IAD Handpump Project

INVENTORY MISSION

Niger/Burkina Faso/Ghana/Kenya

25.11.89 - 14.01.90

Not advanced, but definitely sustainable!

Jos Besselink, 3.03.90

InterAction Design
Onderlangs 125, 6812 CJ Arnhem, The Netherlands

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1 EXECUTIVE SUMMARY

IAD visited a number of projects that improve decentralized drinking water supplies in Niger, Burkina Faso, Ghana and Kenya. The visit took place from 25.11.89 to 14.01.90.

In summary the aim of the mission was to make an inventory of:
- problems with deepwell handpumps with PVC rising mains in these countries, and
- experiences with small scale alternatives; wind-, diesel-, sun- or animal powered.

Mainly technical aspects should be taken into account and those economical aspects that concern the users of the systems.

Apart from that the results of the IADHPP research program should be introduced and compared with field experiences.

MAIN CONCLUSIONS AND RECOMMENDATIONS

Handpumps have gradually become more reliable. But in situations where the water tables are low (medium and deep wells), its application still suffers with sometimes important constraints; technical as well as economical.

The serious problems due to breaking cemented joints of the Volanta handpump, which mainly occur at settings of more than 40 m, should be solved to prevent a serious backsliding of this application. A solution may be near, because the riser tubes don't fracture. But a decent study to solve these problems may be indispensable.

Most projects, implementing improved drinking water supplies from medium and deep water layers, use non-sustainable technology, especially from the financial point of view. To prevent future deterioration, more-sustainable technology should be developed and implemented. Money-making activities, based on these water supplies, should be stimulated.

Direct action handpumps and hand drilled boreholes may have the most promising prospects for being further developed into affordable and thus sustainable technology. More research efforts should therefore be put in such development: to make the technology cheaper, simpler and applicable in the case of medium and possibly even deep water layers.

Further efforts should be put in the adaptation of handpump designs, to facilitate local manufacture and maintenance, and thus to support sustainability of future independant drinking water supplies.

Solar-, wind-, diesel- and animal driven systems are no alternative for deepwell handpumps for small communities (up to about 1000 people) in these countries. Even for larger communities the applicability is limited, because of the limited sustainability prospects (without continuing external support).

2 INTRODUCTION

This mission to Niger, Burkina Faso, Ghana and Kenya was sponsored by the Section for Research and Technology (DPO/OT) of the Netherlands Ministry of Foreign Affairs. It took place from 25.11.89 to 14.01.90.

The purpose of the mission was:
1 To make an inventory of problems with handpumps with PVC rising mains (mainly of those installed at deep settings), related to:
   - local manufacture,
   - installation,
   - operation,
   - management,
   - maintenance.
2 To collect information related to small scale alternatives for deepwell handpumps, using wind, diesel, sun or animal traction. Also related field research activities should be studied.
3 To introduce the results of the IADHPP research program and to compare these with experiences in the field.

Countries to visit were: Niger, Burkina Faso, Ghana and Kenya.
Mainly technical aspects should be taken into account and those economical aspects that concern the users of the systems.

Since 1986 the IAD Handpump Project has been involved in the testing of handpumps with PVC rising mains, and in developing the related theoretical backgrounds and working models. The present mission was meant to introduce and test the project results in the field and to collect information to prepare for a reprogrammation of future research.

By a misapprehension on our part, the management of Direction Departemental de l'Hydraulique, Dosso/Niger, was not informed of our intended visit. My apologies!

Revised version from draft report, dated 30.01.90.

3 GENERAL CONCLUSIONS

3.1 NON-SUSTAINABLE TECHNOLOGY!

For improving the decentralized (drinking) water supply, most development projects use non-sustainable technology at an ever increasing scale. Non-sustainable in the sense of: too complicated and especially too expensive (mainly investments) for the receiving country and its users. Although the users may be helped at the short term, it must be feared that after ending the external intervention, an irreversible deterioration of these systems will take place. Further self-reliant implementation of these technologies will not be achieved. This limits to a large extent the final results of the (external) implementation projects.

In extreme situations (with low water tables) this increasing dependancy on external support risks to turn these people into beggars, who will no longer be capable of taking care of there own (traditional) water supply.

To obtimize the effects of such interventions, only those technologies should be implemented for which the users ask and pay! As long as this cannot be (fully) realized the following should be pursued: (and/or)
- intervening at a more modest level and scale (more sustainable level)
- longterm involvement: 'adoption' (to postpone deterioration),
- development and implementation of (more) sustainable technology,
- the users should pay as much as affordable and reasonable for the wanted and delivered technology.

The main success of efforts to increase the sustainability of these systems is due to:
- increased involvement of the users (responsibility, consciousness);
- increased reliability of the system and lower running costs, due to improved designs (cheaper parts, less frequent, simpler and local maintenance and repairs);
- local manufacture, probably increasing the future availability of spare parts.

Real sustainability for decentralized (drinking) water supplies will only be achieved by further decreasing of the total costs of the systems and by making it part of a money-making infrastructure (small scale irrigation, etc.)

For systems based on handpumps, 'direct action handpumps'[1] with floating rods, are probably the most promising recent developments. Unfortunately the pressure head of the present direct action handpumps is limited (to about 20 meters). Research to increase the maximum pressure head of these pumps and to further lower the price is therefore desirable.

In situations with lower water tables, the well or borehole is by far the most expensive element of the decentralized water supply. It is obvious that further efforts should be made to simplify the technology and to decrease its costs. Development of the hand drilling technology may very well have the most promising prospects (where applicable).

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[1] A handpump by which the pumprod is acted directly, without interference of a crank mechanism

3.2 DEEPWELL HANDPUMPS (with PVC rising mains)

Handpumps have become much more reliable during the last decade. Because the designs have improved and because inferior handpumps are hardly implemented any more.
For problems that may occur with handpumps with installation depths of less than about 40 meters, solutions are now available. Management and maintenance can be taken care of by the users and local mechanics.

Handpumps installed at large depth, can still cause considerable problems: mainly by broken joints. These can probably be overcome by simple design adaptations. But this may need further detailed research.

Modern hand operated piston pumps with installation depths of up to 100 meter do not differ basically from those at smaller settings of about 30 meters. Main difference may be the increased counterweight of the pumphandle. The axial elasticity of the PVC rising main will (sometimes dramatically) reduce the volume of water pumped per stroke. The pump construction (dimensions and materials) may limit the maximum installation depth. For example: the maximum depth for a SWN 80 with a 50 mm piston is about 70 meters, because of the axial elasticity of the riser. (With a galvanised riser greater depth can be handled.) A stiffer riser, a smaller piston diameter and/or an increased stroke may compensate for these losses[2].

There is no (principal) difference in means of production and materials for handpumps for medium and for deep settings (up to about 100 meters).

3.3 ALTERNATIVE SYSTEMS[3]

Only for larger communities, who cannot be fully supplied with water by two or more handpumps, alternative systems may become of interest. The costs of the necessary expensive deepwells or boreholes is for most implementing projects the decisive factor.

Modern alternative systems, like solar, wind or diesel powered systems are much more complex and investments and running costs are higher than for a system with a handpump. But because the alternative systems can in principle serve more people, the costs per head may be about equal, when compared to a handpump system. The alternative systems may give more comfort: just tapping instead of pumping.

Windmill powered systems could be/are build in the countries visited (windmill + tower + piston pump + storage tank). Spare parts can be locally manufactured. But the investments are considerable. An important bottle neck is the wind regime: the available power throughout the day and the year. Unfortunately wind is often scarce where water tables are low.

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2 *Behaviour of deepwell handpumps with PVC rising mains*, by J. Grupa, Wind Energy Group, Eindhoven University of Technology, and J. Besselink, InterAction Design.

3 Soon a report of a study called 'Pre-phase III' will follow, concerning a detailed comparison of deepwell handpumps and alternative systems.

Diesel powered systems use imported engines and pumps. Generally the investments are lower than for wind and solar systems, but the need for fuel and regular maintenance increases the running costs and dependence on imported materials. Although the whole system is complex and probably imported, repairs may be relatively simple if commonly used engines are employed. Most developing countries have a long time experience with diesel engines.

Solar powered systems are still expensive. They fully depend on imported technology. Repairing means replacing in most cases. Only when prices will go down and longtime maintenance is organised, these systems have good perspectives. Because solar energy is abundant in most developing countries.

All these systems are sensitive to lack of proper maintenance, abuse and inexpert interventions. The lack of spare parts or financial reserves may lead to long out of use periods. This counts especially for solar powered systems, of which the knowledge to maintain the system and to produce spare parts is completely lacking in most developing countries.

Therefore management of alternative systems will for the time being only be possible with external support. So the 'availability'[4] and 'sustainability' of the alternative systems will very much depend on such (long-term) technical and financial support.

Animal traction pump systems are in general not seen as advantageous when compared to handpump systems, for communities who are not traditionally used to it. The investments in efficient animal traction systems may be considerable (compared to a handpump).

Alternative systems need a reservoir to overcome peak demands and low-supply hours.

A water supply based on a number of handpumps offers more reliability.

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4 Availability = proportion of time for which the pump is in working order.

4 TECHNICAL PROBLEMS WITH (DEEPWELL) HANDPUMPS

4.1 INTRODUCTION

N.B. The available monitoring data (of PHVD[5], PBM[6] and others) does not permit detailed conclusions concerning problems, causes, etc, because the material is not very explicit and reliable[7].

Of the technical problems occurring in the field, the following are probably the most inconvenient:
- corrosion,
- fracturing of the riser joints,
- breaking rod connections,
- worn-out bearings,
- build-up of sediment in the cylinder,
- heavy weight of substructure of the pump, in the case of repairs.

Wear of the bearings will increase with depth. Valves are no longer a problem and for the piston/cylinder combination simple and lasting solutions are available.

Galvanised steel should not be used when the acidity is less then 6: it will not last more then a few months or a year. Non-corrosive materials such as stainless steel and/or plastics are then the proper solution.

Most pump manufacturers have choosen for stainless steel rods and PVC rising mains. Although PVC is cheaper than stainless steel, GWSC[8] has introduced stainless steel for risers as well for their India MkII pumps, because they expect a better reliability from it.

Only for depths up to about 25 m, thick walled PE can be used effectively, like in the NIRA 85 direct action pump.

Piston pumps with PVC rising mains can be used at depths up to 100 m, if the dimensions of the riser, the piston and the gross pump stroke have been choosen correctly[2].

At an installation depth of less than about 40 m most non-corrosive rods and risers will last for years. At greater depths more frequent fractures occur in both the risers and the rods: mainly in the joints.

There seems to be no clear relation between installation depth and frequency of fractures of rods and risers, for installation depth of more

5 PHVD = Projet d'Hydraulique Villageoise, Departement de Dosso, Niger

6 PBM = Projet d'Hydraulique Villageoise de la Boucle du Mouhoun

7 That is a more common problem in field projects. At the beginning of a monitoring phase, the importance and the nature of the problems that later might occur, is mostly unknown. And teams operating in the field are normally more focussed on 'solving' the problems with short term solutions than on monitoring.

8 GWSC = Ghana Water and Sewerage Corporation, Accra, Ghana

than about 40 m. Probably because not only the fluctuating loads, causing fatigue, are important but as well the 'history' of the parts (accidently bending of rod threads during installation and maintenance, etc.). These causes are still underestimated. Design adaptations and an increasing awareness of the maintenance mechanics is desirable.

Not many handpumps have so far been installed at settings of more than 40 meters. PHVD[5] is probably the most 'experienced', with 100 Volantas installed with a mean installation depth of about 60 m and a maximum depth of 99 m! PHVD and PBM[6] have similar problems with Volanta's installed deeper than about 40 m. These pumps suffer with serious problems with mainly the riser joints, which need to be solved.

These problems occur so frequently, that even villages, having intensively used the pump for a few years, decided not to repair the pump anymore: because of the costs and the limited 'availability' of the pump. The result is that neighbour villages already refuse boreholes, because of the future consequences to have to repair the pump. This is a anti-publicity for 'save drinking water supply'. At last this may become a very serious obstruction for the implementation project.
It already indicates what may become the final result of the project after its conclusion: a cemetery of pumps on no longer used expensive boreholes.

The question is justified if the management teams of implementation projects are fully aware of these possible consequences. Anyway, a research effort to try to solve this technical problem seems more than justified.

4.2 PVC RISING MAINS

At deep settings and after a number of years of intensive pumping, hardly any broken rising main tube was observed (Volanta up to 100 m, SWN at 65 m and Afridev up to 45 m). This leads to the conclusion that the PVC tube itself can be made strong enough to withstand many years of use[9].
The riser joints have shown to be the weakest part of the plastic rising main. At installation depths of more then about 40 m even cemented joints may cause considerable problems: Frequently fractures occur in the middle of the (Volanta) sockets along the surface where the two tubes join. But the fact that the tubes don't fracture, makes it plausible that simple solutions for breaking joints can be found. See Figure 4.1.
The joint material is probably weakened (brittle?) by the solvent in the glue. This together with stress concentrations due to sudden changes in wall thickness and diameters, probably results in these early fatigue fractures of the sockets.
I have suggested to the project staff that a possible solution for this problem might be found in cementing the tubes in the socket while keeping a distance of a minimum of 10 mm between the ends of the tubes, see Figure 4.2.

JVI has worked out a riser joint of a special conical shape trying to overcome the problem of fractures. Fieldtests with this joint have started in Niger a few months ago.

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9 This is in line with the conclusions of the IAD Handpump Project. For details see publication mentioned in footnote 2.

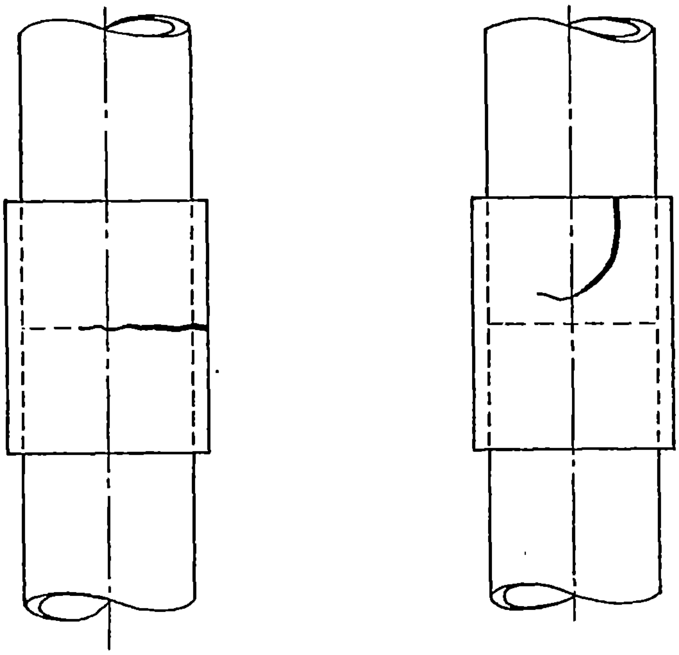


Figure 4.1 *Fractures in the cemented riser joint of the Volanta, occurring at deep installations*

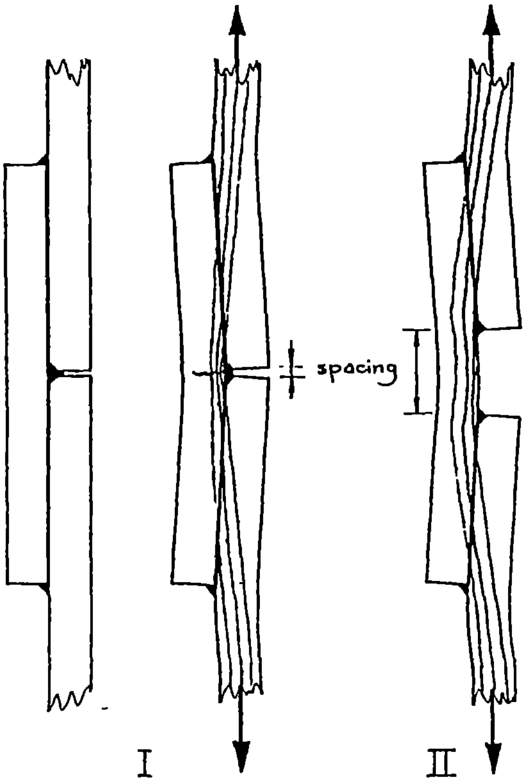
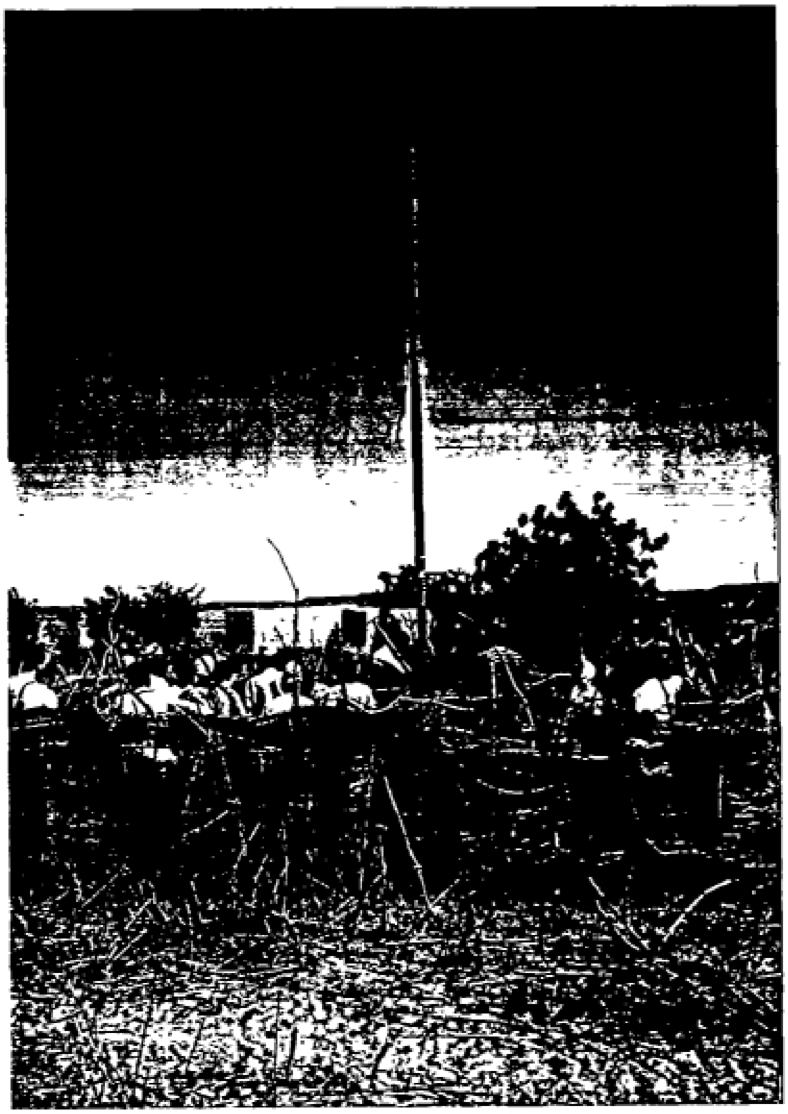


Figure 4.2

I = Actual riser joint of Volanta with limited interval of deformation, causing high relative strain and thus high stress fluctuations, probably resulting in fractures in the socket

II= Suggested configuration with increased spacing, probably resulting in lower stress fluctuations and increased lifetime

—— = stress line (simplified)



In some cases the cemented connection would come lose after a few weeks of pumping. Experiments with different glues (JVI/glue manufacturer/PHVD), could not solve this problem. The reason(s?) for these weaker cemented joints have not yet been localised[10]. Longer sockets may solve this problem.

Other fractures have been observed in a few cases, which started at the end of the socket, see Figure 4.1. These may very well have been caused by earlier riser repairs, whereby sometimes pieces of tube of more than 8 m length (three standard tube length) are cut for lifting of the riser and later glued together again for installation. See photo. These cracks are probably due to very much increased bending stresses during handling of these riser pipes.

It has been observed that the mechanics succeed in recovering old cemented sockets for reuse. This indicates something about the reduced strength of the cement. Reusing old sockets, already the weakest part, must be discouraged!

The Afridev riser has longer cemented sockets (L=2d) and a smooth transition from the tube towards the tulip joint. The Afridev agents of WB-Kenya said no problems had occurred with the Afridev riser joints recently at installation depth up to about 45 m.

Since an extra tube ('anti-swing riser bracket') is installed around the top part of the SWN rising main, hardly any breakages of the riser have occurred. Those left were mainly due to partly worn-through topjoints, caused by rubbing of the pumprod against the inside riserwall. This was probably possible after continued pumping with very much worn-out bearings.

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10 These problems may need further research: to clarify the relationship between the shape of the joint/ type of glue and weakening effects/ cementing conditions/ lifetime of the joint. It may require detailed chemical, fatigue and practical (field) experimentation.

The threaded SWN riser joints with teflon tape are hardly watertight at deep settings. SWNV, the Dutch SWN manufacturer, has now opted for rubber rings between the tube-ends, giving a better sealing.

Swinging and snaking of the rising main and the cylinder and wear on the outside, by rubbing against the wall of the well or the borehole, is not a frequent problem. This can be effectively limited/prevented by the installation of rubberlike centralizers or guides around the riser. In non-lined, inclined and/or bent boreholes rubbing and wearing cannot always be effectively prevented.

4.3 PUMP RODS

In just a few cases rods had broken lately: mainly at the top or the bottom end.
Breaking of the top thread (SWN) is partly due to increased rod hanger bearing friction[11], bending of the thread during lifting and/or installation of the pump head, plus fatigue. A slightly stronger top rod (12 mm diameter) and better handling of the rod(-thread) during maintenance will probably overcome this problem.

Some threaded (Volanta) rods of 8 mm broke at the bottom end, due to increased friction of the piston in the cylinder. The rod will then be bent on the return stroke. This may happen when fine clay particles pass the pump filters and build-up in the cylinder. Slightly increasing of the play between the piston and the cylinder and regular cleaning of the cylinder, will overcome this problem.

For deep settings rods of 9 or 10 mm with M10 threads are recommended. Especially because the rods are frequently bent while lifting and installing the pump. Rolled-on threads are stronger, but cannot simply be made and repaired without special tools.

To limit breaking of hook-and-eye joints (8 mm rods, Volanta/Burkina) minor changes have been made in the shape of the hooks which was said would overcome the problem. See Figure 4.3.
Remade hooks and eyes that are made in the field don't last.

To prevent rods breaking at deep settings PBM replaces the hook-and-eye by 8 mm threaded joints. This will probably not solve the problem; it may be even weaker in practice!

The Afridev has 10 mm rods with partly welded hook-and-eye joints, which proof to be reliable (tested up to 45 meter depth).

Worn rod guides are not always replaced in time resulting in wearing-through of riser tubes, so that sometimes even replacement of tubes is necessary. More resistant and better pairing of materials together with instruction of mechanics can limit these problems.

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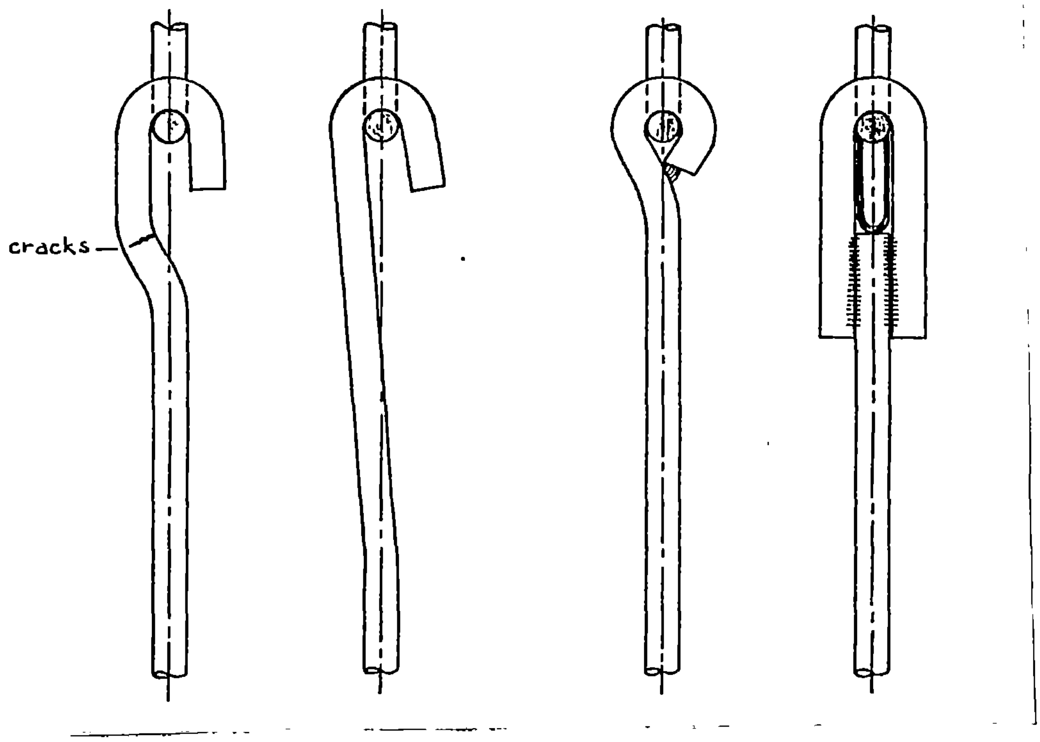
[11] The plastic bearing material will swell because of increased temperatures and the absorption of water. This may even lead to clamping of the bearing round the axle, when the clearance does not suffice.



'Standard' and improved Volanta hook

Volanta and Afridev eye

Figure 4.3 Different hook-and-eye configurations

4.4 BEARINGS

The desired durable, cheap and simply manufactured and replaceable bearing has not yet been found:
Ball-bearings (India MkII) last for about two years but replacements don't last in general, due to inexpert installation. A solution is sought in installing flange-bearings in a wider head (Ghadev).
Thick-walled plastic-on-steel bearings (SWN) last for one or more years, but need to be replaced in a workshop.
Thin-walled plastic-on-plastic bushes (Afridev) last for about a year and are simply replaced and cheap. But local manufacture is limited.
The expensive Volanta pillow block bearings last 'forever', but the connecting rod bearings may need replacement after some years.

Even with direct action pumps the handle guide bearings need regular replacement (as sometimes the handle itself).

As long as spareparts can be simply obtained and are installed in time, the worn-out bearings should not cause particular problems. Two important conditions!

5 PROBLEMS RELATED TO (DEEPWELL) HANDPUMPS

5.1 INTRODUCTION

The initial expenses for an improved drinking water supply (pump plus well or borehole) largely exceed the financial strength of most villages in developing countries. Especially in the case of deep water layers.

Although a borehole or deepwell costs about ten times more then a handpump, even the handpump is often found too expensive; a matter of income and priorities.

Only when the purchase of a handpump is found profitable, the users might decide to buy one and to take care of the management and the maintenance.

Especially in the case of deepwells, handpumps are relatively expensive and not very reliable as yet.

Efforts should be payed to lower the costs (purchase and running costs) and to increase its reliability. Its hygienic, comfort and money-making prospects should be underlined in information programmes.

Apart from problems directly related to the technology of handpumps, most of the problems of implementation projects with handpumps originate from the fact that the initiatives do not come from the villages themselves.

It is evident that for similar reasons cheaper solutions should be worked out for the actually far too expensive improved (deep-)well or borehole.

Only then a situation might be created where the decision to improve the drinking water supply and the capacity to maintain it, will again be in the hands of the users, where they belong.

5.2 LOCAL MANUFACTURE

Further efforts should be given to adapt and optimize handpump designs to local manufacturing capacities and locally available tools and materials.

Special tools, materials, working and parts create an often unwanted dependence on one particular (external) supplier and will extend the need for investments and know-how. All this limits to a large extent the potential of local manufacture (and maintenance).

For example for pressure die-casting of plastic parts (like bearings, pistons, rod and riser guides) a mould is needed of about $ 10,000 for each different part. Only at very large production levels such an investment will be justified and affordable.

Because of the low cost of local labour, it is mostly much more efficient to make the parts by cutting, welding, turning, etc. This leaves the local manufacturer much more flexibility in the choice of tools, materials and suppliers.

Examples of more easily manufactured pump parts can already be found in existing handpumps.

To arrive at a good quality product it may be necessary to put more effort in training and control. This will add to the quality of other products of the same manufacturer as well.

It is very often simply possible to redesign the product or parts in such a way that much more flexibility and increased production tolerances can be allowed.

All this will add to a more sustainable local manufacture of the pumps and spare parts and its local availability after the conclusion of external interventions.

Adapting pump designs to local situations means that more different versions of a pump will exist. But as long as mainly a local market is served and basic dimensions are kept standard (flanges, etc) this will not necessarily lead to problems.
(For example: the SWN manufactured in Kenya uses galvanised steel risers, because thick walled PVC is not manufactured in the country. That means probably a reduced lifetime because of corrosion.)

Using, adapting and/or changing existing pump designs may lead to copyright problems.

A basic barrier for profitable local manufacturing is the fact that in many developing countries materials are more heavily taxed than completely imported pumps.

5.3 INSTALLATION

Although the installation of a deepwell pump with PVC riser may need some sort of lifting device for installation depths of more than about 40 m, the installation in itself is not more complicated. This will stay a job for a trained team.

Participation of future users of the system at the installation stage will probably increase later involvement.

The users are not always fully aware of the importance of clean surroundings of the well or borehole. Sometimes a spillwater catchment facility is fully lacking, resulting in a mess. See photo.

In details the pump designs could be adapted to facilitate the installation and to help to prevent damaging of the pump parts and limbs.

The installation of more than one hand driven pistonpump on a borehole is not a succes. The pumps will probably damage one another.

5.4 OPERATION

Most modern handpumps are reasonably user-friendly at medium installation depth. At deep settings, it becomes (much) harder for the user to drive handle driven pumps. Not only because of the increased forces, but also because of the reduced discharge, therefore asking more strokes for the same amount of water.

Small children will have difficulties to handle these pumps at deep settings. Smaller piston diameters may be of help in these cases[2].

Pumping handle pumps with short quick strokes is a general phenomenon at medium installation depth. At deeper settings the axial elasticity of the rising main forces the users to make longer strokes to get water, which will automatically limit the pump frequency.

The standard SWN80/81 with a 50 mm piston should not be used at installation depth of more than about 70 m, the standard Volanta up to about 100 m. (At larger depth the discharge and user-friendliness will be insufficient.)

Most users lack the knowledge and the involvement to realize the consequences of pumping with worn-out bearings, etc. Good supervision of the pump is therefore indispensable.

5.5 MANAGEMENT

The sustainability of a (decentralized) drinking water supply strongly depends on proper management. Good management is based on involvement and a sense of responsability, which cannot be imposed.

Traditionally the smaller communities fully control their drinking water supply. It may not be advanced, but it is/was sustainable.

In most implementation projects the initiative for improving the decentralized (drinking water) supply by means of handpumps and deepwells or boreholes does not originate from its future users. Mainly because they know it is too complex and expensive for them to realize.
(So the users themselves have not decided to improve their drinking water supply, and/or have not choosen for the system, nor for the suppliers and contractors; the users have not paid for it, and the pump may not be installed where they wanted it. How do you want them to feel responsable?)

You need 'tricks' to make them feel responsable: by 'sensibilisation', have them paying a symbolic part of the costs, by making conditions ('choose a water and sanitation committee, register yourself as an official foundation, open a bank account and deposit a certain reserve, choose a mechanic, follow a course, etc').

A proper management, (partly) by its users, is necessary for a longterm functioning of this infrastructure. Therefore the process of involving the future users/responsible persons in an early stage is a delicate but indispensable matter. Implementation projects will have to take care of this as long as the villagers cannot fully manage and afford the needed(?) improvements themselves or up to the moment that a public utility will effectively take over (if ever).

Most recent implementation projects try to involve the users to a large extent. The GWSC may be the main exception: the villagers pay a fixed amount every three months for maintenance costs to the GWSC, who takes care of the rest, as a public utility. (For how long, once external funding is stopped?)

PBM, LBDA and Kefinco have succeeded in involving the users to a large extent in the management and the maintenance of the improved water supply. Apart from that the projects still have/need systems that permit a regular stimulation (and control) of the users and maintenance mechanics. PBM is the most advanced where it concerns the establishment of a commercial pump- and spareparts supply and maintenance system, independent from the project. LBDA prefers more grip on these factors.

A tension exist between delegating management responsabilities (and related cash) to the users and the natural need of projects to control, often resulting in unnecessary heavy project structures.

If the reliability of the implemented technology (especially the hand-pumps) is insufficient, it will be difficult to fully delegate the management and the maintenance(-costs) of these systems to the village. Improving the implemented technology is than a first necessity.

If the running costs and the costs of the maintenance are (/will stay) too high to be fully supported by the users, and/or if they don't want to bear these costs, the drinking water supply is probably doomed to fail (without continuous external funding).

A step by step delegation of the management and the costs to the users, after the realisation of the improved drinking water supply, will be counter productive for their involvement: 'The villagers would never have accepted if they had known all the consequences from the beginning!'

The involvement of women in the management and maintenance of the improved drinking water supply is intended/realized in most of the projects. In itself this revaluation of women in developing projects must be welcomed.

Traditionally the women were responsable for the daily provision of water in the household ('women affair'). The contribution of the men consisted mainly of the realisation and maintenance of the well. In the new situation with the improved water supply, however, it must be feared that men may fully withdraw from their responsability. The result may be that now only women will have to pay for the water and the maintenance of the system. (While a men still guards the key of the pump lock?) Will this finally increase the sustainability of the system?

5.6 MAINTENANCE AND REPAIRS

Most communities know a certain specialisation of tasks. For mechanical devices like a handpump it is mostly preferred by the users to leave the maintenance to 'specialists', especially where it concerns repairs. Inspection, replacing worn-out parts and regular cleaning could be a users task.

Sustainable local production and maintenance (replacing and/or repairing) of handpumps can probably only be realised in a commercially profitable situation. Such a situation can only be derived when a minimum handpump 'density' is attained. That might be the main task of a drinking water supply implementation project, apart from 'sensibilisation' of the population.

A main problem is the creation of an awareness of the users, that regular maintenance is necessary. Postponing the replacement of worn-out parts will probably lead to much more costs afterwards. For example: pumping with worn-out bearings has lead to cut-through handles (India Mk.II), worn-out fulcrum axles and bearing housings, and worn-through rising main top joints (SWN).

Maintenance by local mechanics can be very effective. If repairs are simple, and not too expensive (to be paid by users) and there are enough repairs to be made ('handpump density'), and parts locally available, this can work without support from projects. Control of costs and quality by the project will be necessary in the beginning. Only by means of free enterprise a sustainable future continuation is likely to be realized.

It is most important that all the parts of the handpump are locally available (commercially), independent from the implementation project: to guarantee the future availability after the conclusion of the implementation project.

Preferably all the handpump repairs should be possible at the well.

Rolled threads are much stronger than cut threads (fatigue!). But in the case of broken rods (or stainless steel risers) new threads cannot be made in situ.

If not even the maintenance costs can be fully supported by its users, the drinking water supply is doomed to fail (after conclusion of the external funding).

Appendix I: ABBREVIATIONS AND ACRONYMS

ACREMA	Tahoua, Niger: manufacturer Volanta
CIDA	Canadian International Development Agency
CSF	Centre Sainte Famille, Saaba, Burkina Faso: manufacturer Volanta
DHV	Consulting Engineers, Amersfoort, The Netherlands
EAF	East African Foundry Works Ltd, Nairobi, Kenya: Afridev manufact
GWSC	Ghana Water and Sewerage Corporation ('3000 well drilling programme in southern and central Ghana')
IAD	InterAction Design, Arnhem, The Netherlands
IADHPP	IAD Handpump Project
IGIP	Consulting Engineers, Darmstadt, West Germany
IGN	Institut Géografique Néerlandais
JVI	Jansen Venneboer International, Wijhe, The Netherlands: Volanta
Kefinco	Kenya-Finland Rural Water Development Project, Kenya-Finland Cooperation, Kakamega, Kenya
LBDA	Lake Basin Development Authority, Kisumu, Kenya
ODA	Overseas Development Administration, London, United Kingdom
PBM	Projet d'Hydraulique Villageoise de la Boucle du Mouhoun, Dédougou, Burkina Faso
PHVD	Projet d'Hydraulique Villageoise, Departement de Dosso, Niger
PVC	Polyvinyl Chloride
RDWSSP	Rural Domestic Water Supply and Sanitation Programme, Nyanza
SKAT	Swiss Center for Appropriate Technology at ILE
SWNV	Nunspeet, The Netherlands: manufacturer SWN
WB	World Bank

WERKBEZOEK VAN IAD AAN NIGER, BURKINA FASO, GHANA EN KENYA

1. DOEL

Het doel van dit werkbezoek is tweeledig:
1 De inzichten welke voortgekomen zijn uit het IAD Handpomp Projekt (fase II) zullen worden overgedragen aan het veld en getoetst aan de inzichten van veldwerkers en de realiteit.
2 Informatie verzamelen als voorbereiding op Pre-phase III. (Zie betreffende projektvoorstel.)

De over te dragen en te toetsen kennis betreft:
- inzichten met betrekking tot het dynamische gedrag van deepwell handpompen met elastische (PVC) stijgbuizen,
- de consequenties voor vermoeiing van de trekstangen en de stijgbuizen.

Voor details zie de projektrapporten IADHPP89.01 t/m .09.

De informatie die verzameld zal worden t.b.v. de pre-phase heeft betrekking op:
1 (Technische) problemen met deepwell handpompen; gerelateerd aan het type pomp en de stijgbuislengte en m.b.t.:
   - lokale fabrikage,
   - installatie,
   - gebruik (-svriendelijkheid)
   - beheer,
   - onderhoud.
2 Mogelijkheden van en problemen met kleinschalige alternatieven voor deepwell handpompen, waarbij gebruik gemaakt wordt van een van de volgende energie 'bronnen': wind, diesel, zon of dieren.
3 Onderzoek in het veld aan deze problemen en de resultaten daarvan.

De inventarisatie heeft voornamenlijk betrekking op technische aspekten en op economische voor zover van belang voor de gebruikers van de systemen. Maar ook zal gekeken worden naar institutionele en socio-culturele aspekten.

2. WERKWIJZE

Deze informatie zal worden vergaard middels:
- bezoeken aan gebruik(st)ers van deepwell handpompen en kleinschalige alternatieven daarvoor,
- bezoeken aan projekten die betrokken zijn bij de fabrikage, installatie, beheer en/of onderhoud van deepwell handpompen in deze landen,
- evenzo m.b.t kleinschalige alternatieven voor deepwell handpompen,
- instanties die beleidsmatig betrokken zijn bij deze aktiviteiten, zoals regional offices van de WB (Abidjan, Nairobi), ministeries en donoren,
- personen in de te bezoeken landen, die speciale expertise hebben op de hiervoor genoemde terreinen,
- het verzamelen van relevante rapporten en publikaties.

Daarnaast zullen foto's worden gemaakt van relevante zaken en zullen waar mogelijk monsters van probleem-onderdelen worden meegenomen, t.b.v. eventueel later onderzoek (IAD/CRL).

3. PROGRAMMA

Vertrek: 26 november 1989 naar Niamey, Niger.
Terugkomst: eerste helft van januari 1990, vanuit Kenya.

Er is geen vast programma opgesteld voor de te bezoeken landen. Wel ligt de volgorde vast: Niger, Burkina Faso, Ghana, (Ivoorkust op doortocht), Kenya.

De volgende personen/projekten/instanties/bureaux zullen worden bezocht:

NIGER:
- ACREMA, Taoua: fabrikant van o.a. Volanta
  Heer W. Spettel, bedrijfsleider Acrema
- Programme Hydraulique Villageoise au Niger, Phase II
  Departement de Dosso
  Heer J. Stofkoper

BURKINA FASO
- Projet Hydraulique Villageoise de la Boucle du Mouhoun, Dedougou
  Heer M. Etienne, le coordinateur
  Heer Lasare Kafando en anderen
- Missie Saaba: fabrikant Volanta
  Frère Hilaire
- IWACO

GHANA
- Ghana Water and Sewerage Corporation
  Heer G.P. Wollschied, Accra
  Heer D. Sharp, Bolgatanga
  Heer K. Riexinger, Kumasi
  Heer E. Baumann, WB Accra

IVOORKUST
- World Bank Regional Office
  Heer B. Roche

KENYA
- Lake Basin Development Authority, Kisumu
  Heer T. van Miert
- African Medical and Research Foundation (AMREF), Nairobi
  Heer M. Woodhouse
- World Bank Regional Office, Water & Sanitation Program, Nairobi
  Heer J. Keen

Daarnaast zullen op advies van de bezochte personen bezoeken worden afgelegd aan andere instanties/projekten/bedrijven, die relevante informatie kunnen verschaffen.

4. RAPPORTAGE

Het verslag zal melding maken van:
- de bezochte personen/projekten/bedrijven/instanties
- de belangrijkste bevindingen en konklusies
- een lijst van verzamelde publikaties + korte inhoud

Daarbij zal een deklaratie met verantwoording van de gemaakte kosten worden gevoegd.

Appendix III: RECORD OF TRAVELLING

26.11.89	Amsterdam - Niamey, Niger by plane Travel to Dosso
27.11	Dosso: PHVD: J. Stofkoper, chef de programme K. van Dijk and others
28.11	Visit to IGN-Dogondoutchi: S. Scheffers Bare Bari Travel to Tahoua
29.11	Tahoua: ACREMA: W. Spettel, Boubacar, responsible for pump manufacture Cissé, responsible for production Yahaya, installation and maintenance
30.11	Visit to Abalak and Badéguisheri
1.12	Travel to Dosso
2.12	Travel to Niamey and Ouagadougou, Burkina Faso
4.12	Visit to CSF, Saaba: frère Hilaire
5.12	Travel to Dédougou: PBM: M. Etienne Ouédraogo J.P. and others
6.12	Visit to Babakuy
7.12	Visit to Taré and Tionkuy: windmills + manufacturer
8.12	Debriefing with PBM staff Visit to Toma
9.12	Travel to Ouagadougou
11.12	Travel to Bolgotanga, Ghana: UNDP/GWSC/CIDA: Bipin Joshi
12.12	Travel to Kumasi
13.12	GWSC/IGIP: C. Riexinger Travel to Accra: GWSC/IGIP: G.P. Wollschied
14.12	Travel to Lomé and back
15.12	G.P. Wollschied
16/17.12	Accra - Nairobi, Kenya by plane
18.12 -	2.01.90 Recess
3.01.90	Travel to Kisumu
4.01	LBDA/RDWSSP: J. Okello, project engineer T. van Miert, DHV K. Keetelaar, DHV Visit to Siaya: L. Oyuke, construction engineer D. Onono, cashier J. Otieno, supervisor wells W. Okoth, supervisor pump maintenance T. Okoth, clerk/storekeeper
5.01	Visit to Siaya Region: Rangala Malunga, Harambee Village, Siaya M. Abayo, maintenance officer
6.01	Visit to Homa Bay: Merk Engineering: manufacturer of SWN pump Visit to South Nyanza Region
8.01	Visit to Kakamega: KEFINCO: M. Leppanieni, O + M manager H. Pelkonen M. Asman
9.01	Visit KEFINCO: lecture about IADHPP-research results Debriefing with LBDA/DHV: T. van Miert
10.01	Travel to Nairobi Visit to WB: J. Keen, design and production engineer
11.01	WB: Mr. Skoda and J. Keen Visit to EAF, manufacturer Afridev, Nairobi
13/14.01	Nairobi - Amsterdam by plane

Appendix IV: DOCUMENTS COLLECTED

Centre Sainte Famille, Saaba, Burkina Faso:
- 'La pompe à main ideal pour l'Afrique'
- 'Volanta: Pièces de Réchange'

Projet d'Hydraulique Villageoise de la Boucle de Mouhoun, Dédougou, Burkina Faso:
- 'Rapport final de la troisième phase septembre 1986 - juillet 1989' M. Keyzer, 30.07.89
- Technische DGIS-inzet Projekt Boucle du Mouhoun', M. Smeets, 16.08.89
- Pomptest rapporten, M. Smeets, 1985

Ghana Water and Sewerage Corporation, Maintenance Unit, IGIP, Accra:
- 'GADEV MK II: Specifications and drawings' (2nd draft)
- 'Second Hand Pump Test Report with a summary of Laboratory Test at CRL (KfW-Test)'

Kefinco, Kakamega, Kenya:
- 'Evaluation of engineering workshops on their suitability for manufacturing NIRA 85 pumps', H. Pelkonen, Kenya, 1989 (personal point of view)

World Bank, Nairobi, Kenya:
- Letter from J. Keen, WB-Nairobi, to T. Harrison, ODA, concerning experiences with uPVC for rising mains. 9.01.90
  Annexe: 'uPVC rising mains in India' by J. Keen, 1987.
- 'Afridev Field Performance', J. Keen, 12.09.88
- 'Afridev Deep Well Handpump Specification', E. Baumann, SKAT, 1989

CWD, Amersfoort, The Netherlands:
- 'Wind Pumping Handbook', J. van Meel, P. Smulders, March 1989