Third Draft
Final Report

"Partners voor Water" Pilot Project Mozambique,

Transfer of Technology and Market Introduction of affordable water supply systems to smallholders

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Abbreviations

ADEM	Mozambican NGO
ADPP	"Ajuda de Desenvolvimento de Povo para Povo"
CWD	Consultancy services Wind energy Developing countries (Dutch)
EPF	Escola de Profesores de Futuro (teacher trainee school)
EAO	Escola Artes y Officias (vocational school, mainly agrarian)
FUNAE:	Fundo de Energia
FACT-Foundation	Fuels from Agriculture in Communal Technologies (Dutch)
GAPI	Sociedade Promotora de Pequenos Investimentos
TA	Technical Assistance
FC	Farmers Club
FAO	Food and Agriculture Organisation
GTZ	German NGO
Magariro,	NGO in Chimoio
ADIPSA,	NGO in Mozambique
Africare	African NGO
MICOA	Mozambican ministry of Environment
TAREMBA	village association,
Practical Action	International NGO
Pump Aid Zimbabwe	NGO
PvW	Partners voor Water, Dutch program from the Government
TaZaMo	Name of a project of Connect International in the countries Tanzania, Zambia and Mozambique, with similar objectives as this project.

1 Introduction

1.1 Project Summary

The long term objective of this program is to improve the quality of life of poor smallholders in Mozambique through improved access to safe drinking water and water for irrigation.

- The aim of this project is: to demonstrate through field tests a number of affordable technologies related to water supply for households and irrigation and to transfer know how on production, installation, operation and maintenance of these technologies. The technologies are described in more detail in Annex I, and summarized in paragraph 1.2.

- A parallel activity is the development of a micro-credit system to enable smallholders to purchase the systems which are aimed at income generation.

The main results achieved within the project are the following [2]:

- Technicians of the EPF-ADPP workshop in Chimoio and staff of ADPP organisations in Itoculo , Bilibiza and Lamego trained in the production, installation, use and maintenance of manual rope pumps, wind rope pumps, brick cement tanks, and the tools needed for manual borehole drilling.
- Two drilling teams, one from EPF Workshop Chimoio and one from ADPP Itoculo equipped with manual drilling equipment and trained to make boreholes
- The installation of 4 wind rope pumps, equipped with tanks of 6 – 10 m3.
- The installation of 14 hand rope pumps, equipped with tanks of 2 m3.
- The installation of satellite tank systems for low cost irrigation with hand rope pump and wind rope pump at 8 Farmers Clubs and Vocational Schools in Central Mozambique, covering an irrigated area of over 4 ha.
- Groundwater recharge systems set up at 8 wells
- 80 siphon filters (Low-cost water treatment systems) introduced in communities and staff of 2 organisations trained in use and maintenance
- The use of low-cost technologies to improve water supply for households and irrigation documented and shared at provincial, national and regional levels with other NGOs, relevant authorities and micro-loan operators
- Two micro credit suppliers found; GAPI and Banco ProCredit, willing to supply credits to farmers for these technologies.
- As a spin off, one small manual drilling company from South Africa successfully trained in production of wind rope pumps, of which they manufactured and installed 10 in South Africa.

[2] For Expected Results, see ANNEX.. Project description

Project partners: Arrakis, in cooperation with ADPP Mozambique and RR Energy and Practica Foundation NL

Project location**:** Chimoio and surroundings in Mid-Mozambique

Beneficiaries: Smallholders, subsistent farming-families in rural Mozambique.

Financers: The main financer is the Dutch organisation "Partners voor Water", contributing 80% of the project costs. The remaining 20% is contributed by Arrakis and its project partners

Project period: April 2006 – December 2007

1.2 The technologies related to the needs.

The technologies introduced in this project are instrumental in fulfilling the following basic needs of the population in rural areas at very low, affordable costs:

- The need of water for small-scale agriculture;
- The need for clean drinking water;
- The need of sufficient water in the wells.

For the need of water for small-scale agriculture and for drinking water, the technologies introduced provide low cost solutions for all subsequent activities involved, namely: developing a well, installing a wind – or hand pump and storage tanks and simple irrigation systems for small holder families.

For making low cost tube wells, **the Baptist drilling method** is used which is a manual drilling technology developed and used in South America. It can drill in sand and compact clay layers down to depths of 60 meters.

The hand pump type introduced is the **hand rope pump**, that has the advantage that it can be produced and maintained with locally available skills and materials. Worldwide over 3 million people use this option. Rope pumps can be used for communal water supply, and at family level for domestic use and irrigation. Costs range from 80-150 US$ ex factory, depending on model and country of origin. This hand rope pump can be installed on hand dug wells, which can be closed by cement covers for drinking water purposes, or left open (for irrigation). It can also be installed on Baptist drilled tube wells, with a minimum casing diameter of 2".

Wind rope pumps
The wind rope pump makes the labour-intensive hand pumping superfluous, which for irrigation purposes, requiring many pumping hours, is a substantial step forward. The wind rope pump is a light weight wind pump in which a number of novel design features-developed at universities by the former CWD- organisation[3] have been incorporated in the design. It drives a rope pump instead of a classical piston pump.

[3] CWD was a Dutch organisation that developed and transferred the technology of wind pumps to developing countries. It was closed in 1990, but many CWD-innovations have been introduced in wind pumps worldwide.

With a cost of some 700 Euro this product is 5-10 times cheaper than comparable conventional wind pumps and more sustainable because of the simple design and local availability of spares.

Brick cement tanks for storing the pumped water are a low cost option compared to the usual heavy all-concrete tanks. They are built from bricks and cement using only simple steel wire for reinforcement. They vary in capacity between 2 and 10 m^3 and have to be placed on a compact bottom.

Micro-tube irrigation systems are low pressure drip irrigation with drippers made of small tubes, which makes maintenance easier than for conventional drip systems. The main hose of the system is connected to a brick tank which is filled up by means of a hand pump or a wind rope pump.

The satellite tank irrigation systems
A more simple system is the satellite tank system. The installation consists of two (or more) small tanks (up to maximally 2 m^3 each), one near the HRP and the other further in the field up to 50 m away, connected with a hose. With the hand rope pump the tanks can be filled up, and the watering of the plants can be done by hand with watering cans, from the tanks. The tanks make the work much lighter, because of easy and close-by access of water, reducing walking distances and reducing costs.

For the need of clean drinking water, siphon ceramic filters are introduced, which can be used at the point of use. Regardless of where the water comes from these filters will kill all bacteria for up to 99,8 – 99,9 % . The **Siphon filter** is combined with a high quality ceramic filtering element impregnated with colloidal silver, with a hose, bulb and non-return valve. This combination produces 20 to 40 litres safe drinking water per day. The filter system costs around $ 8. The ceramic filter element needs annual replacement.

Sodis stands for Solar Disinfection. It uses sunlight to inactivate harmful micro organisms in water almost completely. Transparent plastic (PET) or glass bottles filled with contaminated, but clear, water are exposed to the sun for 6 hours in sunny weather or two days in cloudy weather.

For the need of sufficient water in the wells, well recharge systems are introduced. It is a new low cost option to recharge groundwater aquifers by means of plastic tubes, protruding through the impermeable layers, making direct connection with the aquifers possible. Rain water that would otherwise run off to rivers (on sloped terrains) is caught in contained holes (dug out or dams) provided with a recharge tube.
The collected water flows through the recharge tube into the aquifer.
When these recharge tubes are installed about 10 to 20 m away from wells, they can increase the water available in the aquifer for the well.

For a more extensive description and explanation of the working of the technologies see Annex: I

1.3 Market incentives and transfer of technology

The following methods were used in transferring know-how on the technologies mentioned in 1.2:

Through Technical Assistance (TA) missions, during which theoretical training is combined with hands on training. The equipment to be implemented was jointly produced and installed, whereby instructions and practical guidance were given to the future team of the ADPP-EPF workshop and other participants of sister ADPP organisations from other places as well.
In total 4 of these training missions of about 2 weeks each were conducted.

To support the transfer, manuals of all the technologies were adapted to the local situation and handed out.

During the missions, Plans of Operations plus training plans were made, together with the project leader and the workshop team for the periods in between the missions.

In between the TA missions, very intensive e-mail correspondence was used for guidance.

Seminars/conferences were organised to attract potential credit suppliers and interested organisations as potential clients.

One seminar was organised in the beginning of the project, after the first technologies had been installed and could be showed in the field; a second seminar was held at the end of the project, when results from income raised at the fields using the new technologies could be reported, to the same audience as the first seminar.

Furthermore several visits were made to individual organisations in Chimoio and in Maputo, such as GTZ, FUNAE, GAPI, Banco ProCredit, etc.

For promoting the low cost technologies, the booklet "Smart Water Solutions" was handed out to interested parties, in English and in Portuguese.

2 Achievements

2.1 Introduction

The achievements have to be compared with the objectives and expected results of the project.

The objectives of the project are:

- To demonstrate through field tests a number of affordable technologies related to water supply for households and irrigation and to transfer know how on production, installation, operation and maintenance of these technologies. The technologies are described in more detail in Annex I, and summarized in paragraph 1.2.

- A parallel activity is the development of a micro-credit system to enable smallholders to purchase the systems which are aimed at income generation.

The achievements having real impact that have been reached are:

- Hand rope pumps have actually generated extra income for families;
- Siphon ceramic water filters actually have improved health;
- The demonstration of these new technologies have raised awareness in their potential amongst other organisations; they are increasingly including these options in their activities
- The capabilities of stafmembers have been enhanced to produce an increasing number of technologies; this opens a potential for commercialising these activities.

Based on findings during field surveys and monitoring results after one year of operation by the users, it can be concluded that some of the technologies have been introduced more successfully than others. Hand rope pumps, brick cement tanks and siphon ceramic water filters are the most successful. The manual borehole drilling method and well recharge systems have been transferred successfully, but will not be further expanded in Chimoio area, because of inadequate physical conditions. The Workshop team drilled 12 holes, but in most cases encountered hard rock around 12 m depth. Only 2 drilled wells in Lamego gave sufficient water on which 2 hand pumps were installed which are still working at present. The team of ADPP-Itoculo however is continuing with drilling boreholes in their area, using manual drilling methods.
Until now the wind rope pumps and drip irrigation systems were less successful, but could become successful with longer demonstration time and more TA in the future.

To ensure continuation of market development after the end date of the project, a business plan was made, for which the EPF staff is already trying to find interested organisations to support the plan. Again this is a good achievement that shows that this project has a lasting effect. Many activities will go on after the project has ended.

Apart from the support for market introduction the result has been positive on the issue of bringing on board the credit institutions. The major institutions and banks operating in the region and interested in these kind of technologies have been approached and informed about the developments. In general all these institutions see that the package of hand rope pumps with irrigation is the way to go forward in increasing rural income especially where markets exist for off-season products. Also the farmers groups and associations regard this type of package as being very attractive and feasible in the short term. Most concrete demonstration of interest and willingness was the micro-credit supplying organisation GAPI, to provide micro-credits to Farmers Clubs for packages to raise income including the hand pumps and irrigation systems.

As both Arrakis and Connect International, together with ADPP, are involved in new projects resulting from the present project, it will be possible to give continued support to improve, promote and disseminate the technologies and to extend training.

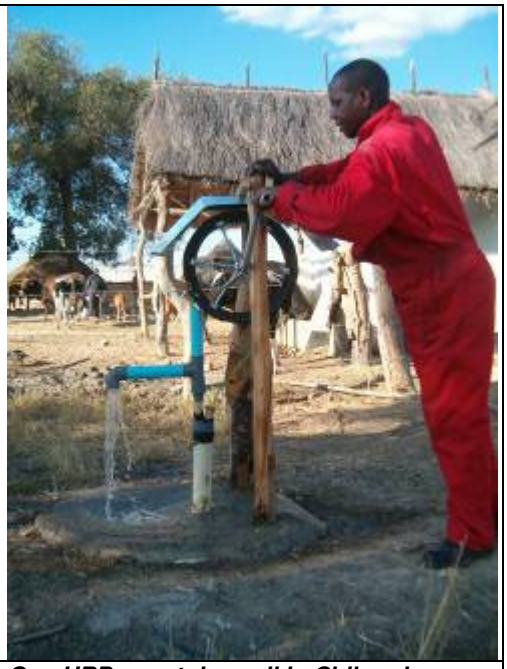
The achievements are discussed in more details in the following paragraph 2.2.

2.2 Detailed achievements

2.2.1 Hand rope pumps & brick cement tanks

In total 14 HRP 's (Pole model), have been installed.

One HRP on a hand dug well, delivering to a tank at EPF Chimoio.



One HRP on a tube well in Chibombo Zambia, produced during the first training.

Cost Comparison			
Conventional Handpump		**Low cost Handpump**	
AFRIDEV		**Pole Hand Rope Pump (PHRP)**	
Cost in US$	**US$**		**US$**
Pump	1200	Pump	150
Installation	800	Installation	100
Mechanical drilled tube well	3000	Hand dug well (incl. lining, bricks and cement)	150
TOTAL	**5000**		**400**

The HRP has been successfully introduced in the market:

- The EPF Workshop has proved to be capable to produce the HRP's and tanks.
- From monitoring of the income raised from crop cultivated with HRPs and irrigation (by hand)several users shows that they can earn the HRP back within one season. The income raised was about $ 440 from 0.4 ha in the dry season, which is about equal costs of the HRP including a hand dug lined well.
- The organisation GAPI who is already providing micro-credit to registered farmers organisations declared that these type of systems fit into their credit schemes, which they are willing to provide.

- Banco ProCredit is also willing to provide micro-credits to farmers, who have a (small) collateral, which means to the group of market oriented farmers (no longer subsistent). Possibly this group of farmers is also a market segment for the pumps.

Low cost brick cement tanks, which have been provided with all hand pumps, have the following characteristics:

Cost Comparison			
Conventional tanks		**Low cost brick-cement tanks**	
Volume 2 m^3		**Volume 2 m^3**	
Cost	**US$**		**US$**
Plastic tank	250	Bricks + 2 bags of cement , sand and wire	50

2.2.2 Siphon ceramic water filters

80 siphon ceramic filters have been distributed in 2 areas, around Chimoio and around Namathanda.

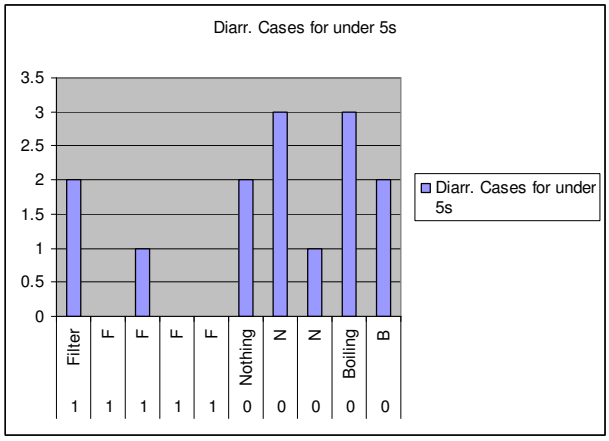
The filters being treated in water with colloidal silver

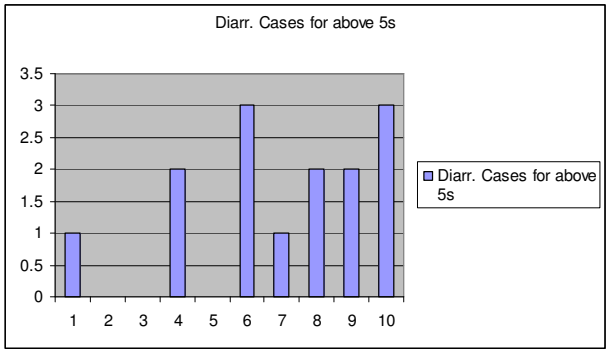
Survey near Chimoio, Nov 2007

Cost Comparison			
Conventional; no treatment or boiling		**Siphon ceramic filter**	
		Capacity 60 liters/day?	
Cost	**US$**		**US$**
kettle	4	Siphon filter	8
Firewood …kg/day	?		
Buckets (2)	6	Buckets (2)	6

The introduction of the siphon ceramic filters was successful, because:

- The effect on the health of the users (decreasing number of illness due to diarrhoea) was clearly positive.
- The users started asking for new filters after one year of use and several people wanted also to have a filter. At the second workshop there were request from organisations where the filters could be obtained.





Graphs on effects from the intermediate survey

An intermediate survey was done at a sample scale of 10 families in rural areas near Chimoio (of the 40 who received a filter). The filters have been used for half a year
The graphs indicate a difference in cases of diarrhoea between the first 5 families that did receive a filter and the last five that did not receive a filter.
The first graph indicates the cases of diarrhoea for children under 5 years old.
The second graph indicates the cases of diarrhoea for household members above 5 years old.

2.2.3 Manual drilling

In total 12 bore holes were drilled manually.

The EPF Chimoio team in action

One of the pumps installed on the manually drilled tube well in Lamego, used for horticulture.

Cost Comparison			
Conventional drilling		**Baptist manual drilling**	
Cost	**US$**		**USD**
	3000	Soft ground	100

Costs of manual drilling depend much on the local conditions, soft layers of ground require only a few days to drill a well of say 15 m, but when the ground gets harder, this may cost a week.

The manual borehole Baptist drilling method has been transferred successfully, because:

- The team of ADPP-Itoculo is continuing with drilling boreholes in their area, using manual drilling methods, after having received more training in Manual drilling within another project (the TaZaMo project from Connect International)
- The EPF Chimoio Workshop team trained extensively and drilled some 12 holes, of which only two gave sufficient water in Lamego, on which hand rope pumps were installed.
- The EPF Chimoio Workshop is capable of manufacturing the drilling equipment

Drilling equipment

Drilling equipment

2.2.4 Wind rope pumps

Under the Portuguese ruling in Mozambique, quite a number of wind pumps were used. Some are left still and even in use. In Chimoio 3 of these classical wind pumps have been spotted. The one visited was still in operation. In the 80 ies, a second generation wind pump, the CWD 2740 model, was transferred to Mozambique. In the Limpopo vally, about 80 of these wind pumps were installed. Presently the local workshop producing them in Chicumbane closed (in 2004) and most wind pumps disappeared. Due to a number of reasons the introduction was not successful, like the civil war and in later years the bad overall watermanagement of the Limpopo river (which includes 3 countries). At present a few new windpumps are imported each year, within projects, or commercially for a few cattle farmers.

4 manufactured and installed.

The first WRP built in Mozambique, installed at Formigas, July 2006

The 2d WRP installed at EPF field, with wooden tower

Although 4 wind rope pumps have been build by the EPF Workshop and installed in the field, the transfer is considered less successful, because:

- Although the wind pumps were in operation, the quality of production and parts was relatively low and no guarantee could be given for a long operation.
- Another factor is the relative high price of the WRP's of approx. $ 1000, which for the target group of the subsistent farmers is still very high. Therefore it was decided, in consultation with PvW, to build 8 HRP's extra instead of the planned remaining 2 WRP's.
- If later on there is interest for wind rope pumps, production can be taken up again, with some further assistance.
-

Cost Comparison			
Conventional WP's Like Climax (imported from SA)		**H-8 wind rope pump Manufactured in Chimoio**	
3 m rotor diameter		2.40 m rotor diameter	
Cost ex factory	**US$**		**US$**
	12000		1000

The cost comparison however shows that regarding affordability, the wind rope pump is by far the cheapest wind pump, with potential for local production and use in Mozambique. However more training in future is needed to improve quality of production and installation., as well as more intense and longer training in agriculture, using the wind pump for irrigation..

2.2.5 Low cost irriation

2.2.5 Low Cost irrigation

According Mohammed Vala, officer of Department of Agriculture in XaiXai, agriculture without irrigation is no longer possible in Mozambique. Various sources reported that rainfall has decreased over the last 20 years and rainfall season has become irregular. Since 80% of the population in Mozambique lives in rural areas and most of them under the poverty norm, it is essential to manage the water and introduce low cost irrigation systems for smallholders and households.

Example satellite tank system installed near the EPF Workshop

Micro-drip irrigation system, at EPF Chimoio

8 satellite tank systems were installed at the following sites:

Type of user	Name of place	Estimated command area In ha.
Farmers Club	Chitundo	0.3
"	Matsinho	0.5

“	Guindingui	0.7
Family	Messica	0.15
Vocational school, Formigas de Futuro	Chimoio	0.5
Teacher training school; EPF Chimoio	“	0.37
Primary school, Josina Machel	“	0.5
Vocational school, AEO	Lamego	0.6
		Total area: 4.22

Cost Comparison			
Conventional irrigation system		**Satellite tank system**	
		Area: ca 0.5 ha	
Cost	**US$**		**USD**
		2 brick cement tanks of 2 m3	100
		Connecting hose of 50 m	85
		8 Watering cans	40
		HRP (pm)	
Total	**n.a.**		**225**

Conventional systems, with motor pumps and steel tubes, are only applied for larger areas.

2.2.6 Well recharge systems

8 well recharge systems were installed.

The hole being drilled with an auger at Josina Machel school

The full pond of the recharge well near the wind pump at Formigas.

Cost Comparison			
Conventional Non existent			**Tube recharge**
Volume			
Cost	**US $**		**US $**
	n.a.		**25- 120**

Costs of the recharge systems, depend much on the depth of the well required.
For depths up to 5 m, when the auger can be used, labour cost plus tube cost may amount to $ 25. For depths up to 15 m, with Baptist drilling in soft ground, cost of the total drilled and installed well may cost up to $ 120.

The effect of the 8 Installed recharge systems, at EPF and Formigas, was for the first time to be seen in November 2007, during the 4th mission of Jan de Jongh. After one night of heavy rain, the two 2 m3 holes with recharge tubes placed higher up near the well of the wind pump at Formigas were totally full, and the collected water gradually seeped into the ground over a two days period.

3 Analysis

The concrete results obtained in relation to the expected results in the project proposal are explained :

Expected Result 1: A workshop successfully trained in building quality wind rope pumps, manual rope pumps and manual borehole drilling equipment as a commercial production.

Expected Result 2: Two drilling teams equipped with manual drilling equipment and able to make boreholes

The concrete results obtained are:

A core team of 4 persons working at the EPF workshop have been extensively trained in producing installing and maintaining the technologies during TA missions of Henk Holtslag and Jan de Jongh which added up to a total of about 8 weeks. These missions were conducted in the first part and second part of both 2006 and 2007. Simultaneously, the core team received some additional training in welding for some weeks at the vocational technical school in Chimoio.
Apart from the core team, also people from sister organisations from Itoculu and Namathande were trained, so that basic capabilities to produce, install and maintain the hand rope pumps and drilling equipment, were developed.
Also teacher trainee students of EPF some times gave a helping hand, thus learning about the technologies as well.
In the process of TA guidance, the quality of the production and installation was improved, by teaching the use of manuals and quality control sheets. Nevertheless, there is still need for improvement of the present level of quality.
Commercial price calculations for the hand rope pumps and tanks were made with Jacob Zulu, which are the basis for commercial selling of the products.
Winfried Rijssenbeek, who came during the last mission in November 2007, made a business plan for the workshop, which proved to be viable; it has been taken up by the EPF staff now to realise the plan.
<u>The wind rope pumps</u>:
Although there were good hopes after the first two wind rope pumps had been produced with TA guidance, that the Workshop team would be able to produce and install the wind rope pumps all by themselves, this proved to be not the case. The third wind pump installed in Lamego would have failed. Henk Holtslag visited the site for a second time and took measures to improve the situation.
Since this is a demonstration project and not a long running implementation program with sufficient support for a number of years, it was decided in consultation with PvW staff to quit the production of wind rope pumps (for the time being) and concentrate on the hand rope pumps instead.

The wind rope pump technology is more complicated than the hand rope pump technology which both are totally new for Mozambique and the workshop. In addition there is knowledge required in how to deal with the wind and site selection for installation and operating the wind pump, which takes considerable time to be mastered.
It has to be noted that up to now there is no single wind pump manufacturing company in the whole of Mozambique, and few wind pumps are left from the Portuguese time, so the technology itself has become unfamiliar.

<u>The manual drilling technology</u>.

The end of project result of the project is that one team (of Itoculo) is continuing to use the manual drilling technology.
The Chimoio Workshop team was successfully trained to produce the Baptist drilling equipment and augers; they practiced drilling with it for a considerable long time period (they drilled 12 boreholes, of which only 2 were finally giving enough water to place a hand pump on, in Lamego). However, in the Chimoio region, due to the hard soil conditions at depths around 10-12 m, the process took too long and was too hard. Digging of wells by hand proved to be cheaper instead.
Therefore at present there is no further scope for manual drilling in the Chimoio area by the Workshop team. The team of Itoculo however is continuing with drilling bore holes and placing hand pumps on it, thereby using the Baptist drilling methods as one of the methods they learned. (They had also been trained in another manual drilling method within the TaZaMo project of Connect International). Some persons of Lamego also followed the training in manual drilling, but need more training to fully master the method.

Expected result 3: *Food production started on 3 ha irrigated fields of 12 Farmers Clubs and Vocational Schools in Central Mozambique*

When the imported micro-tube drip irrigation system proved to be too difficult for the users and too costly as well, a simple system for irrigation, using a hand rope pump, was developed; the satellite tank system. By the installation of two small tanks (up to maximally 2 m3 each), one near the HRP and the other further in the field up to 50 m away, the watering of the plants can be done by hand with watering cans from the tanks. The tanks make the work much lighter because of easy and close-by access of water, reducing walking distances.
Per January 2008, the total area covered by hand rope pumps with two tanks systems, where horticulture production can be done amounts to ca 4 ha, which is more than the intentional 3 ha as proposed in the proposal, but with a different technology.

From the three cases monitored by the users, quite a good idea was obtained in how much could be earned by irrigated horticulture.
This is in the order of US$ 440 for an area of ca 0.4 ha. for the total of sold products to the local market. In addition products were also used for own consumption.
This is without deduction of costs of seed; fertilizer was not used and labour costs are not calculated.

The micro-tube irrigation systems, as imported from India, proved to be too complicated to be used by the FC's without intensive guidance and training for at least one dry season, which was not foreseen in the project. At the start of the dry season in April 2007, 4 users had been equipped with micro-drip irrigation systems, but at the end of the dry season in November 2007, they had all been removed except the one at EPF Chimoio.
The users had difficulties with these new systems, also due to mostly irregular terrains, which required precise tuning of the system to regulate a homogenous flow over the total irrigated area. It became obvious that the users needed intensive TA over the whole dry season, which was not foreseen in the project.
Another point was that import from India was a difficult, long lasting and costly process, increasing the cost of the systems too much, also causing the systems to arrive too late to have it installed to be used during the hole dry season.

Expected result 4: *Groundwater recharge systems set up at 24 wells resulting in decrease in number of months the wells run dry by 10% (compared to accounts from previous years)*

The idea at the start was to drill the wells for the recharge systems manually with the Baptist system. Since the manual drilling at Chimoio did not succeed as expected, although it was tried by the EPF team for a long period, no tube recharge systems were installed.

This also had as result that the period to measure the improvement of water containment (for a longer period) in the well was too short within the project. For a good monitoring of the effect of the recharge wells it would anyway be better to measure during a number of years, taking into account the irregularities of rainfall.
The systems were improved. They were made more simple than originally planned (and budgeted) using local low cost tubes. For lower depths, up to 5 m, a manual operated auger was used to make the wells, which proved to work quite well.
Another point is that operation of the systems (although not much work) is required and also monitoring should be done, of water levels over a period of months, for which only few people can be found who qualify for this activity. Therefore it was decided to place only recharge systems at places were operating and monitoring could be done, resulting in the places as mentioned above. This resulted in the installation of 8 recharge systems, at EPF and Formigas. Within this short project period it was not possible to demonstrate the viability of this technology.

Expected result 5: *Low-cost water treatment systems at point of use (Siphon ceramic filters) successfully introduced to 12 communities; 200 community members adopting the systems*

80 filters were assembled at EPF Chimoio, treated with colloidal silver and equipped with hoses and siphons. The first 40 units were set out in households in the communities in the region around Chimoio, introduced to the households by teacher trainees. The other 40 were handed to the ADPP team of Namathande, which was eager to let the systems be used by the students of the EPF school and the AEO school. In this way two different target groups were involved in the trial.
The midway survey done in April 2007 with a random survey at 10 Households in the Chimoio region showed a very promising result. (6 cases of diarrhoea occurred with users with filter, against 22 cases with users without filters)
The short survey to 3 users of the filters in same area by Jacob Zulu and Jan de Jongh, November 2007, showed even more promising results.
I.e. two of the 3 users had used the filters for over one year, before it came clogged. But of equal importance was the fact that they stated that after the filter stopped, they went on with cooking the water, since they had noticed that no more diarrhoea occurred when they started using the filters. So, the clean water awareness campaigns that accompanied the introduction of the filters had proved to be very useful. The people also had become aware of the value of water, and upon request answered to be willing to pay for the filters.
20 % of the filters, imported from Brazil, proved to be leaking and so could not be used.

Expected result 6: *The use of low-cost technologies to improve water supply for households and irrigation documented and shared at provincial, national and regional levels to other NGOs, relevant authorities and micro-loan operators*

Two seminars/conferences were organized, one in July 2006 at the beginning of the project, after the first wind rope pump, hand pumps and drip irrigation system had been build and installed, and one at the end of the project, in November 2007, when the project had nearly been completed and final surveys had been conducted. These seminars were very instrumental in informing a large number of representatives of the target group.

On both events between 20 and 25 participants from provincial, national and regional levels, from Ministries to banks and micro-loan operators as well as NGO's were present.
By showing and explaining the installed technologies in the fields of EPF and Formigas, combined with power point presentations in the conference room of EPF, the technologies introduced were sufficiently explained and the result of their use it shared.

The use of low-cost technologies to improve water supply for households and irrigation was documented for the same group in the following documents:
1 The workshop report;
2 the paper on the experiences with the siphon ceramic filters;
3 Photo reports of production, installation and use of all technologies;
4 the small booklet Smart Water Solutions (both in English and Portuguese) was handed to those interested at the conferences.

Explanation on production of the various technologies is given in manuals, which are mainly meant for the EPF workshop and teams of Namathande and Itoculo, who received copies of the manuals. The manual on hand rope pump production, installation and O&M has been translated into Portuguese as well.
Most of the documents have been placed on the Arrakis website, from where they can be downloaded for anyone interested, (see www.arrakis.nl).
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4 Conclusions and recommendations

Transfer of Technology
Most of the technologies were transferred successfully to the partners, i.e. they are capable of fabricating and installing the technologies of hand rope pumps brick cement tanks, Baptist drilling, and tube recharge systems. Staff members of ADPP were trained to assemble the ceramic siphon filters from imported parts.
The wind rope pump and micro-tube irrigation system were not successfully transferred yet, i.e. the 4 manufactured and installed wind rope pumps, although they were in operation, were not of sufficient quality to guarantee a long operation. Therefore it was decided, in consultation with "Partners voor Water", to build 8 hand rope pumps instead of the planned remaining two wind rope pumps.
Another factor is the relative high price of the wind rope pumps of approximate $ 1000, which for the target group of the subsistent farmers is still very high.
The wind rope pumps could become successful if more TA could be given in the future.

Micro-tube irrigation systems, as imported from India, proved to be too complicated to be used by the FC's without intensive guidance and training for at least one dry season.
Import from India was a difficult, long lasting and costly process, increasing the cost of the systems too much; it also resulted in the systems arriving too late to be operational in the whole dry season. A new simple system was developed instead, the satellite tank system. By the installation of two (or more) small tanks (up to maximally 2 m^3 each), one near the hand rope pump and the other further away in the field (up to 50 m), the watering of the plants can be done by hand with watering cans, from the tanks. The tanks make the work much lighter, because of easy and close-by access of water, reducing walking distances.
Follow up:
The satellite tank system as concept was taken over as the system to be introduced in the USDA supported National program on FC's, which is going to run for the next 3 years in many provinces in Mozambique. Mr. Jacob Menyani Zulu, who was the present project leader, is now going to lead this new project.

Market introduction
From the beginning of the project, it was tried to interest banks and micro credit organisations to offer micro-credit for these technologies. A LoI with FUNAE was made, early in the project. At the inauguration of the first wind rope pump on the 4 th July 2006, a number of people representing micro-credit organisations or NGO's offering credits came to the workshop in Chimoio. And on the final Conference on the 13th of Nov 2007, some of the

same people and some new also attended and were positive about the technologies demonstrated.
Affordability
From monitoring of the income of several users raised from crop cultivation using the hand rope pumps with irrigation (by hand) it shows that they can earn the hand rope pump back within one season. The income raised was about $ 440 from 0.4 ha in the dry season, which is about equal to the costs of the hand rope pump including a hand-dug lined well.
GAPI already announced that the technologies could obtain credit under their existing schemes, which they were already offering to existing farmers associations.
The outlook for successful irrigation by using a hand rope pump and the newly introduced satellite tank system, for which micro-credit will be provided is therefore quite good.
Recommendation
ADPP could recommend some of the best Farmers Clubs already to put forward a request for financing to GAPI of some pumps, including a whole package ; pumps, seeds etc.

EPF Chimoio Workshop
The EPF Workshop staff has been trained to a level at which it is capable to produce and install HRP's and tanks, with satellite irrigation systems. They are also capable to drill tube wells with the Baptist manual drilling equipment, which equipment they can also produce. They can definitely produce a number of the 250 hand rope pumps presently required in various projects, where ADPP is involved, like TaZaMo, USDA Farmers Clubs, etc. This shows there is a market for this product that, initiated by NGO's and donors, might finally develop to be part of a sustainable livelihood proposition for small holders. The good thing is that on the basis of the number of required pumps, the workshop can develop into a commercial small enterprise. It would not be difficult to obtain the necessary credits for investment and working capital.

The Workshop thus has the capacity to become an independent commercial business, provided that a good manager with technical and commercial background can be found to lead the newly trained team. The business plan shows that the Workshop is a viable business.
Follow up
Anton Veldt, vice director of EPF Chimoio, has taken the decision to commercialise the Workshop. He has already discussed the business plan with the local organisation ADEM, that is positive regarding providing funds for the workshop.

Drilling teams.
Besides the EPF Chimoio Workshop, the team in Itoculo, which followed training in this project, has the possibility to become a commercial drilling company as well. Some more training should be provided however.
Recommendation
Provide more training to the team in Itoculo to develop into a commercial company.

5 Spin off

A new project on bio-fuels started with the FACT foundation, and ADPP Bilibiza.
Arrakis is involved for project coordination and TA for 3 years. In this project 25 Hand rope pumps have to be built and installed for nurseries at Farmers Clubs.

Further introduction of Ceramic Siphon water-filters by Connect International, in which Henk Holtslag is involved.

After participating in the training in Chimoio when the wind rope pumps were built, Stephen Nash, from a small drilling company in South Africa, has built 10 wind rope pumps in South Africa.

One of the 10 Wind rope pumps produced by Stephen Nash in South Africa.

ANNEXES:

ANNEX I: Description of Affordable Technologies

ANNEX II: Project history

The project started in April 2006, and was concluded in December 2007.
A number of the technologies have been produced at the workshop of ADPP-EPF and have been installed at their fields to serve as demonstration. Furthermore the technologies have been installed with Farmers Clubs, schools and private families. In November 2007, user surveys were held to obtain results on their use.

The technology transfer was implemented through TA (technical assistance) missions, during which the equipment was jointly produced and installed, and whereby instructions and practical guidance was given to the future team of the ADPP-EPF workshop and other participants of sister ADPP organisations from other places as well. In between the TA missions, problems were discusses and advice given through e-mail correspondence.

The first TA mission was realised by Jan de Jongh & Henk Holtslag, in June-July 2006. During 2 weeks training in Zambia already 2 persons of ADPP Chimoio participated and the following 2 weeks in Chimoio about 12 Persons from ADPP participated, and two from other organisations in Zimbabwe.

The progress made was reported in the Progress Report no 1: see Annex.

The first results were that per July 2007, the wind rope pump technology with the first drip irrigation systems had been transferred and the farmers and schools were starting to use the systems in the dry season, while ADPP did the monitoring.

	
First wind rope pump produced in the project and installed with micro-drip irrigation system at the "Formigas de Futuro" school.	***Workshop team at the ADPP-APF Workshop where the pumps are being produced***

A one day seminar was organised to attract organisations which might be interested in the technologies and in providing micro-credits. Among the participants of this seminar were representatives of FAO, GTZ, Magariro, ADIPSA, Africare, MICOA, TAREMBA village association, Practical Action Zimbabwe, Pump Aid Zimbabwe.

One organisation Fundo de Energia (FUNAE), based in Maputo, was willing to develop a package for micro-credit for the technologies. The first wind rope pump performed well, reason for PvW to give the green light to start the production of the next 5 wind rope pumps.

A training plan was made for the team to practice manual drilling and a Plan of Operations was made with Jacob Zulu project leader in Chimoio, for execution of the remaining activities up to the second TA mission.

In the period from 26 Oct - 15 Nov 2006, the second TA mission was conducted by Jan de Jongh and Henk Holtslag; a group of 13 participants from ADPP institutions in Chimoio, Namathande, Itoculo and Bilibiza received training.

The second TA mission concluded that progress on actual required hardware instalment was slow, but increasing. The team was ready to produce and install HRP's and make recharge wells with Augers. Three teams from ADPP Chimoio, plus ADPP Namathande plus ADPP Itoculo are now capable of making a borehole with the Baptist drilling option. However, soil conditions in Chimoio are not very favourable for manual drilling (costs seem higher than with digging).
Only half the number of ceramic water filters had been set out. The workshop team in Chimoio still had not yet fully proven that they can produce wind rope pumps. Plans were made by the ADPP team for the next period, based on guidelines given by the TA team.

For more details see the Progress Report no 2: see Annex.

In 2007, the following follow up TA missions were conducted:

Henk Holtslag from 26-30 March
Jan de Jongh from 11 – 17 April

Winfried Rijssenbeek, from 12 -19 November
Jan de Jongh from 5 – 21 November

A second conference on furthering the results of the project was organised for which different organisations were invited. The objectives of the conference were to present the results obtained with the introduction of the installed technologies, lessons learned and their potential. An important part of the conference was directed to a consultation with micro-credit suppliers to subsistent farmer groups, in order to develop viable micro-credit packages for further dissemination of these technologies.

For the presentations and result of this workshop see Workshop report in ANNEX.

Summary of results:
The conference took place on 13/11/07 and some 25 people participated. The people invited were from the Government, from farmers associations, NGO's, International agencies and the micro-finance organizations. Although not all invitees could come, there was a sufficient representation of the stakeholders and interest groups the project intended to reach.
By presenting and explaining the participants most of the technologies installed at the fields of EPF and Formigas, combined with power point presentations and video's in the conference room of EPF, the participants obtained a good understanding on the technologies and where they could be used.
The participants had a positive attitude towards the technologies, and during the consultation session on supplying micro-credit to subsistent farmer groups, good inputs were given.
With one of the participants GAPI, the next day, a meeting was arranged, during which they showed their interest and willingness to provide micro-credit to FC's for the technologies as HRP's and irrigation systems.