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The Water and Sanitation Program is an international partnership for improving water and sanitation sector policies, practices, and capacities to serve poor people

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September 2004

Field Note

Meeting demand for access to safe drinking water

Low-cost pump alternatives for rural communities in Honduras

With financial support from the Swiss Agency for Development and Cooperation (SDC) and the technical assistance of WSP-LAC, the Honduras Water and Sanitation Network carried out a field survey on pumps being used in Honduras directed at identifying successful options for replication. The following report presents advantages and limitations of two types of low-cost pumps - the EMAS Flexi and the Rope Pump - used in several rural communities in Honduras, considering the users´ perspectives.

Pumping is becoming increasingly more common to access drinking water. Unfortunately, many of the alternatives for pumping available to the rural poor have been too costly, too unreliable or too difficult to maintain locally, especially if fuel or electricity are used.

Overview

As much as 30% of Hondurans does not have reliable access to safe water. Most of these almost 1.5 million people live in dispersed rural villages. The growing scarcity of safe surface water limits the use of traditional gravity water systems by making many long-distance projects prohibitively expensive. Pumping is becoming increasingly more common to access drinking water. Unfortunately, many of the alternatives for pumping available to the rural poor have been too costly, too unreliable or too difficult to maintain locally, especially if fuel or electricity are used.

Until recently, some of the difficulties that rural pumping presented included: high costs of operation and maintenance; complicated repairs; lack of locally-available spare parts; no attention to local capacities and motivation at the family level to make a pump sustainable; and long periods of disuse or total abandonment. In this report, two pumps that can effectively resolve the limitations are presented, along with some of the characteristics that make them sustainable, especially regarding costs, local maintenance and repair and user satisfaction.

The EMAS-Flexi Handpump

Manufacture, operation, maintenance and repair

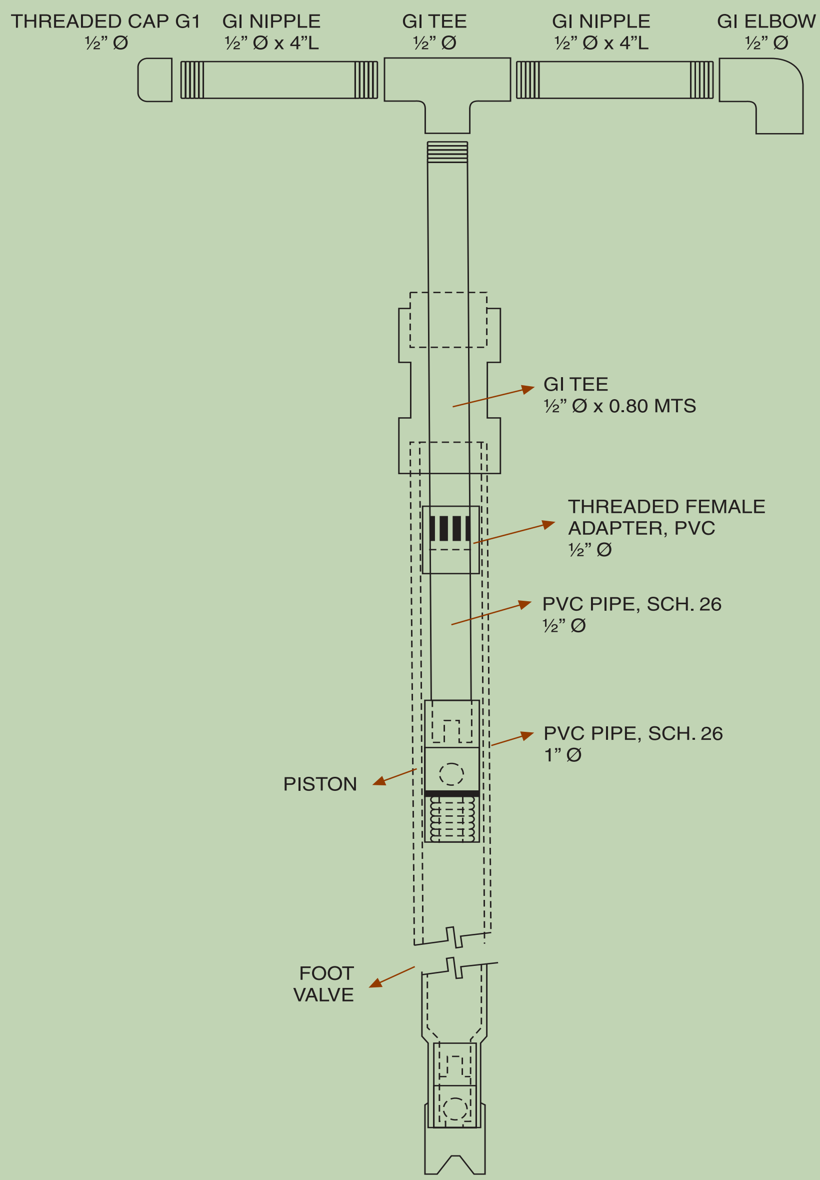
The Mobile School for Water and Sanitation (EMAS, in Spanish) Handpump originated in Bolivia and was first adopted in Honduras by the Ministry of Health and the European Union in the mid 1990´s. Recently, the Honduras Social Investment Fund (FHIS), through the Water and Sanitation Program for Rural Dispersed Communities has been using an improved version. Financed by the German Development Bank (KfW), the EMAS-Flexi handpump being installed is appropriate for individual families and small groups of dispersed homes. The pump is made from locally available materials (galvanized iron and plastic pipes, innertube rubber, and even a child's marble for the valve). FHIS projects pump from hand dug wells or rainwater cisterns of up to 6,000 liters capacity. It can pump from 30 meters depth, lift ground water up to 30 meters and conduct it up to 800 meters away. FHIS installs 75 liter ferrocement storage tanks above and with a hose into each kitchen, delivering safer water at the point-of-use without handling. It is also installed on the buried rainwater cisterns built at either homes, public buildings, schools or health centers.

The EMAS-Flexi pump can require more effort than other handpumps to extract water - up to 2 minutes and 40 strokes to fill a 20 liter bucket. Even still, it is manageable for both children and adults and users did not report complaints.

The EMAS-Flexi handpump has a design life varying from 4 to 9 years. Maintenance is minimal and should include regular cleaning of the tank and cisterns and occasional disinfection of the whole system. Repairs can include changing the output valve (every 2 years or so, depending on use), periodically replacing the plastic bottle installed in line as an air chamber, and occasionally changing the innertube rubber wrapping the pumps riser tube at the mouth of the well or cistern. However, it appears many users do not perform some of this routine maintenance and disinfection or do so infrequently, which could deteriorate drinking water quality.

To initiate a project, a group of households is organized around each shared pump and well, which is improved by installing a small "infiltration gallery-filter" made of concrete, stone and gravel (see picture this page). Wells should be sealed and lines, tanks and cisterns disinfected. The groups then establish a daily timetable for sharing the pump to fill each home's tank. The pump's operation does not present any difficulties, but water quality can be affected if wells are not deep enough and if wells and cisterns do not have concrete sanitary seals (which should extend at least 3 meters below a well's opening). All of this indicates the need to reinforce education on sanitary behaviors, water quality and disinfection. Solar Disinfection, or SODIS, could be a very effective and low-cost option.

EMAS Pump



The pump is suitable for individual families or small groups of 5 or so households, but not sufficiently robust for public service.

Target Population

The pump is suitable for individual families or small groups of 5 or so households, but not sufficiently robust for public service. This, and the capacity to connect a simple network, makes this technology one of the few technical options for many dispersed rural communities, a population that has been difficult to attend. This is the segment of Hondurans with the lowest coverage of water and sanitation services.

Experiences

FHIS is also beginning to train selected local users in the manufacture and repair of EMAS-Flexi handpumps. With help of Health Ministry or NGOs promoters, communities simultaneously participate in a process to increase their awareness of the unhealthy water and sanitation conditions. Additionally, users are informed about the difficulty to find superficial sources, as well as the advantages and responsibilities involved when maintaining their own water source and handpump. If no other feasible options are available and a village selects this technology, agreeing on the type and amount of community co-financing, a community water board is organized to manage tariffs paid by users for maintenance (about US$ 0.50 per month).

The EMAS-Flexi pump being implemented by FHIS is sustainable in most villages. Some users express that “over nine years using EMAS-Flexi pumps, only a very few times” have they had to rewrap the pump with new rubber.

In two years, FHIS has installed more than 1,750 EMAS-Flexi handpumps for 1,500 families in 36 communities. Contractors have included NGOs and “direct execution” (a form of local contracting with communities) of contracts and “social audits” carried out by the communities themselves.

In Honduras, the Reconstruction Unit of the Ministry of Health has implemented the manual drilling concepts created in Bolivia. Equipment is made locally of rope, iron pipe and drill bits from soldered reinforcing rods, which are available in all municipalities for less than US$ 600. Local villagers are trained as contractors to sell there wells and pumps to families, thereby generating income and providing safe drinking water services without government subsidies. A team of three people can perforate wells deep enough to reach higher-quality water and install a sanitary seal.

Costs

The cost of the materials for a FHIS technician to build an EMAS-Flexi pump in a village is about US$ 10. FHIS estimates that if the EMAS-Flexi were available on the private market, it might cost around US$ 20. With support from KfW and the World Bank, FHIS has financed EMAS-Flexi handpumps, household tanks, cisterns, rainwater catchments and improved wells. Costs are shared with the communities, principally in volunteer labor and local materials. In two sample cases, costs for complete FHIS interventions were:

Granadilla, Morocelí:	280 people	US$17,000	($61/person)	45% local costs
San Marcos de la Sierra, Intibucá:	426 people	US$24,500	($58/person)	50% local costs

Advantages

- Very low initial, operating, maintenance and repair costs.
- Easy maintenance and repair by users themselves, and an excellent supply chain – the pump needs a minimum of parts, including a marble, inner tube and galvanized iron pipe, all of which are available in the nearest municipality.
- Pumps from deep enough to reach higher-quality ground water (30 – 40 meters).
- Can lift ground water up to 30 meters above ground level and conduct it to 800 meters distance to fill elevated tanks over household kitchens, enabling increased storage without handling at the point-of-use.
- Service is for individual families, generating the sense of ownership and personal responsibility essential for sustainability.
- When part of a contracted manual drilling strategy, the EMAS-Flexi can create hygienic, reliable solutions at minimal cost and without external subsidies.
- Recommended for rural dispersed communities, the most vulnerable population segment of Honduras.

Limitations

- Compared with other handpumps, the required effort to operate the EMAS-Flexi can be greater.
- When installed on shallow wells or cisterns without sanitary seals, even with an “infiltration gallery-filter” users take the risk of consuming contaminated water.
- It is important to accompany the EMAS-Flexi pump with a program promoting point-of-use disinfection, such as chlorine or Solar Disinfection (SODIS). It is also important to clean household tanks and cisterns frequently and regularly disinfect the system, lines and storage. Algae is frequently observed in the plastic bottles installed in-line as pressure chambers to enable lifting.

Rope pump

Manufacture, operation, maintenance and repair

This pump, known in other regions as the chain or bomba de mecate, has been known for decades. The rope pump is recognizable by its construction from used tires, a wheel of soldered reinforcing bars and a rope with plastic pistons. The development of the rope pump through the private sector in the 1980´s and ‘90´s in Nicaragua, with significant support from the Swiss Development and Cooperation Agency (SDC) has resulted in a simple, efficient, and sustainable device at a moderate cost for rural users. Energy from the user turning the wheel pulls the rope and pistons up through a plastic pipe, with enough tolerance to trap water in sections between the pistons and bring it to the surface. The original, uncovered familiar model is still very popular, but by suggestion of the Regional Water and Sanitation Network of Central America (RRAS-CA) and the Ministry of Health of Honduras in the 1990s, the private sector in Nicaragua developed the covered extra strength model for public service. As well as these two top-sellers, models are also sold for drilled wells, motor, wind, animal and bicycle power.

Other studies have confirmed that the rope pump is efficient and easy to operate. It can lift water from 50 meters but since it does not work by pressure it cannot generally lift water above ground level or conduct it over distances. By adding a length or two of iron pipe, the wind-powered version has been adapted on occasion to lift water some 6 to 18 meters above a well. The hand-operated versions are easily used by children and adults. An adult can extract 11 gallons per minute (gpm) from 10 meters, 5 gpm from 20 meters and 2.2 gpm from 50 meters.

Despite the fact that the familiar model exposes sections of rope and pistons, when correctly installed on a sealed well, this pump delivers water of much better quality than do the traditional open wells the familiar usually replaces. To help assure the best water quality available, programs like the Honduras Association of Water Boards (AHJASA) run chlorine banks in some municipalities. Other agencies like the Spanish NGO Acción contra el Hambre integrate Solar Disinfection (SODIS) in all their water projects, especially those with rope pumps, and with excellent results.

Three models are sold for different populations. The familiar model is appropriate for single family use. The extra strength model is recommended for public service because it is of more robust assembly and parts and includes a metal cover to better protect water quality.

The rope pump also faces few challenges in operation and maintenance. Its design life is indefinite. Versions with ball bearings on the wheel's axle require oil every 1-3 months. Other maintenance is not required. While it is useful to have available a set of spare plastic pistons (sold exclusively by the pump's manufacturer), rope and plastic pipe, these have a relatively long life even in public use.

Target Population

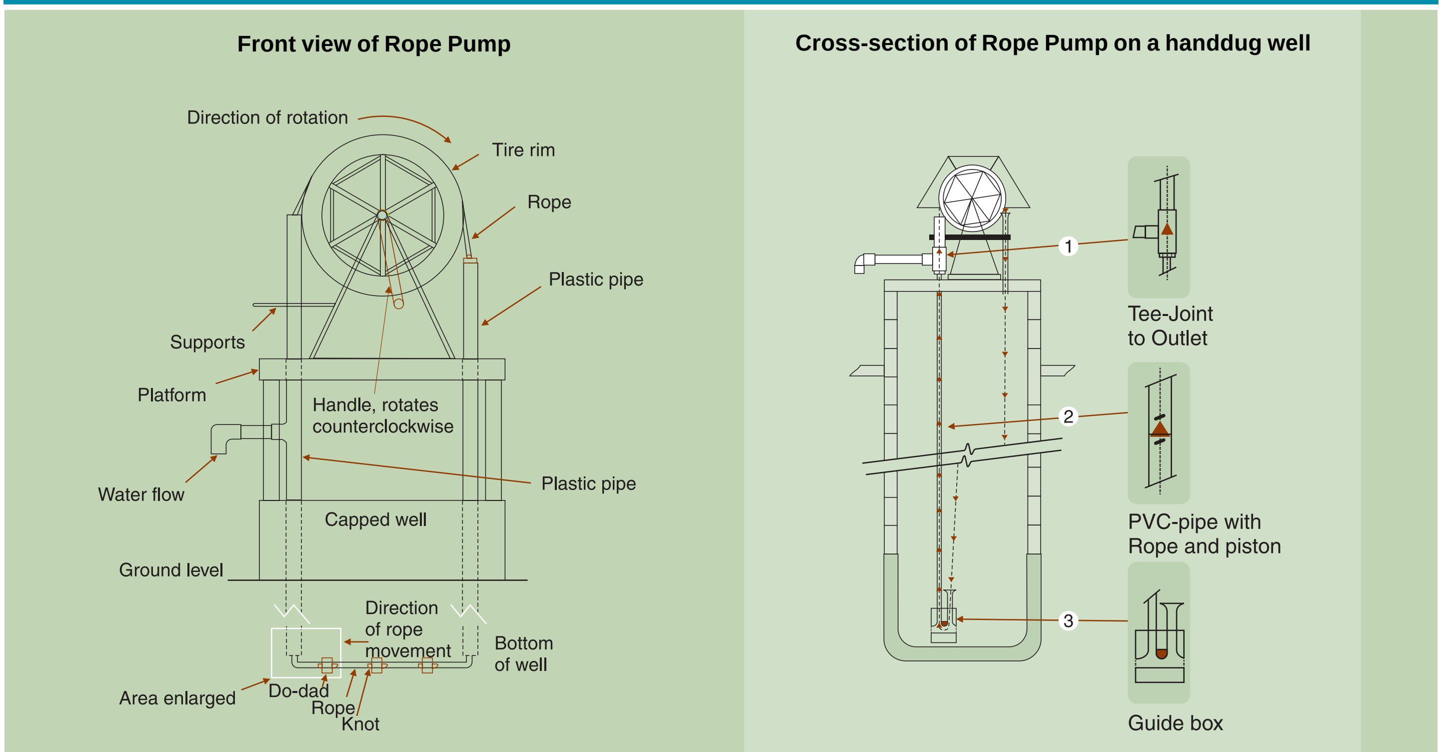
Three models are sold for different populations. The familiar model is appropriate for single family use. The extra strength model is recommended for public service because it is of more robust assembly and parts and includes a metal cover to better protect water quality. A version of the extra strength model is adapted for drilled wells for those that have this more costly but safer source. In Nicaragua, rope pumps that use motors, wind, animal and bicycle power are mostly used for irrigation, watering animals and in some cases for filling an elevated tank for domestic service.

Experiences

The largest manufacturer in Nicaragua, Bombas de Mecate S.A., established a factory in Nacaome in southern Honduras during the 1990´s and has sold more than 2,000 pumps. At least as many more pumps have been imported by programs and agencies from Nicaragua. In Nicaragua and El Salvador the extra strength model has become the handpump officially sanctioned by those governments for public investment programs.

In Honduras, there is only the one manufacturer, while in Nicaragua and El Salvador several private businesses make rope pumps. Thanks to support from the SDC and the Government of Holland, Bombas de Mecate S.A. of Nicaragua developed and published

Rope Pump



materials, norms and manufacturing manuals, which are followed in Nicaragua and Honduras. In El Salvador different manufacturers sell pumps of differing quality. At least 35,000 rope pumps have been installed in Central America. The rope pump is even being replicated in Africa and Asia.

Costs

The extra strength model (Feb. 2004), with transportation and installation, costs in southern Honduras:

Half-cover, with bearings:	US$ 111
Full-cover, with bearings:	US$ 166
For drilled wells, full-cover:	US$ 150
Wind-powered, with bearings:	US$ 222

These costs do not include the construction or improvement of a well. Without installation, costs are US$ 17 less. Depending on use, repairing public extra strength pumps can cost US$ 14 annually in pistons and rope (for wells up to 12 meters) or US$19.50 (beyond 12 meters). Familar pumps can work for 3 years or more before replacements.

Advantages

- Excellent user acceptability and sustainability.
- Purchase, maintenance, repair and parts are all low cost.
- Easy to operate, maintain and repair by users themselves, with a minimum of parts required from outside the community.
- Extracts high-quality water from depths up to 50 meters or more.
- Manufacture and sales are done by the private sector with a public design, making it accessible and sustainable for the public and limiting the need for government subsidies for many beneficiaries.
- The rope pump presents options for purchases, such as service levels, and wind, motor, animal, bicycle and hand-power. It is also useful for agricultural and animal production.

Limitations

- Even when wells are well built and have a full sanitary seal, water can still be subject to secondary contamination when it is transported to homes and stored in kitchens, like using any other pump. As with the other handpump studied here, it is essential to reinforce hygiene and sanitary education in the community, emphasizing point-of-use drinking water disinfection with chlorine or the low-cost Solar Disinfection option.
- The supply chain to repair this pump is adequate. The most complicated repairs would be welding, usually accessible in nearby municipalities. Common repairs would be replacing the rope and pistons. Good rope is available in most municipalities, but pistons must be purchased from the manufacturer. Communities should keep a supply of spare rope and pistons on hand.

- Rope pumps do not readily lend itself to lifting water to elevated tanks or conducting it over distances.

Users´ Demand

In this report, the only pump that responds directly to demand not induced by outsiders is the familiar model of the rope pump, which is accessible to rural family budgets. However, it is frequently installed on traditional wells and does not always deliver the highest quality water, although other studies have shown that in almost every case water is of much better quality than that obtained by extraction by buckets.

The extra strength version of the rope pump allows communities to achieve the

The EMAS-Flexi pumps offer water in the home without handling and secondary contamination, although treatment is still required to assure drinking water meets national standards.

frequently desired level of 24-hour, piped household service, but it is the most expensive of the rope pump options. The extra strength rope pump is often the only alternative for communities that depend on a borehole or public wells, cannot dig their own private wells, and afford the costs of pumping or installing electricity. The EMAS-Flexi pump associated to a FHIS "package" promotes also approaches that are optimal when connected to household tanks and cisterns.

In 1996, the RRAS-CA and the University of Southampton (England) carried out a comparative assessment of rural handpumps: the rope pump, the EMAS-Flexi and the Centroamérica/ Catracha. It found that users of the first two were able to acquire, maintain, repair and sustain their pumps, and were very satisfied with their choice.

To approach sustainability it is usually essential that programs generate demand towards some of these alternatives. From the Honduran experience one can extract that the most successful interventions are those that achieve awareness among users that their traditional sources provide dangerous water for drinking, that they have feasible alternatives and which technology and local organization would make for the most sustainable solution with the least external intervention in the future. The FHIS methodology includes community contracting of water and sanitation solutions, wherein funds are transferred to beneficiary groups for them to hire and supervise the contractor or NGO that builds their infrastructure. The original strategy for implementing the EMAS-Flexi in Bolivia actually created small businesses, where a few neighbors learn to hand-drill a well, build and install the handpump on a paid basis to interested client families in their area. This model is based on user demand, ownership and therefore sustainability, would be worthy of adaptation in other countries.

Chain of basic supplies in water and sanitation services

Chain of basic supplies in water and sanitation services

Users
(Communities, people)

Payment | Goods and services (pumps, spare parts, repairs, loans)

Distributors
(Wholesalers, retailers)

Payment | Goods and services

Suppliers
(Manufacturers, service suppliers)

Some indicators

Main indicators relevant for evaluating new pumps should include:

- User satisfaction.
- Delivery better quality water (and greater quantity, if possible).
- Positive impact on health.
- Sustainability.
- “Scaling-up” for greatest impact.

Although none of the programs studied here were guided by all these, in the case of private sector vendors as with the rope pump, striving for customer satisfaction is explicit. For the other interventions, the number of communities benefited constitutes the most important objective.

Notwithstanding the above observation, the pumps studied here achieve these indicators satisfactorily. In every community visited, users expressed satisfaction with their pumps – all felt their situation is better than before getting their pump, when most had to haul small amounts of low-quality water by hand over long distances. Still, even those that use handpumps still hope someday to get a low-cost household connection with 24-hour service.

In all cases the indicator of quantity of water used now is greater with any of these pumps than with their traditional sources. The quality of drinking water is most likely superior as well, especially when compared to original unprotected

Comparison of Two Rural Pumps in Honduras

	EMAS – FLEXI	ROPE PUMP
Initial costs	**Very low**: 50% or more community financing.	**Low**: Familiar model **Medium**: Extrafuerte
Private sector participation	**Medium**: future users could build their own systems	**High**: all pumps are built by small, private businesses.
Social/economic acceptability to users*	**High**: very low O&M costs.	**High**: low O&M costs.
Community-level operation & maintenance**	**Low**: does not require external support or spares.	**Low**: only models with bearings require some oil.
Community-level repair**	**Low**: does not require external support or spares.	**Low**: rope available locally, pistons from the manufacturer.
Function & reliability	**Medium**: depends on # of users, load, & frequency of use, although easily repairable in villages. Care is needed for good water quality.	**High**: robust pump w/ few breakdowns.Point-of-use disinfection is recommended.
Institutional support required	**Low**: can be maintained & repaired locally when training is given. Strong supply chain.	**Low**: can be maintained & repaired locally when training is given.
Overall sustainability***	**Medium/High**: depends on environment, load and level of use. Strong supply chain.	**High**: Good supply chain (rope, parts available locally, pistons must be purchased from manufacturer).
Target group	Individual families or small groups of 5 or so households.	The familiar model is appropriate for single family use. The extra strength model is recommended for public service. A version of the extra strength model is adapted for drilled wells for those that have this more costly source.

* assumes costs are paid by the users.
** assumes basic training of users.
*** according to principles of pumps with operation and maintenance at the community level.

Source: Table adapted from the National Handpump Evaluation (Regional Water and Sanitation Network of Central America, Collaborative Group of Honduras & Univ. of Southampton, England; 1997).

A good supply chain is essential for sustaining water services. In the rural water sector, goods and services (devices, training, repairs, financial, technical and administrative support) is provided to clients through a supply chain that begins with manufacturers, importers and service providers and passes through a distribution network.

sources. The EMAS-Flexi pumps offer water in the home without handling and secondary contamination, although treatment is still required to assure drinking water meets national standards (0 fecal coliforms). It was not possible to evaluate health impacts yet, however in almost every case users testify to a general sense that diarrhoea and other gastro-intestinal afflictions are less frequent now with their new pumps.

Sustainability:

One additional characteristic of sustainable pumps is the ease and speed with which the users themselves can put an errant pump back into service. Despite the fact that rope and EMAS-Flexi pumps might be more prone to service gaps than more robust pumps, repair can be done by the users themselves usually in a few hours. Pumps that can be repaired locally will spend more time in service and are less likely to be abandoned.

The fact that the rope pumps are made by experienced private companies helps insure fewer failures. If they do occur in rope pumps, users with a minimum of training are capable of their repair. If a community has spare rope and pistons on hand, time spent out of service will be minimal.

A good supply chain is essential for sustaining water services. In the rural water sector, goods and services (devices, training, repairs, financial, technical and administrative support) is provided to clients through a supply chain that begins with manufacturers, importers and service providers and passes through a distribution network. Payments flow in the opposite direction. The strongest supply chains have limited "outside" actors such as governments and NGOs, and are usually more sustainable. The private sector has motivations for maintaining and extending supply chains.

Conclusions

The most obvious result of these alternatives has been thousands of Hondurans benefiting from simple means for obtaining more and higher quality drinking water. However, beyond just the number of direct beneficiaries of these pumps, other significant results have been observed:

- A new spirit among government programs, NGOs and international agencies allows "experimenting" with new solutions for rural pumping that satisfy user demands.
- The pumps presented here respond adequately to the demands and abilities of rural Hondurans: users themselves are capable of paying for and managing their operation, maintenance and repair. Required inputs and spares are for the most part available locally and at low cost, and users can be trained quickly in their maintenance and most repairs.
- The two pumps represent different levels of service and therefore require different strategies for their implementation:
  - The EMAS-Flexi pump and the familiar model rope pump can provide service to individual families, requiring a strategy at that level.
  - The extra strength rope pump has a moderate price. Although it should therefore be accessible to rural communities by direct purchase, it usually is given to communities by programs and NGOs.
- The supply chain for repairing the EMAS-Flexi is the simplest of the pumps studied here, meaning spare parts are easily available almost nationwide. For the rope pump, the spare parts that do not have an adequate supply chain are the plastic pistons; all other parts are available nearby. For the rope pump, local initiative must compensate for a weaker supply chain, usually by keeping spares on hand.
- Only the rope pump has been developed through sales by the private sector directly to *campesino* families. In Bolivia, a similar strategy of creating *campesino* businesses to sell drilling services and EMAS-Flexi pumps to neighbors has been quite successful and could easily be implemented in Honduras and other countries.
- These pumps can only deliver good quality water if they are installed on sources and wells that are well built and hygienically sealed. The challenge of securing access to high-

quality drinking water is especially apparent with the EMAS-Flexi handpump, and special care should be taken in selecting and sealing wells or sources for these pumps and disinfecting drinking water. Treatment using chlorine is feasible. Solar Disinfection (SODIS) presents another option at low-cost.

- To achieve the desired impacts on rural families' health, it is essential that all of these technologies be accompanied by intensive hygiene, environmental sanitation, health education and water quality campaigns.
- If a demand response approach is taken, wherein strategies and alternatives appropriate for each community and local conditions result in a sense of "ownership" of chosen solutions, these two pumps can all contribute to closing the wide gap between those with and those without access to safe water, especially for dispersed rural families still without this basic service.
- The pumps presented here should form part of poverty reduction strategies that are sensitive to user demands, abilities, funds and resources.

Technical Aspects of Two Pumps for Rural Honduras

Pump	**Depth** (meters=m)	**Production** (liters per minute=l/m)	**Lift above ground** (meters=m)	**Pumping distance** (meters=m)	**Minimum pipe diameter**	**Costs**
EMAS-Flexi	30 m	"2 to 5 strokes per liter"	Up to 30 m	Up to 800 m	1.5 inches	US $ 10 in materials; Aprox. US$ 20 complete if commercially available.
Rope pump (manual, wind or animal traction)	50 m	5 m = 83 l/m 20 m = 19 l/m 50 m =8 l/m	Up to 6 m (wind version only)	0 m	4 inches (drilled-well version)	**For excavated wells:** Half-cover no bearings US$ 111 w/bearings US$ 138 Full-cover no bearings US$ 138 w/bearings US$ 166 **For boreholes:** Half-cover US$ 122 Full-cover US$ 150 **Wind-powered:** no bearings US$ 194 w/bearings US$ 222
(motor)	100 m	19 l/m				

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EMAS-Flexi pump

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Rope pump

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