the rods during replacement of hanger bearings.

The fulcrum and handle bearings are identical having concentric plastic bushings which can be hand fitted. The plunger and footvalve are also identical components with rubber valve bobbins and plunger seals.

The cylinder is a 50 mm ID long stainless steel or brass tube fixed into uPVC pipe. At the bottom of the cylinder a foot valve receptacle and a suction tube are glued.

The standard rising mains are 63mm OD uPVC pipes which are joined by solvent cement. The rising mains are suspended from the pump stand using a compressed rubber cone.

The pumprods are 10 mm diameter galvanised or stainless steel with welded connectors at the ends to facilitate easy installation or removal of the plunger and rods without any tools. At each rod connector a centraliser is provided.

Since it has an open top cylinder, the plunger and the foot valve are extractable. A footvalve fishing tool and special spanner (supplied with the pump) are the only tools required for normal maintenance of the pump.

AFRIDEV DIRECT ACTION

This handpump is suitable for a pumping lift of up to 10 meters. It uses standard Afridev rising main, plunger and footvalve assemblies. The cylinder is thick walled long uPVC pipe with a footvalve receptacle and a suction tube glued at the bottom.

The rods are 38mm dia pipes with both ends plugged to make it airtight. The plunger assembly and the handle are connected to the rod by eye and hook connector and the rest of the rods are glued together with solvent cement. The 'T' handle passes through a nylon bushing which also acts as a top cap for the pumphead.

The plunger assembly and the foot valve can be extracted without disconnecting the rising main.

AQUADEV

Aquadev is also lever operated deep well handpump manufactured by Mono Company of England. Though Afridev and Aquadev handpumps look similar and manufactured with same concept in mind the unique difference between the two is the way the rods are connected.

The rising mains are 63 mm OD and 5.8 meters in length. To minimise the number of tools required to do the servicing, the footvalve is connected to the plunger assembly with a short piece of nylon cord so that the footvalve is pulled together with the plunger.

The rods are 9 mm diameter stainless steel with the ends formed in the shape of a nail head. Two small plastic pieces hold two rods end to end and a plastic sleeve, which also acts like a rod centraliser secures the two plastic pieces together.

A socket spanner is the only tool required to make repairs.

VOLANTA

The Volanta is a deep well reciprocating handpump driven by rotation of a large fly-wheel. A crank and connecting rod converts the rotary motion of the fly-wheel to reciprocating motion which is transmitted to the plunger through the rods.

The pump stand consists of an all steel or concrete pedestal with a crankshaft running on a pair of large self-aligning ball bearings. A connecting rod with a pair of smaller self-aligning ball bearings at each end joins the crankshaft to the guide rod. The stroke length can be adjusted for different pumping lift by attaching the connecting rod to the appropriate hole on the plate welded to the crankshaft.

The cylinder is a glass fiber reinforced epoxy resin tube with stainless steel end caps and a seal-less stainless steel plunger. Molded rubber check valves with brass weight are fitted in the plunger and footvalve and a 0.1 mm slot size screen is placed at the intake. The cylinder assembly rests on a conical sleeve at the bottom of the rising main and can be removed along with the rods.

The 75 mm OD uPVC rising mains are joined by solvent cement. 8 mm stainless steel pump rods are with eye and hook connectors and a plastic rod centraliser is bolted to each rod.

No tool is required for standard servicing but a few tools and a mechanically skilled person are required to replace the crankshaft bearings.

NIRA AF-85

The NIRA pump is a direct action shallow well handpump manufactured in Finland. . The pump can be very effectively used for lifting water from a depth of 10 meters or less.

It uses 64 mm OD HDP pipes as rising mains and 40 mm OD HDP pipes as rods. The valve and the plunger seals are made of plastic. The only metal component is the pump body and T handle.

The rising main and air-tight hollow rod have threaded connections and can be tightened or loosened very easily without any tools. The lower section of the rising main is used as a cylinder and a footvalve is screwed on to the lower end of the cylinder. The plunger can be removed without removing the rising main but the footvalve is accessible only after pulling the rising main.

A special 'F' spanner (spanner in the shape of F) and an allen key are the only tools required for servicing.

HANDPUMP CHARACTERISTICS

	Afridev	AFD-dir	Aquadev	Volanta	Nira
Pump					
No. of Pumps	14	1	16	12	8
No. Installed	13	1	14	12	8
Model	Deep	Shallow	Deep	Deep	Shallow
Made in	Kenya	Kenya	England	Burkina	Finland
Cylinder					
Make	Afridev	Afridev	Mono	Volanta	Nira
Material	SS Lining	uPVC	SS Lining	Fiberglass	HDP
Diameter (mm)	50	50	50	50	51.5
Stroke (mm)	225	810*	225	Adjustable	375
Swept Volume (lts)	0.44	1.60	0.44	0.18-0.61	0.78
Rising Main					
Material	uPVC	uPVC	uPVC	uPVC	HDP
Diameter OD (mm)	63	63	63	75	64
Pump Rod					
Material	Steel	uPVC	S.Steel	S.Steel	HDP
Diameter (mm)	9	38	9	8	40
Maximum Lift (m)	45	12	45	45	12
Cylinder Setting (m)	11.0 - 39.0	12	14.0 - 22.3	10.0 - 23.5	7.0 - 13.5
SWL (m)	5.0 - 26.0	2.0	3.4 - 16.0	4.0 - 14.6	3.6 - 8.2

NOTE:

- AFD-dir - Afridev Direct Action Handpump
- Nira - Nira AF-85 Direct Action Handpump
- SWL - Static Water Level
- * - Stroke length is 810 mm but not practical to use more then 400 mm.

PROBLEMS

The age of the handpumps in the field varies from 3 to 17 months. Over this period there had been problems with various components of the handpumps.

Afridev handpump uses polyetheline rod centralisers. The centraliser has two motions - one relative to the rising main and the other relative to the rod. There is wear on outside as well as inside the slot of the centraliser. When the wear on the slot increases the centraliser breaks into two pieces. Some of these centralisers are now being replaced by new type of molded rubber centralisers.

The centraliser used on the pin type of rod connector also acts as a guard preventing the rods from disconnecting due to vibration. When the pin and the corresponding hole on the rod connectors wear and the slot on the centraliser elongates at the same time, the rods can easily disconnect. On two occasions the rods have disconnected in this fashion. The hook type of connectors do not have this problem. These rod centralisers cannot be replaced by new molded rubber centralisers.

The centralisers used on stainless steel rods with forged rod connectors are rubber molded around a metal piece. It has been experienced that the rubber part comes off the metal piece in the course of time and the metal starts to rub the rising main. In one case the metal rubbed through the rising main. These centralisers have now been replaced by molded rubber centralisers.

Aquadev handpumps also use polyetheline centralisers. The area of contact of the centraliser is small, in three occasions the centraliser rubbed through the rising main. The centraliser is also a part of the rod connector and cannot be replaced by any other centraliser. The problem of perforated rising mains in other pumps is anticipated if this arrangement is not modified.

As no check nut is provided to the hooks at the end of Afridev direct action pump rods, it has disconnected once. The rod end had to be cut in order to have access to the nut and then the plug had to be glued.

On two occasions the Volanta rod broke in one pump where the pump setting was 23 meters and the SWL 15 meters.

Threaded stainless steel rods with forged quick disconnect rod ends used on Afridev Handpump have broken six times. Four of the rods broke in an installation where the pump setting is below 30 meters. The problem did not repeat when these rods were replaced with galvanised rods having quick disconnect connectors.

PARTS REPLACED

	ADF	AFD-Dir	AQD	VLT	NRA
No. of Pumps	13	1	14	12	8
No. of Repairs	8	1	5	2	-
Parts Replaced:					
Rising Main	1	-	3	-	-
Rods	6	-	-	2	-
Rod Centraliser	17$	-	-	-	-
Foot Valve	-	-	-	1*	-
Cylinder	-	-	-	1#	-

NOTE:

a) These parts were replaced because of defect or brakedown. The schedule replacement of parts after one year is not included in this.

b) All the pumps were not installed at the same time.

$ 7 were replaced as they were broken or worn badly and the rest were replaced on the same pumps.

* The footvalve dropped because of damaged thread on the cylinder.

The cylinder had to be replaced because of damaged thread at one end.

RECOMMENDATIONS

AFRIDEV:

- the length of hanger pin should be reduced to prevent it from rubbing on the side of pump head.
- a vent hole should be drilled below the top flange of the pump base to prevent contamination of well (if well casing is not extended).
- rod connectors should be standarised. Pin type of connectors are not reliable.
- the two slots made in plunger/footvalve body near the groove for plunger seal should be eliminated or rounded to prevent Injury to thumb while pushing the bobbin to remove.
- to eliminate the excessive wear of fulcrum bearings, the hanger and fulcrum bearings should be interchanged every six months.
- if resistance is felt while inserting the plunger into the cylinder, the rod should be rotated and pushed down slowly. If more pressure is applies the plunger seal could come off the groove.
- the lock pin on fulcrum and hanger pins should be stronger (some of them have sheared).

AFRIDEV DIRECT ACTION:

- reduction in height of the pumpstand will make the pumping easier for the children.
- the T handle extends too much. Even if the length is reduced by half the operators will not be able to use full stroke.
- all the rods should have quick disconnect type connectors so that the rods do not have to be bent every time it is pulled (for training or demonstration).
- check nut should be provided for the hooks to prevent disconnecting.
- a pin hole should be made just below the plug towards the open end of the rod so that while joining the rods by solvent cement the compressed air has a passage to escape.
- the length of the plunger, rods and the T handle should be equal to the length of the cylinder rising main and pump stand (In our case 1.2 m long pipe had to be added to equalise the length of plunger, rods and T handle).

AQUADEV:

- footvalve and plunger should not be connected by cord. A footvalve fishing tool should be supplied with each pump.
- slots on hanger for bearing lugs should be opposite to the connector for top rod (this way the village mechanics will have one step less to remember).
- length of the rising main should be reduced for easy handling.
- the material or the shape of rod centraliser should be changed to avoid perforation of rising mains due to rubbing.
- the extension T bar should be permanently fixed to the handle assembly.
- nut retainers should be properly secured by spot welding.
- hole should be drilled below the top flange of the pump base to vent the borehole and to prevent contamination (if the well casing is not extended).
- lock pin on fulcrum and hanger pin should be solid pin.
- check nut should be provided on the top rod to secure it to the hanger.

VOLANTA:

- the material of cylinder should be of better quality so that the threads are smooth and of good quality (the threads are brittle and in one case the foot valve assembly disconnected and dropped into the well).
- the holes on spout flange and base plate should be symmetrical so that any can be changed.
- threads on T spout should be cleaned (on lath) so that the top cap can be screwed on easily.
- greasing nipple should be provided on all bearing blocks.
- the length of thread on wing bolt should be standarised.

NIRA AF-85:

- some type of thread sealant should be used on the rising main connections.

- the bobbin valve should be improved (it does not seal properly).

- height of the slot for 'F' spanner on pump cap (guide bush for T handle) should be increased.

- positive stop should be made on footvalve bobbin guide/receptacle so that it could not be screwed fully and prevent the bobbin to function.

- a rubber seal should be provided between the pump body and the foot rest to prevent contamination of well.

USER PREFERENCE

Usually a pump community draws water from a particular handpump. Only when a handpump is inoperable does the community go to the next pump to fetch water. While there are three different types of handpumps installed in the project area, they were installed looking into the nature of the borehole and the characteristic of the handpump - the communities were given no choice.

It has been seen that the communities prefer high discharge pumps even if more effort is needed to operate them. Nira pump which is suitable for shallow well and is without a lever or fly-wheel for mechanical advantage is liked by the villagers for its discharge rate.

The introduction of this new generation of handpumps and exposure of the village mechanics to the repair of handpumps has brought a new outlook towards water supply to the villages. If given a choice, they prefer to have handpumps which is simple and can be repaired by themselves. In general, however, any type of handpump brought to the community is accepted.

The quality of water also plays major role in preference of sources of water. High iron concentration in ground water is not a serious problem in this area. Galvanised rods in certain wells have corroded and will eventually have to be replaced. If other below ground components used are of non-corrosive material then it will be better to use stainless steel rods at a slightly higher cost.

SUMMARY OF FINDINGS

AFRIDEV:

Installation: It is fairly easy to install the pump. The plunger, footvalve, and rods can be installed after installing the rising main. Precaution should be taken while joining the rising main to ensure a good joint.

Maintenance/Repair: Scheduled maintenance can be carried out by trained community mechanics, using a single spanner and a fishing tool. But some of the repairs like replacement of rising mains or fishing out broken rods will require higher skill and special tools.

Reliability: The pump is more reliable with hook and eye type of rod connectors than pin type.

Corrosion Resistance: Except for the galvanised pump rods, all other below ground components are corrosion resistant. Stainless steel rods should be used where the ground water is aggressive.

Abrasion Resistance: Nitrile rubber plunger seals are durable provided sand can be prevented from entering the cylinder. In general the seal is performing well even after one year of use.

VLOM Potential: If village mechanics are adequately trained, the repair and maintenance of the handpump can be handled by the village mechanics.

AQUADEV:

Installation: Balancing of rising main is difficult during installation because of its length. The footvalve, plunger and rods can be installed after installing the rising main thus making the installation easy.

Maintenance/Repair: Scheduled maintenance can be carried out by trained community mechanics, using only one spanner. They will require a footvalve fishing tool to extract it if the cord joining the footvalve to the plunger breaks. Repairs such as replacement of rising mains and disconnected rods will require special tools and higher skills.

Reliability: The pump will be more reliable if the problem of rod centraliser can be resolved.

Corrosion Resistance: It uses all non corrosive below ground components. The hanger and fulcrum pins do not have stainless steel sleeves so they corrode after some time.

Abrasion Resistance: Nitrile rubber plunger seals are durable provided sand can be prevented from entering the cylinder. In general the seal is performing well.

VLOM Potential: If village mechanics are adequately trained, the repair and maintenance of the handpump can be handled by the village mechanics.

VOLANTA:

Installation: The cylinder assembly can be installed together with the rods after the installation of the rising mains. But for the smooth operation pump should be levelled properly. Precautions should be taken to remove excessive solvent cement from the conical seat for the cylinder cap to avoid leakage.

Maintenance/Repair: *There is no scheduled replacement* of bearings or bobbin valves with this pump as in Afridev or Aquadev. Depending on the nature of the breakdown, the repair can be carried out by trained village mechanics. However, repairs like replacement of crankshaft bearings or rising main would require special tools and skills.

Reliability: The is very reliable, but when it breaks down, repairs are likely to require the services of mechanics with higher skills. Better quality of cylinder material would prevent damage to threads during maintenance.

Corrosion Resistance: It uses all non corrosive below ground components.

Abrasion Resistance: It uses seal-less plunger and a very fine (0.1 mm slot size) screen in the inlet of the pump. The bearings are also sealed type.

VLOM Potential: It requires slightly higher skilled mechanics to do some of the repairs, but still the pump has VLOM potential.

NIRA AF-85:

Installation: Since the rising mains and the rods are light and threaded, they can installed easily. It just needs two simple tools for installation. However care should be taken while connecting the HDP pipe to the pump base to avoid cross threading or damage of the thread on the pipe.

Maintenance/Repair: Even if the footvalve is not extractable, the rising main can be pulled easily and the community mechanic can work on footvalve or do other repair work.

Reliability: The pump is reliable but sometimes the footvalve and the rising main joints leak. Since this is a shallow well pump, the leakage is not a serious problem.

Corrosion Resistance: It uses all non corrosive below ground parts. The pump body is coated with plastic but that peels off fairly quick at the spout.

Abrasion Resistance: It uses HDP pipes as cylinder and rods. The plunger seal is also made of plastic, the presence of sand in water will be harmful to this pump. Since the rising main is used as cylinder, the worn cylinder can be replaced by another rising main.

VOLM Potential: It is a shallow well pump so the village mechanics can easily repair it.

AFRIDEV DIRECT ACTION:

Installation: The installation of the rising main is the same as that of the standard Afridev pump, but the hollow rods are solvent cemented. The fixing of the rods will be easier if there is a pin hole below the plug for the compressed air to escape.

Maintenance/Repair: The replacement of bobbin valves and the plunger seal can be easily done by the village mechanics but fishing the disconnected rod could be a problem.

Reliability: The pump is only six months in the field and it is too early predict anything.

Corrosion Resistance: Except for the hooks used on the first and last rod all other below ground components are non-corrosive.

Abrasion Resistance: The cylinder is unlined thick walled uPVC pipe, the presence of sand in water will be harmful to the cylinder.

VLOM Potential: If all the rods could be joined by eye and hook type of rod connectors as used on first and last rods, the maintenance and repairs will be easy.

AFRIDEV HANPUMP

The top rod is 1/2" in diameter instead of 12 mm so the diameter of the rod has to be reduced before threading to get good quality threads. This process is tidious in the field but would be simpler if it could be done at the workshop where a gringing wheel or even vice and file could be used effectively. To do so the length of the top rod to be cut should be known in advance.

In one of the deep installations an experiment was carried out to find the length of the top rod to be cut for different pump settings. These readings differed slightly from the readings from other installations. After compairing all the readings the following conclusions were drawn:

No. of pipes	Length of top Rod to cut
4	26.5 mm
5	27.5 mm
6	28.5 mm
7	29.6 mm
8	30.7 mm
9	32.0 mm
10	33.0 mm
11	34.0 mm
12	35.5 mm
13	36.5 mm
14	38.0 mm
15	39.5 mm

This information should also be included in the installation manual so that the installation becomes even easier.

If the rod is cut according to the above table and is slightly longer,the extra length will be compensated by the space created below the plunger when the hanger is lifted to connect to the handle fork and the chances of plunger hitting the footvalve during pumping does not exist.

If the height of the pump base is raised by 100 mm the user will not have to bend as much to pump. The new height of pump will not be too high for the maintenance crew to work.

The length of the hanger pin must be reduced to prevent it from rubbing on the side of the pump head due to sideways play of the handle when the bearings wear.

It would be better to mark the extension handle at the factory for different settings.

The galvanised rods corrode within two months.

The welded hooks bent very easily while disconnecting if there is some resistance because of welding spot or corrosion.

The plastic centraliser becomes loose on the groove and do not stay at its position to secure the rod connectors.

The maintenance kit contains three different types of rod centralisers but the communities will be able to use only one type. So only one type of rod connectors should be packed in the maintenance kit.

EASE OF INSTALLATION

Criteria	Afridev	Aquadev	Volanta	Nira AP-85
Maximum depth				
Manufacturer's spec.	45 m	45 m	45 m	15 m
Manually possible	45 m	45 m	45 m	15 m
In project	39.6 m	22.6 m	23.2 m	115 m
Crew size:				
Manually	3	3	2	2
Tools/materials required	Socket Wrench (24mm) and Foot Valve Fishing Tool (supplied by Afridev), Spanner for anchor bolt, Sirit level, 12 mm Rod Die & Sotck, Hack Saw Blades & Frame, Flat file 200 mm, Emery Cloth/Sand Paper, Tin of Cleaning Fluid, Tin of Solvent Cement. A piece of Cloth, 1 inch Paint Brush, Pipe wrench - 18" (!)	Socket Wrench - 24 mm (Supplied by Aquadev), Spanner for anchor bolt, Spirit Level 12 mm Rod Die & Stock Hacksaw Frame & Blades Flat File 200 mm, Emery Cloth/Sand Paper, Tin of Cleaning Fluid, Tin of Solvent Cement, 1 inch Paint Brush, A piece of Cloth, Pipe Wrenches - 18" (!),	Spanners - 30mm, 24mm, 17mm, 10mm (2); Pipe Wrench - 18" (!), Spirit level Alan Key - 4mm; Hammer - 5 kg; Emery Cloth/Sand Paper; Tin of Cleaning Fluid; Tin of Solvent Cement; 1 inch Paint Brush; A piece of Cloth;	F' Spanner and Alan Key (supplied with the pump)
	SPECIAL TOOLS	SPECIAL TOOLS	SPECIAL TOOLS	SPECIAL TOOLS
	None	None	Automatic metal clamp or wooden clamp for holding uPVC pipes	None
Remarks:	A wooden pipe clamp would make the installation easier and also reduce the number of crew.	A wooden pipe clamp would make the installation easier and also reduce the number of crew.		

Criteria	Afridev	Aquadev	Volanta	Nira AF-85
Advantages	Foot valve, piston and rods can be installed after rising mains are installed.	Foot valve, piston and rods can be installed after rising mains are are installed.	Cylinder assembly can be installed after rising mains are installed.	Plunger assembly and rods c be installed after rising mains are installed.
	Quick disconnect rod connectors and drop in foot valve simplify installation.	Eye and hook rod connectors simplify installation.	Threaded rising mains and rods can be coupled without any tools.	
	Three people can install pump to 30 m setting.	Three people can install pump to 30 m setting.	A crew of two people can install pump upto 30 m setting.	Rising mains can be uncoupl easily to have access to fo valve.
	No special installation tools needed.	No special installation tools needed.		
		Threaded top rod simplifies installation.		
Disadvantage	Proper care and right procedure should be followed to get good PVC joint. A minimum curing time for each joint and a maximum of 24 hours should be given before pumping water.	Proper care and right procedure should be followed to get good PVC joint. A minimum curing time for each joint and a maximum of 24 hours should be given before pumping water.	Proper care and right procedure should be followed to get good PVC joint. A minimum curing time for each joint and a maximum of 24 hours should be given before pumping water.	Pipe couplings and foot valves leak.
	Cutting and threading of top rod in the field is not convenient.		Excess solvent cement should be removed from the cylinder If the base plate is not levelled and connecting rod is not vertical the pumping becomes hard. rising main to ensure proper sitting of cylinder cone and to prevent leakage.	Metal thread on pump base could damage thread on HDP pipes.
				Some plugs used on hollow r allows water to enter into the hollow rod and make it heavy.
				Without gasket between foot rest and pump base the well could not be sealed.
			If the base plate is not levelled and connecting rod is not vertical the pumping becomes hard.	
Remarks	If pump setting is known the top rod could be cut and threaded at the workshop.		An automatic rising main tool makes the installation easier, but a wooden clamp can also be used.	
			Because of its unique design the pump requires 40cm high platform for installation.	

EASE OF REPAIR

Below Ground Components
Replacing Piston Seal and Foot Valve

Criteria	Afridev	Aquadev	Volanta	Nira AF-85
Can community mechanic make the repair?	Yes	Yes	Yes	Yes
Can area mechanic make the repair?	Yes	Yes	Yes	Yes
Repair time, (min) for 30 m	45 min	45 min	45 min	20 min
No. of persons needed, (manually)	2	2	2	2
Tools required	Spanner & Foot Valve Fishing Tool supplied with the	Spanner supplied with the pump	Short piece of cable or strong rope if setting more than 30 meters	F' Spanner and Alan Key supplied with pump
Advantages	Piston and foot valve can be extracted without removing rising main. Quick disconnect rod connectors make extraction and installation quick and easy.	Piston and foot valve can be extracted without removing rising main. Quick disconnect rod connectors make extraction and installation quick and easy.	Cylinder assembly as a whole can be extracted without removing the rising mains. Quick disconnect rod connectors make extraction and installation quick and easy.	Plunger assembly can be extracted without removing the rising mains. Rising mains and rods can be disconnected without any tools.
Disadvantage		Foot Valve fishing tool will be required if nylon cord breaks.	Sometimes the opening of cylinder caps with hand (standard procedure) becomes difficult.	Foot Valve Bobbin guide could be installed in reverse direction thus preventing the operation.

Below Ground Components
Replacing Piston Seal and Foot Valve

Criteria	Afridev	Aquadev	Volanta	Nira AF-85
Remarks	The rope securing the rising mains makes it easier to extract the rising main if it brakes.	The rope securing the rising mains make it easier to extract the rising main if it breaks.	Broken rising main could be removed from the welll by pipe fishing tool (supplied).	Disconnected rising main could be extracted from the well with the help of other rising mains.
	The repair of the rising mains usually requires cutting and joining by solvent cement.	The repair of the rising mains usually requires cutting and joining by solvent cement.	The repair of rising mains usually requires cutting and solvent cementing. Broken rod could be extracted by rod fishing tool (supplied).	Disconnected rods can be removed by pulling rising mains.
	If the rod brakes it might also call for pulling the rising main or using rod fishing tool (depending on type of rod connector).	If the rod brakes it might also call for pulling the rising main or using rod fishing tool (depending on type of rod connector).		

EASE OF REPAIR (contd.)

Above Ground Components
Replacing Bearings/Guide Bush

Criteria	Afridev	Aquadev	Volanta		Nira AF-85
Can community mechanic make the repair?	Yes	Yes	Conn. Rod Crankshaft	Yes No	Yes
Can area mechanic make the repair?	Yes	Yes	Conn. Rod Crankshaft	Yes No	Yes
Repair time (min)	10 min	10 min	Conn. Rod Crankshaft	15 min >60 min	10 min
Tools/Material required	Spanner supplied with the pump.	Spanner supplied with the pump.	Spanner: 30 mm, 24 mm Alan Key 4 mm Hammer - big (5kg) Drift Punch - big Emery Cloth Lubricating oil Grease & Grease Gun		F' Spanner supplied with the pump.
Advantages	Only one tool required and no special skill needed.	Only one tool required and no special skill needed.	Only one spanner required to replace small bearing at the site.		Only one tool required and no special skill needed.
Disadvantage			Replacement of crankshaft bearings require time, few tools and calls for a skill above community level but can be done at the site.		
Remarks	The life of bearings could be increased by interchanging hanger and fulcrum bearings after 6 month's use.	The life of bearings could be increased by interchanging hanger and fulcrum bearings after 6 month's use.	The mode of operation gives less shock load to the bearings and last longer.		

Corrosion Resistance of Major Components

Criteria	Afridev	Aquadev	Volanta	Nira AF-85
Foot valve	Plastic Molded Rubber	Plastic Molded Rubber	Stainless Steels Molded Rubber, Brass	Plastic
Piston	Plastic Nitrile Rubber	Plastic Nitrile Rubber	Stainless Steels Molded Rubber, Brass	HDP, Plastic
Cylinder	uPVC body and Stainless Steel or Brass Sleeve	uPVC body and Stainless Steel Sleeve	Fiberglass	HDP Pipe
Pump rods	Galvanised Iron or Stainless Steel	Stainless Steel	Stainless Steel	HDP Pipe
Rising main	uPVC	uPVC	uPVC	HDP
Bearings/Bush	Engineering Plastic	Engineering Plastic	Self aligning ball races	Nylon
Bearing housings	Steel or with Stainless Steel Sleeve	Steel or with Stainless Steel Sleeve	Cast Iron Bearing Blocks	Steel
Fulcrum/Hanger pins	Steel or with Stainless Steel Sleeve	Steel	Steel bolts	N/A
Pumphead	Hot dip galvanised steel plates	Galvanised and painted steel plates	Painted standard 3" T-piece with stainless steel cap.	Plastic coated steel.
Pump Pedestal	steel plates	Concrete or galvanised	painted pedestal for crankshaft support	Concrete or all steel
Advantages	Use of corrosion resistant on all below ground components make the pump also suitable for aggressive water.	Use of corrosion resistant on all below ground components make the pump also suitable for aggressive water.	Use of corrosion resistant below ground components make the pump also suitable for water.	Below ground component do not use any metal

Corrosion Resistance of Major Components

Criteria	Afridev	Aquadev	Volanta	Nira AP-85
Disadvantage	The galvanised coating on the rods, specially at the welded hook connectors, give away fast.	The paint on the pump body peels off The bearing housings and hanger and fulcrum pins corrode.	The GI T-piece corrods at the threaded portion and unscrewing stuffing box becomes difficult. The bolts (shafts for the connecting rod) corrode and becomes difficult to remove	The plastic coating comes off
Remarks	Better galvanisation precess or use of stainless steel rods will solve the problem	Stainless steel sleeve on bearing housings and on the pins will prevent corrosion	Applying a coat of grease to the threads would make stuffing box and the bolts easier to disconnect.	

Criteria	Afridev	Aquadev	Volanta	Nira AF-85
Sand in water		Nitrile rubber seals are more abrasion resistant.	The sand could embed on the walls of the cylinder and would act as sand paper for the cylinder.	Sand could embed on the solft HDP pipe and rods and act as gringing stone.
Dust in bearings	Plastic bearings are susceptible to abrasion.	The plastic bearings are susceptible to abrasion.	Dust could wear the cone of the bearing and the outer race would rotate on the cone instead of inner race rotating on the ball race.	Sand could embed on the soft nylon bearing could act as sand paper.
Between moving parts		Rod centralisers wear the rising main. Bearings are susceptible	The material of rod centralisers are softer than the rising main, so it will wear faster.	Pipe and rod could wear together.
Remakrs	The design of handpump calls for the replacement of bearing every year, which is less than the life of the bearings. Suction pipe minimises the quantity of sand entering the cylinder.	The design of handpump requires that bearings are replaced every year. This period is earlier than life of bearings. Suction pipe minimises the quantity of sand entering the cylinder.	Usually the screen will prevent sand from entering into the cylinder, but if there is too much silt in the well, the fine screen (0.1mm) would be blocked.	