Groundwater and Drilling Conference
The Handpumps and Wells Issue

1. Introduction

Handpumps has been used to lift water from wells for centuries, or even millenniums. Despite their longevity, however, the rationale for them has not changed much: it is to shorten the horizontal distance traveled in order to fetch water from a surface source, instead of another source – a well – just a few meters vertically from where one is standing.

The early pumps were for use by a single family, whereas the current use is for communities – communities that are distant from urban centers, that are, in many cases, at low levels of development and poor. The wells for water have been getting deeper as more and more water is abstracted from the groundwater and thus pose additional burden to the communities and the handpumps.

It is therefore essential to think about everything around a handpump whenever rural water supply via handpumps is considered. The pump itself, the well, the users and the general working environment all have significance in the system. The handpump alone is only part of this whole.

The report below first briefly describes what should be done to enhance the User's participation in handpump systems. Then the handpumps currently widely used in Ethiopia are described with a view to select the best options for the Country. A discussion then follows on the main issue here of wells for handpump use. The hand, auger and machine drilled wells are discussed and a drilling strategy suggested in order to come up with faster and more reasonable drilling costs. Finally, the rationale for an R&D department in the Water Sector is outlined.

2. The Users

The handpump now serves whole communities, rather than individual families as it did for centuries. Unlike the case where a single family took care of handpumps, methodologies have hence been set-up in the last two or more decades where the User communities participate in all aspects of handpump use. The pumps hence need to be maintainable at the User level. This has been a critical problem for the last 25 years or so.

One of the biggest worry around handpumps is that maintenance at village level has not progressed nearly as much as one would have liked. Communities work nowadays more closely than before with the organizations that dig wells and install pumps. However, reliable Community Maintenance has not been achieved yet.

User participation varies from place to place. But the main structure is where a committee (Water Committee) is selected from among the Users and is delegated with all activities involving the handpump system - starting from where the wells are to be dug, labor input in construction, through funds raising for spares, paying for the caretaker, etc.

In the highland communities, it appears that most maintenance is left to the men. This is not a problem because the main objective is the availability of the pump- whoever fixes it. People who have some technical expertise (bicycle repairers, operators of the village grinding mill, etc.) are well suited for handpump maintenance. In many communities, however, the village caretaker's job appears limited to a handpump watchman or guard. He does little else.

A study of Supply Chains for water supply and sanitation showed many parties especially women - were not even considered for handpump maintenance. In the pastoralist communities of Somali and Afar, this would have made quite a difference, especially as women members of the community do not normally move in search of water and grass for their livestock. They are relatively sedentary and therefore handpump maintenance, or any other development work for that matter, can anchor on them.

In almost all localities, spares were supplied, usually from the respective Water Bureau, as free handouts. There are no spare parts commercially available; there cannot be because no trader can compete against spares that are freely supplied.

Despite that the handpump program in Ethiopia was a pioneer in community maintenance, arguing for it as far back as 1979-80 before VLOM came into the picture world-wide, it appears we have not progressed as much as we should have. The basic requirement for any community based water supply is the felt need for water in the Community. If it is high, the probable success of the community maintenance / management will also be high. Strong and realistic measures particular to the area should therefore be drawn for each community in a handpump program wherein the User participates in all phases of a handpump project implementation. Sustained follow-up from leaders is essential as such apparently simple, yet crucial steps in project implementation are sometimes ignored.

3. Handpumps

3.1 General

Handpumps are the easiest way to abstract water from a well. They can be used in most every rural area because they are inexpensive to buy, generally simple to produce, install, maintain and operate. Most rural water points are equipped with handpumps even now. Handpump utilization must go on at an accelerated pace if there is going to be a meaningful increase in the supply of potable to the rural areas in the next 10-15 years.

WSDP requirements over the 15 years (2002-2015) is:

27338 pumps would be required for hand-dug wells.
2332-6997 (25-75% of 9329) – drilled wells will be equipped by handpumps
17801min - 21735max pumps would be required for replacement and for NGOs

Total = **47471-56070** handpumps shall be demanded over the fifteen year period.

This turns out to be a minimum of 60 handpumps per week for 15 whole years! This is a large number and the system needs to be prepared now to supply the pumps and spares in a sustainable manner.

A brief description of the pumps to use is given according to the well depths: shallow, medium and extra-deep.

3.2 Shallow Well Pumps (1-10, 15m)

Direct Action Pumps are good for pumping heads of 0-10 or 15m. They are considerably cheaper and simpler than handpumps with lever.

However,

- The wells they are usually installed in – hand-dug wells – could be so expensive as to cancel out their relative low-cost.
- In addition, some of their components could be complex enough to warrant a long supply chain for spare parts.
- The well water level in many instances is receding – in a drought or a dry season, when the well water is needed most. This would in turn increase the pumping head considerably, making pumping action relatively heavy.

Cast iron suction pumps can also be used for shallow wells. However, they are susceptible to breakage and relatively difficult to produce or maintain. They also need priming which can pollute the well water and are therefore not recommended.

In view of the above, it is suggested to keep only a few types of handpumps as the User is less confused that way in pump selection. Only one type of handpump should hence be used for shallow and medium wells. This will increase and consolidate the demand for this one handpump, such that the supply chain and hence commercial availability for it and its spares can be strengthened.

It is therefore recommended that no direct action or any shallow well handpumps come into the picture at all at this point in time. In the future, when problems in production of hand-dug wells are sorted out, it would be possible to re-introduce Direct Action pumps.

3.3 Medium Wells

Due to the recommendations against Direct Action and other shallow well handpumps above, the pump type selected here shall serve shallow and medium deep wells, i.e. 0-45m.

Here the theoretical number of pumps to choose from is many. However, the real contenders are Afridev and India Mk II only, as these are the pumps extensively tried and tested in Ethiopia.

Alternative 1: India Mk II is a robust pump that has also been tried and tested in Ethiopia and elsewhere. Millions of MKIIs are being used in the World.

However,

- Installation and maintenance are difficult because it is heavy and requires many tools and well trained technicians in the neighborhood, something not achieved over the last two decades or so in Ethiopia.
- The galvanized steel components corrode easily in aggressive well water common in this Country.

- Once the handle and rod hanger ball bearings fail, they cannot be installed properly in the field such that subsequent failures occur more frequently.
- MKII is not suitable for very shallow wells. It needs direct linkage of handle with the rod, and without the chain link. So it cannot really replace other pumps in heads of 0~10m.

There are other handpumps in the family of MKII:

- **Mk III,** though easier to maintain, is so much heavier to install and uninstall. It is no more corrosion resistant than its predecessor. Its extractable foot-valve is difficult to manage without proper technicians. It is also very expensive. It is no contender to either the Mk II or Afridev. In fact, no region buys it now and many local suppliers have already stopped stocking or indeed transactions in MKIII and the Indian program does not seem to actively promote it anymore.
- The **VLOM50PVC** version of this pump has quite an appeal because it has a threaded PVC riser pipe, which is so much lighter, more corrosion resistant and so much like Afridev in its down-hole components.
    - The detachable uPVC riser, if successful, could also be adapted to the Afridev.
    - However, the Mk II VLOM50PVC version of this pump is not really tried and tested in India. Constant improvement can hence be achieved only on the strength of feed-back from users which may be too far away from India.

Alternative2: Afridev is the most widely used handpump in Ethiopia for depths up to 45m.

- It lends itself to adapt for use in areas where there is aggressive ground water; a considerable proportion of the at least the Rift Valley and the Somali Region come under this category.
- Although there is little fabrication being done currently, there was considerable experience in local manufacture of the pump. There is still an on-going local production of fast-moving spares.
- There exists a complete set of documentation prepared for Afridev family of pumps by SKAT/ HTN for manufacture, exports, etc. Any potential manufacturer could get access to these relatively easily.
- Most regions already use the Afridev as their standard for shallow and medium wells.
- Many more traders in Ethiopia keep Afridev in stock than they do all other handpump types put together. Therefore a commercial supply chain for this pump is already developing, and changes at this time could spell a disaster for profit oriented businesses.

Afridev is therefore preferred for wells of 0-45m due to an already relatively well established supply chain in Ethiopia.

3.4 Extra Deep Wells

Very Deep Wells here are defined as static water levels of 45m -90m, or sometimes to 100m.

Such deep wells were rare in Ethiopia until a few years ago as the majority of wells have been hand-dug wells. There is hence little field experience in extra deep wells with handpumps. However, drilling programs are now taking off with the result that increasingly deeper wells are being used with handpumps.

The real choice here again is between the Afridev with Bottom Support and India Mk II Extra Deep handpumps.

Alternative 1: India Mk II Extra Deep handpump has been used for a relatively long time in India and elsewhere. Few extra-deep wells (deeper than 45m) existed in Ethiopia until a few years ago due to the fact that handpumps were installed primarily in shallower dug-wells. Current growth in drilled wells will require many extra deep well handpumps. In addition, replacements of old handpumps for which there are no spares: e.g. Mono, Moyno, Boswell pumps, is being done by MKII Extra Deep in many regions.

Alternative2: Afridev with Bottom Support (AfriDeep) is a relatively new pump. It is a direct derivative of the Afridev and has many parts – including fast moving spares – in common with Afridev. It weighs only a fraction of the MKII Extra Deep. Its cost is also expected lower than the MKII Extra Deep. The main stumbling block is it has no field experience in Ethiopia and little anywhere else. Any failures in the uPVC riser could entail an expensive repair and long delays. Reinstallation of the riser after a repair would be staggering, as it would entail managing one, long piece of pipe up to 90 or 100m!

In the choice between the two handpumps, first instincts are to go for standardization and go for the Afridev with Bottom Support. However, a very long riser pipe in one piece will be difficult to install. Further, there has been little documented experience of Afridev Bottom Support anywhere.

The better current choice is therefore **Mk II Extra Deep handpump**, which is also the current de-facto “standard”. All regions specify Mk II Extra Deep in their very deep wells. There is no reason to change this trend at this point in time for fear of disrupting the supply chain.

On the other hand, trials in Ethiopia on Afridev Bottom Support must begin as soon as possible. This pump will be lighter, probably less expensive and less tiring to use than the MKII Extra Deep. Most of its components and its fast moving spares are identical to the Afridev. It would also be easier to locally produce and hence become a more sustainable solution in the long-run.

3.5 Standardization

Standardization is fait-accompli in Ethiopia at the Regional Level because almost all regions already use the Afridev; it is the handpump of choice in well depths to 40-45m. Legalization of the standardization process yet remains to be done at the Federal level,

which will give additional impetus for further commercialization and subsequent local manufacture of the pump.

3.6 Further Tests

Field trials on handpumps are necessary in Ethiopia.

- Afridev now has options in threaded and fiberglass pumprods, in addition to the traditional hook-and eye design.
- Further, the plastic piston and u-seal have been replaced with a brass piston and cup-seal.
- AfriDeep has yet to be tested in Ethiopia.
- The threaded riser design of the VLOM50PVC pipe would do just fine on the Afridev, if it is found successful in field tests.

The tests should be done in a coordinated manner throughout the Country. A Research and Development Center should facilitate the tests.

4. Wells

The previous chapter indicated an average annual demand of over 3000 handpumps in the Country. Production of some 60 units of handpumps per week can be done in one dedicated plant. However, finding the wells for these pumps is considerably more difficult. In fact, even in the case of handpumps over the last 20 years or so in this Country, the supply of wells was the single most important problem.

Supply of wells - hand, auger or drilled - is a bottleneck that ahs to be met as soon as practicable. It discussed below in order to arrive at a better strategy of implementation.

4.1 Dug Wells

4.1.1 WSDP Estimates

The 15 year – 2002-2016 – Water Sector Development Program (WSDP) estimates some 27,000 dug wells in the 15 years period to be needed.

This amounts to a dug well supply of about 1800 units per year, or 43 wells per week, at 42 weeks / year. If a crew completes well digging and pump installation at the rate of 3 weeks per well, a crew of about 130 will be required countrywide.

This is relatively difficult on which all handpump system construction must concentrate. Resource Requirements and Working Methodology need to be addressed in detail to achieve the numbers required.

The Drying of Wells, often in the first few years of commissioning, is the single most important problem of hand-dug wells in Ethiopia. Improvements in digging techniques and uses of simple machinery are suggested to overcome the problem.

4.1.2 Improved Digging Techniques

Here, the main thing is to use of dewatering pumps. Increased water column should be the single most important criterion for improved dug-wells. As per the experiences of other African countries (e.g. Niger), it is suggested that the water column height in a dug-well be targeted at 5m. This should be sufficient to take care of any lowering of the water table in the dry seasons or droughts.

Well digging in the dry season, use of explosives for the areas with hard formation and designs that allow well deepening are also improved techniques.

4.1.3 Simple Machinery

In addition, mechanized drilling should be attempted with appropriate development and adaptation of simple and inexpensive rigs found suitable elsewhere in the World in general and Africa in particular. Simple drilling rigs suitable for the geological conditions in African need to be identified and adopted.

4.1.4 Traditional well diggers

Efforts to train and employ traditional diggers for hand-dug wells have been made, notably by the ESRDF. These can have important input in large-scale dug-well production. Besides their involvement in Water Sector, they could also be used to dig household and school latrines, thus really tackling the Water and Sanitation problems together.

They could be used as a one-stop-shop for handpump maintenance. They can dig or maintain a dug-well, often at a fraction of the cost of classical contractors. They can also keep handpump spareparts and sell them along with their services to maintain the pumps.

Nevertheless, the working environment for traditional diggers must be improved:

- They should be trained to adapt safer and modern well digging tools, equipment and methodologies.
- The present licensing of water works contractors by Ministry of Works and Urban Development is not appropriate. Ministry of Water Resources and Regional Water Bureaus should be able to give licenses to such artisans, as water works are legally their mandate.
- The traditional diggers should be certified and must have trade license in order to participate in larger tenders, especially in tenders of public organizations.
- They must have access to credit, either from banks or micro-credit institutions, as the case may be. However, their constitution, general working environment and the nature of the job lend themselves better to work with micro-finance institutions.

Coordinated efforts must be done by all concerned so that the WSDP targets can be met. This should be seen together with employment generation for the rural poor and efforts must be increased even more. The responsibility for coordination falls mainly on the

MoWR. Else, one is inclined to believe that Dug-well programs may be too slow and complex to be of any use.

4.2 Auger Wells

Auger wells are made by augers (helical type drills) usually of relatively large diameter. When they can be used, they are fast to operate. The machines are relatively inexpensive and simple to operate, resulting in relatively cheap wells.

However, they require a relatively soft, water bearing formation which is not easy to find in most locations in Ethiopia. Their use was hence limited to specific locations (e.g. Asgori area, some 50 km south-west of Addis) where 60cm wide wells were dug about 15 years ago.

Auger wells do not appear to be a large scale solution to drilling in Ethiopia and seem to be increasingly rare nowadays.

4.3 Drilled Wells

This leaves boreholes to be the most important source of wells for handpumps in Ethiopia. However, they are very expensive; drilling rates over USD 300 per meter were common in the early nineties. Output from rigs was relatively very low, around 6.2 boreholes per year per rig! (Bantihun and Sehmi, Second National Handpump Workshop, 1991) Even now a complete borehole can cost a fortune (over half million birr) in some regions and drilling rates over Br. 2000 per meter are not uncommon.

The main factors given at the above workshop for this appalling performance are poor equipment selection, i.e. big rig for a small job, too large diameter of wells, low number of rigs, poor maintenance and availability of rigs, high incidences of dry wells and poor organization of drilling exercises. These are a whole lot of shortcomings, and we will therefore need to identify the major problem or problems.

4.3.1 Shallow Drilled Wells

In the WSDP, number of shallow drilled wells (<100m deep) over the 15 year period for both motorized and handpumps is 9329 wells.

This works out to an average of 622 shallow drilled wells per year. Considering an effective 45 weeks (315 days) per year and at 5 days per well per rig, the number of shallow well rigs will be about 10 rigs for the whole country in order to meet WSDP targets! This is a relatively small number.

This assumes a uniform distribution of rigs in the Country, but is acceptable for the main conclusion that the main constraint in the production of drilled wells is not the number of rigs, their design or quality or the well diameter – but the effective management of the well drilling system. Hence, in order to meet WSDP targets and to bring Drilling to acceptable standards, a Drilling Strategy that best meets the financial, technical and other challenges in the Country needs to be drawn.

4.3.2 Drilling Strategy

In order to systematically tackle the management aspects of Drilling, recommendations in Drilling Methodology are given below, roughly in the order of importance. As per the discussions above, items that deal with the rig proper have been down-graded.

These are given as suggestions for improvements by the participants.

1. **Drilling in Clusters**: Wells shall be sunk in clusters of about 10 units in one area. This will improve on output of rig and crew, among others, through improved logistics, technical support and reduced incidence of dry-wells. The next set of clusters will also be near by so that there is as little inter-site mobilization as possible.
2. **Logistics**: All the necessary hardware and software inputs must be ready and on hand for easy transfer to the well sites.
3. **Well Siting**: The incidence of dry wells is uncomfortably high in some conditions. Better well siting techniques using more modern equipment needs to be employed.
4. **Training:** Formal training of key field crew members must be raised in order adopt the new drilling methodologies, to meet particular problems in the field more scientifically, etc.
5. **Crew Size:** Some Drilling crews are reported to be too large and expensive for effective management at the field level.
6. **Casing dimensions**: A four inch casing in PVC should be sufficient for handpumps.
7. **Licensing:** Drilling companies are not always properly licensed such that they operate without the proper tools and technical back-up and discontinue operations, often at the expense of the Customer.

8. Rig Selection

The existing selection of drilling rigs and accessories is far too many to sustain successfully in the Country. The Drilling Strategy therefore needs to employ:

- **Simpler rigs** over expensive high-tech rigs that require expert attention at all times. Parts supply, purchase and subsequent operation and maintenance costs, roughly increase with rig complexity: Percussion, simple Rotary and DTH.
- **Smaller rigs** over larger rigs: There is no need to assign a rig of 300m capacity to an area where the ground water level is known to be around 50m.
- **Standardization**: Drilling equipment and accessories should be standardized or rationalized to a few makes and types so that operation, parts supplies, maintenance, etc., are made easier.
- **Local Support** from within the Country for rigs is also an important criterion. The support should include **Maintenance Facility** and adequate **Spares Supply. Close External Support**: Direct link of User with the Manufacturer, with or without the Local Agent, needs to be in place.

9. Local Manufacture of Rigs

Local manufacture of rigs and components should be encouraged by Sector Partners and the government, through giving technical and marketing assistance to local producers.

- There are many fabrication shops that serve the transport sector and can be adopted for rig body manufacture and assembly.
- The particular problem of used compressor import for local manufacture of DTH rigs poses an acute problem because the tax level on used compressors for DTH rigs is quite high. It should be addressed through improvement in the tax environment.
- There should be association of local rig manufacturers with foreign manufacturers of repute, with a view to assemble and gradually fabricate components.
- Building in-country capability of reconditioning of used rigs can be of crucial importance as new DTH rigs can be prohibitively expensive.

Current experience in drilling efficiency is very much encouraging. The Water Bureau of the Southern NNP Region operates one DTH rig supplied to it by UNICEF. Drilling exercise is now well planned and is done in clusters. The output for 1995EC (2002/3) has been 89 wells per year. All wells in the SNNP Region were for handpumps and have a 4" casing. There were virtually no dry wells. Tigray Region reportedly has even better output.

In one instance in Mesqan and Mareqo, 22 wells were dug, casings put in and handpumps installed in 42 days in an emergency operation! Well depths were 40-60m; there were no dry wells. This is very good.

The output from Water Works Construction Enterprise in the same Region is still reportedly only a small fraction of the Water Bureau crew. So real change is still some distance away and pressures must be exerted by all concerned until reasonable output is achieved by commercial drillers. Else, a deep structural change in the management of WWC Enterprises appears necessary.

4.3.3 Funding Drilling Programs

This is really part of any Drilling Strategy. However, it is given separately because it cannot be treated the same way as other parameters.

Mechanized Drilling is less expensive per meter of borehole dug. However, an efficient drilling program requires all hardware inputs ready on site: casings, pumps, pipes and fittings, fuel, etc. As these are consumed at a relatively fast rate, the flow of funds to the project should be able to match the rate of physical works.

Availability of the right amount of funds, at the right time, to the right party, in the right form of payment, coupled with the institutional arrangements to handle the disbursements should be put in place in good time. Disbursement of the available funds should also be reasonably flexible in order to tackle difficult, yet unforeseen circumstances.

In conclusion, the Drilling Strategy should therefore consider the management of rigs, the availability and disbursement of funds carefully, before embarking on large drilling programs. A strategy where simple and small rigs are selected and where local manufacture of appropriate rigs is encouraged will support a sustainable drilling program. Regions should be encouraged to learn of good practices in Drilling from each other.

In areas where commercial drilling is still too expensive - and that is most everywhere - deeper structural changes in management and modus operandi may be necessary.

5. Research & Development

Innovations in handpumping technologies are now a thing of the past. Such activities were widely funded and undertaken in the eighties during the Water Decade. However, R&D is still necessary and must go on, albeit at a reduced scope.

- The Afridev now has many options, each with its own strong and weak points. These need to be tested and the best options selected for different areas of the Country.
- There are areas that still need improvement. The threaded option for PVC risers is one that looks promising. Tests should therefore be done in the field with the results closely monitored.
- Afridev with Bottom Support has not been at all tried in the field in Ethiopia.
- There are other pumps unused or need improvements in Ethiopia, but could be well suited to the rural situation in Ethiopia, e.g. Rope Pump, treadle pump.
- Global programs in such tests are currently being led by the Handpump Technology Network, HTN together with SKAT. Detail modus operandi should be availed from there.

The set-up of R&D must be at Federal Level, with a mandate and close working relations covering all regions.

Some more identified activities:

Handpumps: Improve quality of local spares; Complete formal standardization procedures for Afridev with stake-holders; Preparation of Installation / Maintenance manuals in local languages, etc.

Wells: Standardize dug well aprons, casings and commissioning water column heights; isolate and improve on digging problems; employment of traditional diggers after training, organizing, equipping and licensing them for operations.

Users: Assistance in the selection and training of Users for maintenance.

Mechanized drilling: identify existing technologies and adapt them for different geological conditions in the Country.

etc.

Other topics in the Water Sector could be introduced could include:

- Solar and wind pumps
- Improvements in conventional and non-conventional water collection, treatment methodologies
- Selection, evaluation, testing, standardization of electro-mechanical equipment, water meters, pipes, etc
- Data bank set up and management for rural water supplies, irrigation
- etc.

The choice of topics is wide and should be narrowed down as per the felt need of Regions. Availability of funds are not expected to be a major problem.

R&D is expensive and no attempts should be made to "reinvent the wheel". Working together with bodies like the SKAT/HTN, DFID on a global basis should greatly shorten the learning curve and enhance general experience sharing on rural water supply technologies in general and on handpumps in particular. It would also be less costly.

6. Conclusion

Handpump systems are envisaged to be the main instruments of RWS in the WSDP. They must therefore be accorded the attention they deserve. Each of the main components: the pump, wells and the Users need the continued support for a sustainable program.

The Afridev handpump selected needs to be formally standardized so that the commercial availability is improved for pumps and spares. The shortest and most accountable supply chain for pumps would be if they were locally manufactured to an international specification.

Wells have been and will continue to be the main bottle-neck in the wide scale use of handpumps. All efforts must be exerted so they are supplied to international standards and prices.

Adaptation of existing technologies is encouraged with the establishment of a research and development center and liaison with global Handpump Technology Network.

Enabling environment creation and sustenance by the MoWR and Federal authorities is imperative if the Handpump is to play, as expected, a major role in rural water supply in Ethiopia. Efforts to encourage local manufacture, the will to introduce commercial outlets for products, rather than supply inputs freely or in a heavily subsidized manner, to revise tax schedules if the need arises, are all examples of this.

Else, the WSDP will remain a program.