PRACTICA

Foundation

Module 1 of the Rope Pump Manual Ethiopia

Introduction to the Rope pump

Hand dug well & Borehole model

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Photo on cover:

Women using a new installed Rope pump

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Disclaimer

This manual is often used in **technical training courses** organised for the intended users. In case, you want to organize such training, you may contact TTP/ETC or the Practica foundation for further information and support.

Note to those considering translation or modification: To avoid duplication of efforts, unintended mistakes, and for suggestions about adapting the ideas and information in this manual, please contact TTP/ETC and the Practica foundation before beginning any translation or modification.

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Introduction

This manual is made as a guide for organizations and workshops which are involved in the introduction process of the manually operated Rope pump and for technicians to be trained in Production, Installation and Operation & Maintenance of the Rope pump models: 'Hand dug well' (AH) and 'Borehole' (AB).

Experiences indicate that for a successful introduction, production and installation of Rope pumps on a large scale, the use of any production and installation manual has to be combined with hands-on training by an experienced trainer! The trainer will guide the organization and/or workshops through all aspects of the introduction and production process. Lessons learned from the past show that a number of small mistakes usually are made during the first years of production. However, these minor 'mistakes' can have a large influence on the life time and functioning of the pump. If these impurities are not corrected in time by a professional, the Rope pump option will gain a negative image amongst users and others in an almost irreversible way!

It is therefore that it is strongly suggested this manual will only be used in combination with a professional training, whereby the manual will be distributed to the participants, who can later use it as a reference handbook. The practical training will focus on all essential aspects for producing and introducing the Rope pump.

Modules

The Manual consist of four modules:

1 Introduction to the Rope pump
2 Production
3 Installation
4 Operation and Maintenance

The four modules can be used separately:

- All four modules together are meant for organizations and/or workshops which are involved in the complete introduction process.
- Modules 2, 3 and 4 are meant for the producing workshops.
- Modules 3 and 4 are meant for distributors and installation technicians.
- Module 4 can be plasticized and distributed to users when they obtain the Rope pump.

MODULE 1:

INTRODUCTION TO THE MANUALLY OPERATED ROPE PUMP

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1.1 General Aspects

1.1.1 Context

A commonly used device to pump up water, from hand dug wells or boreholes, is a piston pump, which has a reciprocating movement. Another option, with a rotating movement, is the so called 'Rope pump'. New models of Rope pumps are based on the ancient principle of the 'Rope and washer' pump. With new design inputs and modern materials, improved Rope pumps are now very efficient, reliable and affordable and pump up water from wells with a water level as deep as 35 meter.

1.1.2 Type of hand pumps

Hand pumps can be divided in suction pumps and lift pumps.

Suction pumps
The piston is situated on ground level. Water is sucked upwards by the piston because of the relative under-pressure below the piston. Theoretically the suction head of a suction pump is 10 m., unfortunately in practice this is 6 to 7 m. A good example of a suction pump is the 'Treadle pump'. These pump types are relatively inexpensive and can be produced and repaired locally.

Lift pumps
Piston pump: The piston is now situated below the water level. Water is forced upward by the piston (positive displacement). In general, pumps of this type are more expensive, as it requires long pump rods and rising mains. Examples are the Nira-, Afridev-, Indian Mark- and Volanta pump. It is not easy to produce these pumps locally and most of these pumps and their spare parts have to be imported.

Rope pump: The Rope pump is a lift pump with continuous upward movement of a rope and a number of pistons in a tube. The Rope pump has a relative lightweight construction and is made of locally available materials and can be produced and repaired locally.

1.1.3 The advantage and disadvantage of the Rope pump.

Advantages

- Low cost, a cheap pump on household level (<10 households).
- Absence of dynamic forces (rotating movement).
- Tubes can be made of low pressure PVC tubing.
- The total weight of pump parts is approximately 15 Kg (which is 5 to 10 times less than piston pumps). The pump can be taken from the well without any lifting tool.
- No valves, valve seats, and ball bearings. Therefore less 'critical' parts, resulting in higher reliability.
- High overall efficiency 80 – 85% (if well made).
- Technology, without 'black box', is easy to understand, produce and maintain.

Disadvantages

- The Rope pump is not 100% closed. At the discharge and return tube, the pump is open to the air and contamination of the rope is possible via contact by hand.
- The Rope pump is not a pressure pump (no pressure in outlet).
- Especially with deep wells, it takes some time before the Rope pump delivers water. (When not in use, the water level in the pump falls back to the water level in the well).
- The Rope pump is NOT designed for communal use by more than 10 households.
- "Stone age" image. Many people know the Rope pump as a self made, low lift pump. This image hampers acceptance by water organizations, institutes and users.

Evaluations show that 90% of the Rope pumps continue working, even after years of operation. This high percentage is due to the simplicity of the pump. The users understand the working of the pumps and are able to maintain it and, if necessary repair it themselves or with the help of a local workshop 'around the corner'.

1.2 The Rope pump

1.2.1 How it works

The Rope pump consists of a wheel and an endless rope with small pistons, made of polyethylene (or car tire in home made models) that are attached to the rope at intervals of 1 meter. The pistons fit, with a clearance of around 1 mm, in the PVC pipe called 'rising main'. The rope and pistons move freely (and not in a pipe) down into the well. At the bottom, the rope is led by a guide box into the rising main. The wheel and handle are mounted on a support structure on top of the well. The rope and pistons are lifted by the wheel. The water is brought up by the pistons and discharged at the surface. When an additional wheel is added it can even be higher than ground level. Rope pumps can be used on open hand dug wells or boreholes with a diameter as small as a 3 inch (75 mm).

The Rope pump can be classified as a positive displacement pump producing a constant output, unlike the pulsating flow of piston pumps. The weight of the water column is equally carried by all pistons in the rising main. The pressure built up in this tube is only the height of the water column between two pistons (1 m). As a result, the forces on the pistons and the radial water pressure on the rising main are small, making the use of 'thin wall' or 'low pressure type' PVC pipes possible. In a piston pump (with a foot valve) the pressure would be created by the height of the entire water column.
The maximum force on the rope is determined by the volume of the water column in the rising main. The continuous flow not only reduces peak forces on the rope, but also maximizes the effective flow of water through a given tube diameter.
Finally, the absence of peak forces and the gradual filling of the pump tube, contribute to good human ergonomics. The Rope pump has a relative lightweight construction and is made of local obtainable materials (for drawings, please see module 2 and Annex II).

1.2.2 Various Rope pump models

The manually operated pump models
The manually operated Rope pump models can be divided in options for boreholes (tube wells) and hand dug wells. The choice for the model to be used depends on the well type and the budget of the owner.

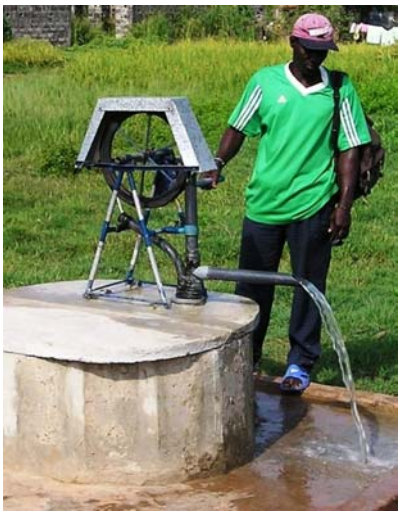
The following three models are available:

- The **AB Model** is designed for boreholes (tube-wells).
- The **AH model** is designed for hand dug wells and preferably includes a concrete well cover.
- The **Pi Model** is sometimes used on hand dug wells on household level.

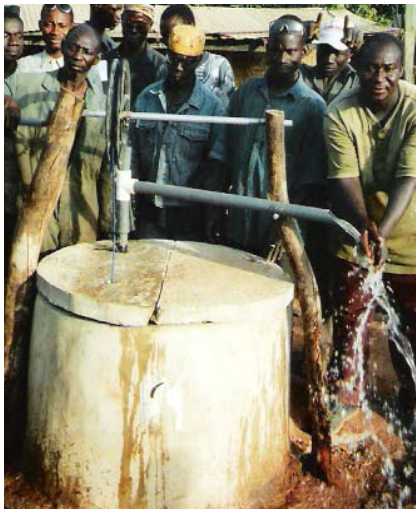
The major difference between the AB, and the AH model is the length of the frame. The most ergonomic pose and the strength of the arm muscles are optimal when the axle of the pump is situated at elbow (belly button) height. The cover of most existing hand dug wells is constructed higher than ground level, while most of the borehole casings (tube wells) are cut off just above the ground.

The Pi model is constructed on wooden poles, which are sometimes already installed besides the hand dug well, and can be used on single household level. Although the Pi model is cheaper than the two A models it is not recommended to use it during the introduction of the Rope pump as alternative pump option. The durability of the Pi model is less than the regular A models and it is wise to wait with it's introduction until the Rope pump has build up a name as a reliable and sustainable pump. This manual will only describe the AB and AH model.

AB (A model, Borehole well)



AH (A model, Hand dug well)



Pi (Pi model, Hand dug well)

Other pump models

For higher yields, special models were developed powered by pedals, electric motors, gasoline engines, animal traction and wind mills. Of all special options the motorized Rope pump is most promising, with a high yield making the Rope pump suitable for irrigation.

1.2.3 General data of the Rope pump

Discharge [1]:	Water level, up to 10 m depth: 35 liter/min up to 20 m depth: 20 liter/min up to 35 m depth: 10 liter/min
Maximum depth:	35 meter (water level)
Input power [1]:	approx. 50 Watt
Discharge level:	1 m above ground level (no pressure) (with an additional wheel and structure up to 6 m above ground level)
Application:	1 – 10 households (approximately 50 users maximum)
Cost:	€ 40 - € 90 (depending on model and country)

Re 1): The discharge is based on an input power of approx. 50 Watt, which is the power that women and children can deliver for longer periods.

1.3 Introduction and dissemination

1.3.1 Quality

Although the Rope pump technology seems (and is) simple, there are still many details in production, installation and use which needs attention especially in the first years of production and introduction.

Experiences in a lot of other countries have learned that drawings or a technical training alone is not enough to ensure the quality of the first produced pumps. The workshop trainees usually have a lot of practical experience, but often didn't attend school for a long period of time. This often creates a lack of basic fundamental knowledge on mathematics and physics, which are useful during construction and installation of the pump. During a training course the students gain a lot of background and practical information, but there is always a chance that small mistakes will be made in construction, installation or in the maintenance training they provide to the users, after the training course is over. Unfortunately, these minor mistakes can have a large influence on the life time and functioning of the pump.

Therefore quality control is crucial in the phase of introduction when the Rope pump still has to build up a name as an accepted, reliable and sustainable pump by manufacturers, users, government, NGO's and donors.

If the quality of the pumps, produced in the first years, is bad and results in broken or rusted parts, the Rope pump will build up a negative name amongst users in an almost irreversible way! As a result the pump will be rejected. Unfortunately this is a hard lesson learned is a number of countries.

1.3.2 Monitoring

Part of effective quality control is monitoring, which will create an overview, making it able to detect problems in time. In order to make this easy, it's recommended to mark the pumps with a serial number and the initials of the workshop. The workshop owners will keep a log of the produced pumps and note down:

- Pump number
- Production, Selling and Installation date
- Name of the buyer and place of installation
- Model
- Price

After a production period of 6 months or 30 pumps, it is strongly recommended to evaluate the encountered problems, using the inventory, with the producers and users of the pumps during a follow-up training by an experienced trainer. Using field visit as a base, the students can be trained in correcting occurring problems at existing pumps and future production. In order to keep monitoring transparent it is not recommended to have more than 5 workshops trained at the time. Please, see Annex I for a technical checklist, which can be helpful during monitoring.

1.3.3 Marketing

Strategies
As the Rope pump is fairly unknown by most people at first introduction, it is recommended to bring the pump under the attention of the public and establish a connection between the potential buyers and the producing workshops. In general the media is a useful tool to reach people. Especially if people are known as rather conservative, it is important they come in contact with the Rope pump through several different sources such as: radio, TV, newspaper, magazines, distributed flyers and demonstration models.

Starting this marketing procedure, it is important to realize what information is important to the public. First of all it is important to note on which wells and water levels you can apply the pump, in short it's working, application (household level), flow rates, the price and in which way they can get more information or obtain the pump.

Price and name
It is recommended to calculate a standard price for the hand dug well- and borehole model. Note that the manufactures need profit to continue production, but be aware that the price will stay 'low', in reach of the user's budget. By announcing the price during marketing, misuse of the monopoly position of the workshops in their region is avoided.

As a lot of potential users don't speak English, it is advised to choose a name in local language for the Rope pump.

Demonstration models
Seeing and trying is believing! Especially when people are conservative and low in budget, they will not invest in a, for them expensive, pump before they're convinced of its working and quality. Not only the quality of the pumps has to be good, they also have to be 'good looking' and professional, all to convince the public in the first phase of introduction.

Until a 'critical mass' is reached and the Rope pump fully accepted by the public, marketing will be necessary. Once enough people know about the pump and are convinced of its working, information on the pump will get spread through social contacts among people by itself, making marketing less important. Unfortunately, reaching a 'critical mass' is not an easy task.

The role of thump in this is: It's better to place 20 demonstration models in 1 town instead of having 20 towns with one pump! With a high concentration of pumps in a small area, people in that area will easily adopt the pump if it works fine. They see the pump at the house of neighbors, family, friends, etc. From there information will spread easily through the region when people are traveling.

Another good way to let people try the pump is putting out demonstration models when people are interested. The users can use the pump for a period of one month before they take the decision whether they buy the pump or not. When they buy the pump, users can pay directly or monthly in 6 or 12 terms (if the workshop can handle it. The pump can be seen as a guarantee, if people stop their payment the workshop can remove the pump).

Annex I Rope pump technical checklist

Date of visit:	…….	
Name technician:	…….	
Pump number:	nr……	,produced by……..

User(s)

Name owner:		
Name of area:		
Number of users:		
Comments of users:		

Pump

Installation date:		,installed by…….
		Comments
Water level:		dry / wet season
Well depth:		
Well type:	hand dug well / tube well	
Well cover:	concrete / open / other:	
Piston size:	PE / rubber	size:
Piston quality:	OK / cracks / holes / all present /	
Rope quality:	OK / warn out / broken /	
Rope tension:	OK / loose / tight /	
Rope connection:	OK /	
Grip on wheel:	OK / slipping /	

PVC

T-piece:	OK / broken / clean / dirty /	
Reducer:	OK / broken / clean / dirty /	
Riser main:	OK / broken / clean / dirty /	
Flares:	OK / broken / clean / dirty /	

Structure

Welding:	OK / broken /	
Painting:	OK / come off /	
Rust:	Yes / no / little / much	Place:
Axle:	OK / damaged	Wall thickness:
Bushing:	OK / damaged	Wall thickness:
Handle (grip):	OK / PVC broken /	
Grip lock:	wrong direction / right direction	
Height of handle:	OK / too height / too low /	
Wheel:	OK / damaged /	

Pumping

Pumping:	easy / difficult / resistance /	
Guide box:	OK / clean / dirty / rusty /	
Water discharge:	OK / very little / …….	Turbidity: high / low / clear

Problems:	
Actions taken:	