

Learning Note 2: Manual Drilling at Scale — India, Senegal & Bolivia (18 February 2014)

Introduction

The second webinar focused on the experiences of manual drilling from India, Senegal and Bolivia. In all three countries manual drilling has become well-established and provides drinking water for tens of thousands (Senegal and Bolivia) and millions of people (India). While India's manual drilling history goes back numerous generations, the technology has only been known for about 30 years in Senegal and Bolivia. Both India and Senegal witnessed the application of the technology expand from irrigation wells into domestic water supplies.

Of particular note is the fact that there seems to have been relatively little change to the sludging technology used in India for generations, whereas both Bolivia and Senegal have witnessed considerable modifications and improvements to manual drilling techniques. In all three countries private enterprises play a major role in drilling, but Bolivia and Senegal both have NGO projects with funding to innovate, test and introduce new ideas. In contrast, the Indian experience appears to be more concentrated on local enterprises that do not have access to these innovations.

Government interest and involvement in manual drilling varies. In Bolivia there is more interest among political leaders than government staff. In India, manual drilling is also used by Government whereas in Senegal the technology is a key component of the USAID-funded programme. There is no regulation of manual drilling in any of the three countries.

Case Study

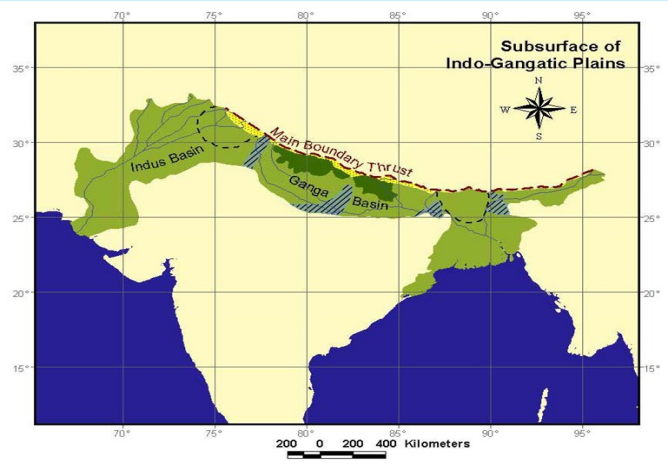
Manual Drilling at Scale - Case Study 1: India

India is the largest user of groundwater in the world. The JMP (2013) indicates that 36% of the population in India rely on tubewells for their drinking water supplies. A high proportion of these are private wells. Manual drilling, mainly through the sludging and jetting techniques, is contributing significantly towards fulfilling the drinking water needs of millions of people in rural India. The technology is used in areas with soft formations and shallow water tables, particularly in the Indo-Gangetic Basin.

Although manual drilling has existed for generations, it was the expansion of irrigated agriculture that encouraged more entrepreneurs to engage in it to support their livelihoods. From irrigation manual drilling subsequently expanded to provide drinking water supplies to households.

Rota-sludging in India

It is estimated that today there are over 2 million shallow wells for drinking water supply and 600,000 irrigation wells in West Bengal (Sinharoy 2014). The WASH Network estimates that 15% to 20% of India's population continues to use their tube wells despite the fact that they have another improved water source as their primary supply (2014a). This is attributed to unreliable public services and lack of assurance regarding water quality (World Bank 2014). In addition not all community members are able to access the public supplies due to equity issues. Dave (2014b) estimates that a million new tube-wells (drilled manually) are sunk in India every year.



Map showing the states with alluvial strata where manual shallow well drilling is popular

"In India, community behaviour is inclined towards accessing a tube-well in the backyard whenever it is possible and available" Dave (2014).

Rotary-sludge drilling in India

Groundwater is also used for an estimated 60% of India's irrigated agriculture. Considerable numbers of wells are drilled manually for irrigation. World Bank (2005) notes that if current abstraction trends continue, within 20 years, 60% of all aquifers in India will be in a critical condition.

Dave (2014b) calls for modernisation of manual drilling in India with respect to well diameter, drilling fluid, well development, drilling techniques and pump technologies. However, with over 400 million tube well users, and numbers rising every year, reaching out and raising awareness is a (formidable) challenge.

Manual Drilling in India: Key information	
Type of manual drilling:	Mainly sludging and jetting
Scale:	At scale: an estimated 4.4 million wells across 3 states
Regulation	None as yet
Types of pumps:	Mark-6 Cast Iron Pumps & Direct Action Pump-TARA
Drilling costs:	Can be $1 per meter, with teams of 5 to 7 people responding to local demands.

Case Study

Manual Drilling at Scale - Case Study 2: Senegal

Hand-augering in Senegal

Low Cost Drilling technologies were first introduced into Senegal in the early 1990's. The evolution of manual drilling comprises of four key milestones:

In 1992 injecting a wrapped filter into the bottom of hand dug wells by jetting was introduced by Richard Cansdale. This increased well capacity and overcame problems of sand ingress in certain parts of the country.

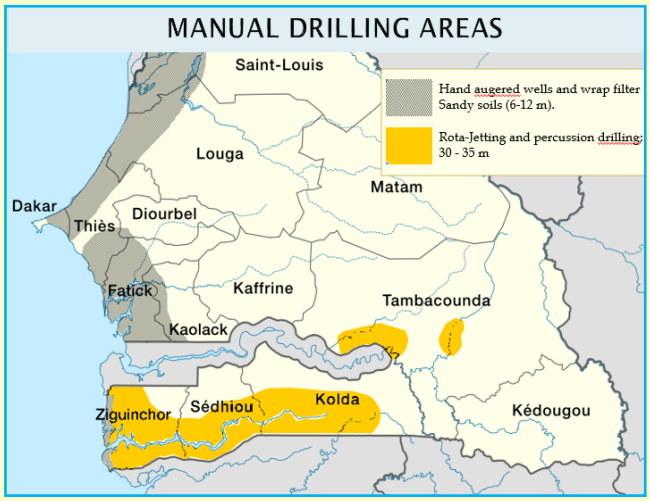
In 1997 hand augering was introduced by Enterprise Works in areas where there were sandy soils and shallow aquifers. The technique would typically drill between 6 to 12 m. This was undertaken as part of a small scale irrigation programme.

From the 7 businesses that were trained initially there are now 40 hand auger teams operating in Dakar, Thies and Ziguichor regions. An estimated 3,000 wells have been installed in gardens and population centres without access to piped water (for building construction). The wells are also often used for domestic purposes.

In 2002 the rota-sludge was introduced by Enterprise Works and the Practica Foundation in order to drill deeper wells (where rope pumps were installed for domestic water supply), but only ten wells were drilled with this technique.

In 2009 rota-jetting and percussion drilling were introduced under the auspices of a USAID/PEPAM project. Wells could be drilled to a depth of 30 to 35 meters but the technique was not able to penetrate solid rock. A total of 13 enterprises have been trained in these techniques so far in the Ziguinchor, Sédhiou, Kolda and Tambacounda regions. These enterprises have also received training on hydrogeology, business management and how to respond to tenders.

To date, almost 400 wells have been drilled by these businesses for the USAID/PEPAM programme as well as for individuals and businesses. Most of the wells serve villages with between 80 and 300 inhabitants and are equipped with India Mark II or rope pumps. Some wells, particularly those used for irrigating gardens and for use in tourist locations, have been equipped with electric submersible pumps.



The wrap filter jetting and augering techniques are most often used in areas where there are shallow, sandy aquifers. These areas can be found along the coast from Dakar to Saint Louis (Niayes) as well as in the Thiès and Kaolack regions. The rota-jetting and percussion drilling methods are used in the south and middle of Ziguinchor, Sédhiou and Kolda regions.

Mamadou and Diouf (2014) estimated that about 95% of the irrigation wells are paid for by water users themselves (i.e. self supply). In contrast only 5% of the wells for domestic use are paid for by the end users with 95% funded by projects or NGOs.

In 2011: A small portable mechanised rig (LS 3000) was introduced in the USAID/PEPAM project to penetrate harder formations and drill deeper. After a test phase, two local manual drilling businesses were selected and trained. These enterprises are now paying off the equipment cost with the work that they are currently undertaking.

The wrap filter jetting and augering techniques are most often used in areas where there are shallow, sandy aquifers. These areas can be found along the coast from Dakar to Saint Louis (Niayes) as well as in the Thiès and Kaolack regions. The rota-jetting and percussion drilling methods are used in the south and middle of Ziguinchor, Sédhiou and Kolda regions.

Mamadou and Diouf (2014) estimated that about 95% of the irrigation wells are paid for by water users themselves (i.e. self supply). In contrast only 5% of the wells for domestic use are paid for by the end users with 95% funded by projects or NGOs.

Manual Drilling in Senegal: Key information	
Type of manual drilling:	Jetting of wrap filter, hand augering, rota-jetting and percussion.
Scale:	Tens of thousands of people across several regions
Regulation:	None as yet
Types of pumps:	India Mark II, rope pumps, vergnet pumps and electric submersible pumps
Drilling costs:	Between $1,600 and $2,000 for a 30m well ($53 to $67 per meter); for the small mechanised rig it costs between $5,800 to $8,000 for a borehole of 30 - 60 meters ($96 to $193 per meter).

Case Study

Manual Drilling at Scale - Case Study 3: Bolivia

Currently, access to improved drinking water in rural Bolivia is estimated to be at 71%, considerably less than the urban equivalent of 96% (JMP 2012).

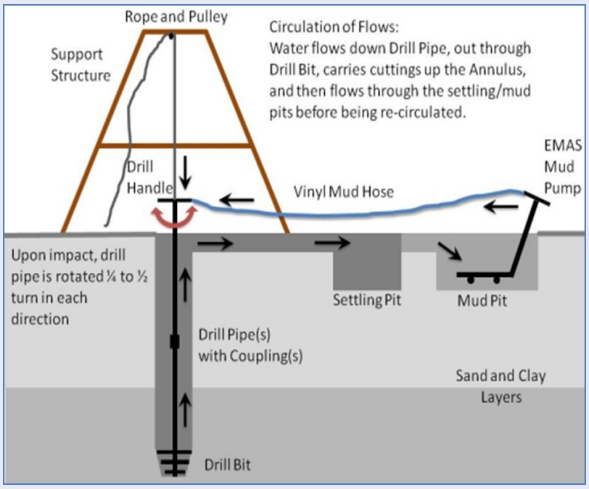
Low-cost water supply technologies in Bolivia date back to the mid-1970s, when manual drilling and pump techniques were introduced by a Mennonite missionary organisation. It was in 1983 that EMAS (a Spanish acronym for Mobile Water & Sanitation School) started to develop manual drilling techniques and low cost hand pumps. Additionally, Terry Waller of "Water for All International" developed the "Baptist" drilling technique in 1993.

It is estimated that between 50 and 100 small enterprises in Bolivia currently construct EMAS systems. Usually family members provide unskilled labour to help keep the costs down.

EMAS drilling in Bolivia

EMAS estimates that over the past 30 years, 30,000 to 35,000 manually drilled wells have been installed in households throughout Bolivia using EMAS methods (Buchner and MacCarthy 2014).

Quality control remains a challenge. Although the drillers are not regulated, since most clients pay for the work themselves, word travels fast if standards are high. About 75% of these wells have been completely financed by small private farmers and ranchers. The remaining 25% have been financed by public institutions and are used for drinking water. A few thousand "Baptist" manually drilled wells have also been installed, primarily in eastern Bolivia.



The EMAS drilling technique (percussion, sludging and rotary)

Manual drilling is in fact one of several low cost technologies, (including pumps and rainwater harvesting) which are promoted by EMAS. The drilling method combines three techniques: percussion-suction, sand sludging (jetting) and rotary action. The first of these three techniques can drill to 100m through sands, clays and thin layers of soft rock. The diameter of EMAS wells is particularly small; 1.5 to 2 inches which helps keep the cost low. The EMAS strategy also aims to train local independent technicians from across Bolivia. The training, which takes a month, is subsidised by EMAS and is carried out 1-2 times per year (often co-sponsored by the Bolivian Government). There are also extensive training materials available on the internet (see Resources section), and videos are broadcast on Bolivian television. Following the success of EMAS in Bolivia, a training centre is currently being set up in Sierra Leone.

Manual Drilling in Bolivia: Key information	
Type of manual drilling:	"Standard EMAS" is a hybrid technique that combines percussion, sludging and rotary actions
Scale:	At scale in several regions
Regulation:	None as yet
Types of pumps:	EMAS Pump
Drilling costs:	The cost of the well (with handpump) is between $10 and $15 per meter (if no labour is provided by the client) or $4 – 10 (if the client provides labour).

Issues for further discussion

The three country case studies raised many questions from amongst the participants. The main issues discussed were:

Cost and Price: Per meter and per well costs vary tremendously between the three countries, ranging from US$1/m in India to $180 for a private well in Bolivia and almost $2,000 in Senegal. However simplistic comparisons are dangerous. More analytical work is needed to understand how the costs are calculated and how construction techniques, materials and markets differ between the countries.

Borehole Design - Diameter: Dave (2014b) recommends that the diameter for a manually drilled well in India be increased in order to facilitate proper gravel packing. It was noted that increasing the diameter of a borehole will not result in higher yields and that it is the length of screen in the aquifer that significantly increases the rate of flow into a well. The EMAS technique drills a diameter of 1.5 - 3". Participants raised concern as to whether this allows enough space for gravel packing. In the case of EMAS, the wells are cased, but gravel pack is not used.

Borehole Design – Sanitary Seal: A number of participants raised questions about the sanitary seal. In the case of irrigation and household wells in India and Senegal, there is no cement sanitary seal. With EMAS drilling, the hole is backfilled with the materials drilled. In contrast, the practice being encouraged for community wells in Senegal is to install a cement sanitary seal of a certain depth. Conventional drilling practice is to backfill the hole and then install a sanitary seal to a depth of 3 to 6m. Opinions varied among the participants as to what good practice for manually drilled wells should be.

Borehole Design – Screens: Dave (2014b) recommends slot sizes of 0.5mm but later added that the slot size needs to be matched to the grain sizes of the aquifer. Questions regarding the experiences of filter cloths for very find sands remain.

Questions and Answers

Can you explain a little bit more about the type of drilling that is done in India?

When drilling through softer rocks, the Cable Tool Percussion method and the Hydraulic Rotary method (Direct and Reverse) are used.

When drilling in alluvial and soft formation, Sludging is the most common technology. This is the most common traditional manual drilling technology used for shallow wells popular in Indo Gangetic plains (see map in the India Case Study box). This requires comparatively less labour and drilling depths - hence the cheaper cost.

Water jet drilling is another technique which is suited for use in coastal alluvial areas for deeper drilling. This requires more skill, labour and bigger scaffolding, and requires rotary motion and downward thrust for drilling.

Screens of 0.50 mm were discussed during the Webinar - don't they clog easily and reduce the yield from the BH?

Yes, 0.50 mm screen do clog, and the recommendation is to reduce the size of screen using high density PVC pipes which have been used to tap fine to very fine sands in the coastal areas of West Bengal. This will also ensure sustaining the yield.

Can you explain what is included (and excluded) from the $1 per meter that you mentioned? For example, which equipment is used, how many people are involved, what materials are installed and does it include the pump cost? And have the costs changed much over time?

The cost of $1 per meter includes the cost of primarily labour and transportation - excluding the cost of pump for manual drilling in rural areas.

The cost of labour includes only drilling the hole by a team of 5-6 drillers. The cost of putting a tubewell with a pump (hand or motor) is not included in the cost. For installing the tubewell you need to add the cost of blank pipe, screen, connectors, gravel/sand as packing material, bail plug, pump and well completion

The equipment used for drilling includes a drilling pipe made of iron (which is raised and lowered in the hole by means of a lever), bamboo scaffolding, 1½ inch couplings to connect the pipes and a drill bit, a standard 1½" x 2", 3" or 4" reducing coupling.

The cost in rural areas (for 50 mm bore diameter) ranges from between INR 18 to INR 22 per feet which is on an average $ 1 per meter and is the prevailing cost over last couple of years. However in urban areas the cost is higher and is around INR 40-50 per feet which is $2-3 per meter.

You mention that the borehole diameter should be increased. What is the current diameter and why should it be increased?

The diameter of the manually drilled bore well is mostly 50 mm for installing suction pumps, however, for hand-pumps with cylinders; the diameter of bore well is larger i.e. 100 mm. The diameter of the bore well should be increased to facilitate proper packing medium i.e. gravel, the size of which will depend upon the slot width and the grain size of the aquifer materials.

Did you miss the webinar?

You can watch the webinar on: http://vimeo.com/87084964.

A summary as well as all presentations and scripts (English and French) is available on: http://www.rural-water-supply.net/en/resources/details/565

Additional Resources

BUCHNER W and MACCARTHY M (2014) Experiences from Bolivia – EMAS Manually Drilled Wells/ Expériences de la Bolivie – les Forages Manuels EMAS, Presentation at the 2nd UNICEF -RWSN Webinar on Manual Drilling, 18th Feb 2014, Available on: http://www.rural-water-supply.net/en/resources/details/565

DAVE, S (2014a) Key findings of the pilot project study to develop participatory water safety and security plan - Jointly implemented by PHED, Government of West Bengal and UNICEF, Draft presentation-6th August 2010, Available from shdave@unicef.org

DAVE, S (2014b) Manual Drilling in India / Forage Manuel en Inde , Presentation at the 2nd UNICEF -RWSN Webinar on Manual Drilling, 18th Feb 2014, Available on: http://www.rural-water-supply.net/en/resources/details/565

JMP (2012) Progress on Drinking Water and Sanitation 2012 Update, Joint Monitoring Programme of UNICEF and WHO, Available on http://www.wssinfo.org/

JMP (2013) India: estimates on the use of water sources and sanitation facilities (1980 - 2011), Joint Monitoring Programme, WHO/UNICEF 2013, Available on http://www.wssinfo.org

MAMADOU, I and DIOUF, A (2014) Low cost drilling: experiences from Senegal/Forages à faible coût- Expériences au Sénégal, Presentation at the 2nd UNICEF -RWSN Webinar on Manual Drilling, 18th Feb 2014, Available on: http://www.rural-water-supply.net/en/resources/details/565

SINHAROY, SP (2014) A Note on the Manual Drilling for construction of water supply Tube wells in West Bengal, Dr. S. P., Chairperson, Fluoride Taskforce, Government of West Bengal -2014, Unpublished Report, Available from shdave@unicef.org

WORLD BANK (2005) India's Water Economy: Bracing for a Turbulent Future, Washington DC: World Bank

WORLD BANK (2012) Deep wells and prudence: towards pragmatic action for addressing groundwater overexploitation in India, World Bank

Additional Resources on EMAS (Bolivia)

MACCARTHY, M.F, BUCKINGHAM, J.W. & MIHELCIC, J.R (2013) EMAS Household Water Supply Technologies in Bolivia Increasing Access to Low-Cost Water Supplies in Rural Areas, Rural Water Supply Network, Available on http://www.rural-water-supply.net/en/resources/details/518

Over 40 training videos of EMAS technologies, including text descriptions in English and Spanish, can be viewed at: http://vimeo.com/emas / Plus de 40 vidéos de formation des technologies EMAS, y compris les descriptions de texte en anglais et en espagnol, peuvent être consultés à l'adresse: http://vimeo.com/emas

'Water For Everybody' EMAS Technologies manual (multiple languages) / L'Eau Pour Tous" EMAS Technologies manuel, Available on http://www.emas-international.de/