22nd WEDC Conference New Delhi, India, 1996

REACHING THE UNREACHED: CHALLENGES FOR THE 21ST CENTURY

Handpump standardisation

Brian Skinner, WEDC

ONE COST-EFFECTIVE technology which has an important role in 'reaching the unreached' with potable water is the use of handpumps on boreholes and hand-dug wells.

Unfortunately handpump programmes have often not shown themselves to be sustainable. This failure has often resulted because reliance has been placed on costly centralised maintenance systems which have not been affordable. However as Fonseka and Baumann (1994) report from experience in west Africa, even where community management of maintenance is practised, often 3-5 years after a project ends only 60-70 per cent of handpumps are operational, usually because preventive maintenance has not being carried out.

From their study in Ghana the same authors conclude that the most determining factor for the cost of maintaining handpumps is not the organisational structure (i.e. whether it is centralised or community based) but is the number of pumps covered by the maintenance system.

When a country uses a wide variety of handpumps the number of pumps of any one type is relatively small. In such countries, standardisation on the use of just one or two types of handpumps is a necessary step to increase the number of pumps of a particular type to a level at which a sustainable maintenance structure is possible.

In this paper I will consider various aspects relating to the standardisation of handpumps.

Situation with no standardisation

The worst scenario occurs where there are many different types of pump spread all around a country. It is then virtually impossible to set up a sustainable handpump maintenance system, in particular, because the market for sales is so small:

- There is no incentive for in-country manufacture of any pump or pump spares.
- Pump manufacturers from overseas are unlikely to be willing to guarantee the availability of spares.
- Private traders will not be interested in setting up importation and distribution systems, nor will it be cost-effective for anyone else to do this.
- Local traders in rural areas will not be interested in stocking spares because of the small turnover.

Also the variety of pumps:

- Increases maintenance training costs since the training has to focus on more than one pump.
- Makes it difficult for area mechanics because they need to be competent and have the specialist tools to repair a number of different pumps (see above).
- Makes effective spares supply to communities, or area mechanics, very difficult.
- Makes national handpump campaigns difficult because they can have no clear focus.

Improved situation with standardisation

Clearly if a country can standardise on just one or two handpumps the negative aspects mentioned above will no longer apply.

As the number of installed pumps of one type increase several benefits arise:

- If the pump is of a non-patented design which is already internationally manufactured to a standard specification, the pump, or parts for it can be obtained from any manufacturer in the world. This is already the case with such pumps as the Afridev and India Mark II and III, which are produced in a number of countries in Africa and Asia. However, the feasibility of in-country production should be considered before purchasing internationally. The existence of a specification makes quality assurance a possibility so that the quality of the spares is maintained.
- There is an increased potential for sales of standard pumps and spares. Consequently manufacturers, suppliers and traders are more likely to want to become involved.
- Handpump maintenance training and management systems will be easier to organise and sustain.
- Local mechanics will become more interested in the money that can be earned from carrying out repairs and preventive maintenance.

Problems Governments face when deciding to standardise

In recent years a number of governments have seen the benefits of standardisation and have specified a restricted number of handpumps for use in their country. Standardisation can be a difficult step to make because:

- Donors that use tied-aid often require handpumps to be purchased from a manufacturer in the donor's country. The recipient government finds it hard to refuse a 'gift' of handpumps which at first appear to make a positive contribution to meeting the objectives of 'reaching the unreached' with water supply. Decision makers in the recipient country should instead consider the long term sustainability of such water points, and realise that non-standard pumps are likely to give only short term gains.

- The situations in which a handpump will be used may vary across the country. In particular the groundwater level, the corrosivity of the groundwater and the water demand at the water point may at first indicate that for cost effectiveness and technical reasons a number of different pumps are needed.
- The best choice of handpump may be one which, although it has proved itself in other countries, is not yet widely used in the country wanting to standardise. The problems associated with introducing a new pump may be discouraging. There is obviously a cost implication, particularly when eventually existing non-standard pumps have to be replaced.
- Governments may want to avoid being seen to favour one manufacturer's or one country's product over another. They may also fear that once they have standardised, a manufacturer of the chosen pump will 'corner' the handpump market and will artificially raise prices to make more profit. (This latter problem does not occur for pumps like the Afridev, the Tara and the India Mark II & III which have designs in the public domain).

The need to consider sustainability not pump cost

The cost of the handpumps forms only a very small part of the whole cost of a rural water supply programme. When choosing a particular type of pump it is therefore not sensible to base the choice only on the capital cost of the pump. Rather emphasis should be put on which pump is likely to be sustainable. Producing a borehole has a high investment cost (e.g. US$15,000) whereas the capital cost of a handpump is typically less than US$1,000. The borehole investment can no longer provide benefits if the pump used on it fails and can not be repaired.

How many standard types?

As mentioned above the operating conditions for handpumps often vary across a country and this may suggest that a number of pumps are needed. However, pumps designed to cope with difficult operating conditions are usually also suitable for less onerous conditions. In particular this means that:

- a deepwell pump (typically able to lift water > 25m) can usually replace a suction pump (able to lift water a maximum of about 7.5m) or replace a direct action pump (able to lift water by about 12m). That is, a deepwell pump is also suitable for drawing water from shallow or intermediate depths of groundwater. The capital cost of the deepwell pump may be greater than for either of the other pumps, but it may be more sustainable to standardise on just the deepwell pump instead of choosing three standard pumps, one of each type.
- Similarly a direct action handpump is suitable for shallow groundwater levels so it can replace any suction pump. Indeed it has other advantages over the suction pump, particularly that it does not lose its prime (so there is no risk of contamination from using polluted priming water). If there is a danger that in the future groundwater levels will fall to near the limit of the suction pump (about 7.5m maximum lift) then it is wiser to choose a direct action or a deepwell pump.
- A corrosion resistant pump is of course suitable for non-aggressive groundwater as well as for aggressive water.

I believe that serious consideration should be given to choosing just one corrosion resistant deepwell pump to be used for all installations in a country.

Standardising on corrosion resistant pipes and rods

Stainless Steel

If a country standardises on the use of stainless steel pump rods and rising main pipes instead of using galvanised steel this will make the pump suitable for aggressive groundwater. It could be argued that money is wasted when the corrosion resistant stainless steel is also used in waters which are considered to be non-aggressive, but:

- Even in non-aggressive groundwater galvanised mild steel rods and pipes will eventually corrode, particularly where galvanic (or bimetalic) corrosion can take place.
- Stainless steel pipes are lighter, making it easier to lift the rising mains (this operation is necessary to reach the valves and piston seals of traditional designs of deepwell pump).

Glass-fibre rods

The use of glass fibre rods may soon also become attractive as increased international demand leads to a reduction in price.

Plastic

Plastic rising mains are corrosion resistant and have been successfully used in the design of a number of pumps such as the Afridev, Tara and Nira AF85 pumps. They are much cheaper than stainless steel pipes. Only high quality pipes and solvent can produce a good solvent cemented PVCu pipe joint. Thin walled PVCu pipe can not be successfully threaded but coarse threaded screwed couplings can be solvent cemented, glued with resin, or fixed in other ways to the pipe to create a joint suitable for dis-assembly during maintenance. These joints usually have rubber 'O' -rings to ensure water-tightness. Air-filled plastic pipes are usually used for the operating rods of direct action pumps.

In Sri-Lanka PVCu rising main pipes have been successfully used to replace the small and large diameter galvanised iron mains normally used with the India Mark II and III respectively.

Advantages

Standardising on the use of only corrosion resistant materials reduces the stocks of spares needed because no non-corrosion resistant spares are required. Also, the maintenance task of replacing corroded rods and pipes will become unnecessary, avoiding the cost of the vehicle which is needed to bring these long items to site. The use of non-corrosive materials also has the advantage of eliminating the problem of bad taste which can result from corrosion products in the water.

Standardising on open-top cylinders

Deepwell reciprocating piston pumps designed with open-top cylinders (OTCs) use a rising main with a slightly larger internal diameter than the cylinder. The rod and piston can therefore be withdrawn through the water in the rising main without the need to remove any pipes. This is a very much easier task than lifting the weight of the whole length of the water-filled pipe, the operating rod it contains, and removing sections one by one. Good designs of OTC also allow the footvalve at the bottom of the cylinder to be withdrawn through the rising main. This is clearly a major advantage since the rising main will never need to be lifted during maintenance. This makes it feasible to use PVCu plastic rising main with solvent-cemented spigot and socket joints (as used in the Afridev) or solvent cemented couplings. Such joints are much cheaper than screwed joints. A rope connection from below the cylinder to the pumphead (as in the Afridev) will guard against the loss of pipework should a cemented joint fail.

Sharing spares between deepwell and direct action handpumps

If, despite the contrary arguments already presented, there are advantages to standardising on both a direct action and a deepwell pump it may be possible to standardise on a pump of each type that share many of the same spares. This is not as attractive as it first sounds because many parts will still need to be totally different, but at least some the main wearing parts such as the piston seals and both the valves can be identical.

The Nira AF2000 (a deepwell pump) and the Nira AF85 (a direct action pump) already use the same piston, footvalve, and rising main. However, the pumphead, handle, operating rod (an air filled pipe rather than the steel rod) and other parts of the Nira AF85 are different to those of the Nira 2000.

Identical plastic mouldings and rubber poppet valves are already used for the piston and footvalve in the normal *deepwell* Afridev pump since this reduces manufacturing costs and allows the use of identical spares. People in a number of countries, including Malawi, have worked on the production of a *direct-action* handpump which uses the Afridev piston, footvalve and deepwell cylinder. The field testing of prototypes has not yet finished.

Fitting standard parts to existing pumps

The commonest type of deepwell handpump is the reciprocating piston pump. In this type of pump the cylinder is positioned at the bottom of the rising main. It pumps water when the rod in the rising main causes the piston in the cylinder to move up and down. For a particular cylinder it does not matter what type of pumphead is used to provide the reciprocating movement as long as:

- The movement of the piston does not exceed the limits of the cylinder (allowing for dynamic and long-term changes in the length of plastic rising mains where appropriate).
- Sufficient force can be applied for the size of the piston.
- The discharge rate of the pump will not, in the opinion of the users, be adversely affected by any reduction in the length of the piston stroke which results from a different pumphead being used.

Thus it is possible to adapt some deepwell reciprocating pumps already installed by using parts of a new standard pump. This can be used as an interim measure before complete standardisation comes into force.

Hence it should usually be possible to connect a new pumphead to an existing rising main and rods. Likewise new standardised rods could replace existing rods (although pipe or rod adapters will be needed where the existing and standardised pump do not have compatible joints).

In a similar way an existing pumphead may be retained and a new standard rising main, rods and cylinder can be fitted. However, if the new cylinder is smaller in diameter than the existing one, users will have to be willing to accept a lower discharge rate.

Changing just parts of existing pumps could make a valuable contribution to reducing the capital cost of the transition to a new standard pump.

Fitting standard pumps to existing boreholes

Where the standard pumpstand needs to be bolted down onto a concrete apron slab its baseplate may not have hole spacing to suit the bolts already at the borehole. There are four ways to overcome this problem:

- If there is space, additional holes can be drilled in the baseplate to suit the existing holding down bolts. If it is done after manufacture the holes need protecting with corrosion resistant paint.
- An adapter with two drilled flanges separated by a piece of large diameter pipe can be manufactured to convert to the required bolt spacing.
- The old bolts can be cut off and new bolts can be fixed (using resin based glue) into holes drilled into the concrete.
- The apron slab can be reconstructed.

Where an existing pump pedestal is cast-in (as is the case for the India Mark II and III pumps) it may be possible to bolt the new pump onto the existing high level flange (using an adapter where necessary). The Afridev pump already uses a flange designed for bolting onto an India Mark II or III pedestal if one exists.

Establishing local manufacture of pumps

Standardisation increases the feasibility of local manufacture of handpumps. However, for widely used, internationally available pumps such as the India Mark II or III (and to a lesser extent the Afridev) it is very hard for local producers to compete with the very large scale government supported production being practised in India (Baumann 1992).

Governments wishing to encourage in-country production may have to intervene in the market by increasing import tariffs on pumps and reducing import tariffs on those raw materials (such as stainless steel and chemicals for plastics) to be used for local pump manufacture.

Donors and international agencies can play an important part in encouraging local manufacture in its early stages by being willing to procure pumps locally even though they may be more expensive than ones imported (sometimes tax free). Large programmes can help by at an early stage entering into contracts ordering specified quantities of quality controlled pumps for a number of future years. Where necessary, they can also help by using foreign currency to purchase pumps locally; the manufacturers can then use this foreign exchange to buy imported raw materials.

Contracts for the supply of handpumps to governments, donors or NGOs can contain special clauses which set out the basis on which imported and locally produced pumps will be compared during tender analysis. For example the contract can state that during tender evaluation, the price of locally produced pump will be reduced by a certain percentage (e.g. by 15 - 20 per cent) in recognition of the benefits of local production.

It is best if some form of pre-qualification of suppliers is carried out to check the capabilities of any supplier. Prequalification lists should be reviewed annually at which stage the performance of the supplier / manufacturer can be evaluated.

The local production of just some parts of the standardised handpump may be feasible, although this is usually less financially attractive to manufacturers.

Contracts for pumps, installation and supply of spares

In recent years there has been increasing interest in attracting manufacturers / suppliers of handpumps to become involved in more than just pumps and spares supply. There are advantages to be gained from offering them a chance to profit from the added value of pump installation, and spares supply and distribution. Supply and distribution is not usually financially attractive on its own, but tying it in with handpump supply and installation makes it a more viable business for local entrepreneurs. It is particularly attractive where standardisation leads to large numbers of identical pumps. Training communities and local mechanics so they can maintain the pump can also be a contractual responsibility of the supplier.

Some governments insist that pump suppliers have feasible plans for spare parts distribution network set up before they can become pump suppliers. Renewal of the supply contract is based on a satisfactory annual review of the performance of the pump and the availability of spares in rural areas.

Some donor supported projects put a contractual demand on suppliers to provide after sales service but usually this is not enforceable after the project ends.

Countries which have standardised

The advantages to standardisation described above have encouraged an ever increasing number of countries to follow India's lead and to standardise.

Ghana has standardised on four pumps: Nira AF85, Ghana modified India Mark II, Afridev and Vergnet. From these pumps it has recommended specific ones to be used in each region (Fonseka and Baumann 1994).

Cambodia approached the subject of standardisation by organising a two day workshop where interested parties considered the advantages and disadvantages of a number of pumps for public water supply points. The workshop recommended three pumps: the No.6 pump for suction lifts (<7m), the Tara pump for medium lifts, the Afridev pump for deep lifts. Kjellerup and Ockelford's (1993) paper about the preparation for and organisation of the workshop will be useful to any country considering standardisation.

Sudan has for some time considered the India Mark II to be the standard handpump for their country although more recently experts have been considering whether or not the Afridev would be a better choice.

Pakistan has chosen to standardise on, and is manufacturing, the Afridev (alias "Afridi") pump.

Conclusion

A large number of factors need to be considered when choosing standardisation for handpumps but there are clear advantages to the adoption of this objective. Now that international specifications for good handpumps of non-patented design are available, production of these pumps is increasing world-wide and a move towards standardisation in more countries is likely in the next few years. This should make a positive contribution to reaching the unreached with sustainable water supplies.

References

Baumann E. (1992), Local Manufacture and Distribution of Handpumps in Ghana, World bank / UNDP Regional Water and Sanitation Group Discussion Paper, Accra, Ghana.

Fonseka J. and Baumann E. (1994), Evaluation of Maintenance systems in Ghana, SKAT, St. Gallen, Switzerland.

Kjellerup B. and Ockelford J. (1993), Handpump Standardisation in Cambodia, Waterlines Vol.12 No.1, Intermediate Technology Publications, London, pp23 -25.