FINAL REPORT

EVALUATION REPORT

NICARAGUAN EXPERIENCES WITH ROPE PUMP

The Netherlands, September 1995

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Measuring the efficiency, the technological, socio-economic and institutional sustainability, the affordability, the acceptance and replicability of a specific groundwater lifting technology

Evaluation for Royal Netherlands Embassy in San José (Costa Rica), the SNV programme PASOC in Nueva Guinea, Nicaragua, and the IRC International Water and Sanitation Centre

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Translation, editing and finalization was done by Eca Zepeda, Nicolette Wildeboer and Mallane de Jong, all of IRC.

CONTENTS

ABBREVIATIONS AND ACRONYMS USED

CARE	Cooperative for American Relief Everywhere
CAPS	Drinking Water Supply and Sanitation Committees
CEPAD	Council of Evangelic Churches (Consejo de Iglesias Evangelicas Pro-Alianza Denominacional)
CICUTEC	Centro de Intercambio Cultural y Técnico
CITA-INRA	Centre for Applied Technology of the Nicaraguan Ministry of Agrarian Reform
Post-Chinorte	Chinandega Norte (Follow-up of Former Swiss Project in Northern Region)
COSUDE	Swiss Cooperation for Development
DGIS	Directorate General for International Cooperation (The Netherlands)
ESA	External Support Agency
IDWSS	International Drinking Water Supply and Sanitation Decade
INAA	National Water Supply Institute (Instituto National de Acueductos y Alcantarillados)
DAR	Direction of Rural Aqueducts
IRC	International Water and Sanitation Centre
M&E	Monitoring and Evaluation
MIDINRA	Ministry of Agriculture and Agrarian Reform
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
PASOC	Programa de Agua, Saneamiento y Organizacion Comunitaria (Water, Sanitation and Community Organization Programme)
RNE	Royal Netherlands Embassy
SNV	Dutch Organization for Technical and Social Cooperation
SWOT	Workshop held using analysis of strengths, weaknesses, opportunities and threats
UNICEF	United Nations Children's Fund
UNOM	INAA Unit for Operation & Maintenance

EXECUTIVE SUMMARY

There is a continuing need to develop and introduce appropriate technologies for water supply in developing countries. One such technology, which is reportedly very successful, is the rope pump which has been further developed and applied on a wide scale in Nicaragua. Matching this need and reported success resulted in an evaluation mission to assess the potential of the rope pump technology. The mission was fielded in the period 8-14 March 1995. The evaluation was jointly financed by the Royal Netherlands Embassy in Costa Rica, the SNV-supported PASOC Program in Nueva Guinea (Nicaragua), and the IRC.

The Evaluation Team consisted of five experts comprising two IRC staff, one Dutch consultant and two Nicaraguan consultants. Their expertise covered mechanical engineering; institutional issues; community participation and social issues; water supply technology; and economic and financial issues.

The overall objective of the evaluation was to assess the short- and long-term performance of the rope pump in Nicaragua in view of its potential for wider application and active promotion outside Nicaragua. The specific objectives related to the technical functioning and performance; the materials used and manufacturing quality; comparison with other handpumps; success factors for introduction in Nicaragua; technical and financial sustainability; affordability; cost-effectiveness; acceptance; private sector involvement; and replication of private sector involvement in other countries.

The evaluation was preceded by a literature review financed by IRC on world-wide experiences with rope pump technologies. The review document was used by the Evaluation Team as a briefing paper.

The Evaluation Team held a half-day briefing workshop on evaluation issues, and ESAs' and sector agencies' experiences with the rope pump in Nicaragua. The Team had discussions with local organizations, communities and users, and with personnel of mechanical workshops. Major rope pump workshops were visited to evaluate the production process. Technical aspects of the pump were assessed in the field. At the end of the short mission, an half-day participatory workshop was held to present and discuss the Evaluation Team's preliminary findings, conclusions and recommendations.

The major conclusion is that the rope pump can potentially form a valuable addition to the range of appropriate groundwater lifting technologies in other countries.

For many countries the rope pump has the potential to be locally manufactured, marketed and installed by the private sector, including smaller local mechanical workshops. Operation and maintenance requirements are relatively low and simple, and therefore with some minimal support from the local private sector (e.g. through some repairs, spare parts support), O&M can be done by the users themselves. This is particularly attributable to the absence of piston, foot and piston valves, pump rods etc. However, there is a need for constant attention to simple but regular maintenance requirements. The rope pump is, for many conditions, a sustainable technology.

The relatively low level of investment (approximately US$ 80) makes the technology accessible for individual households and farmers, although for the poorer sections of society the rope pump will not be affordable on a private basis. In that case, either the communal rope pump or the self-made rope pump (approximately US$ 25) could be considered as an option. For both, the O&M and costs will be feasible.

Although the rope pump has been under continuous technical development in Nicaragua since 1983, the pump still needs technical improvements. In particular, as no standardized designs and manufacturing processes are prescribed, the individual workshops differ in their designs and product quality. ESAs demand such design criteria and standards, as well as quality control of the product.

The success of the rope pump in Nicaragua is the result of (i) the initial interest of the individual families to install the pump for farm activities (cattle watering; small-scale irrigation) and also for domestic water uses, and (ii) the interest of national technical institutions and the private companies (small workshops) to experiment with design and to improve the parts of the pump. The role of the ESAs has also been substantial, particularly in the development of the communal rope pump. One company has been very active in the promotion and commercialization of the manufacturing and installation of the pump, which has substantially contributed to its popularity and high coverage in Nicaragua.

The recommendations include activities to promote the proven appropriate technology internationally. These activities include development of promotional materials (publications, video); organization of a workshop in Central America; publication of articles for sector journals; dissemination of the technology in conferences etc.; and development of pump selection criteria, standardized designs, manufacturing processes and quality control procedures for the rope pump. Furthermore, a series of recommendations are made on how to introduce the rope pump in specific countries.

For Nicaragua, a number of specific recommendations are made with regard to technical, manufacturing, community organizational, and training aspects. Thereby, a division is made between the 'industrial' pump, the 'self-made' pump and other types. Special attention is paid to the problem of the affordability of the pump for the poorer sections of the country.

In an initial follow-up of the evaluation, the potential funders for the most important recommended activities will be approached to discuss and agree on actions and budgets. This was not possible in the time-frame of the evaluation.

1. INTRODUCTION

1.1 Background

Water supply for drinking water and other household uses is generally viewed as one of the most basic needs for hygiene, health and development. A reliable and safe water supply lays the foundation for improvement of living conditions and for development in general. In rural areas, water is often also the key factor for subsistence and development of commercial activities including small scale farming and livestock.

The International Drinking Water Supply and Sanitation Decade has greatly increased the attention international organizations pay to water supply and sanitation. Despite this, the overall water supply situation in many countries is still deplorable. The major problem behind this bad situation is not primarily, as is often said, the limited financial resources, but more often the insufficient consideration in planning for the long-term sustainability of the water supply facilities. The common experience is that handpumps break down within a couple of years after installation, and diesel engine-powered water supply systems stop functioning because spare parts are not available or fuel supply is too intermittent. The sustainability of the installed systems is low for various reasons, including high operation and maintenance costs, unclear division of responsibilities between the users and the water agency, poor management structures, inappropriate technologies, etc. The water agencies' role is changing from provider of services to promoter and facilitator of community-based water supply improvements. The sector institutions are now realizing that involvement of the users in selection of service level and technology is a crucial aspect in reaching sustainable systems. This implies that agencies have to provide a range of technology options from which communities and users can choose the most appropriate. Only through sustainable systems that are properly functioning and used by all, can a strong foundation be laid for achievement of the higher goals of improved water supply, i.e. better health and a higher standard of living.

Where the preference for more family or neighbourhood-based water supply systems is expressed or where circumstances make groundwater supply through handpumps unfeasible, additional technologies must be offered. The criteria for selection of these technologies include hydro-geology, affordability, durability, operation and maintenance (O&M) requirements (technical and financial), availability of local repair capacities and spares, social acceptability.

The Nicaraguan rope pump seems to fulfil the criteria for an appropriate groundwater lifting device. The rope pump can serve a substantial segment of the handpump market at household level, because of its low-cost investment, its low operation and maintenance costs. The technology offers also good opportunities for local management and local repair using existing capacity. Locally manufactured spare parts are available. Various organizations in Nicaragua, both locally and externally supported, report on promising technological developments, local manufacturing, applications and installation of the Nicaraguan rope pump, among others, reference can be made to the Nicaraguan Journal Enlace (no.1, 1992) and Van Hemert et al. (1992). A publication of Stichting Demotech (1986) gives a more general development view of the rope pump. Even wind-powered rope pumps are being installed in Nicaragua. Its reported high volumetric efficiency and limited mechanical problems seem to be major causes of the high social acceptance. At the same time the pump

is reported to be highly reliable, and malfunctions are easily repaired. The pump can be used on hand-dug wells and on large diameter boreholes.
Compared to the limited technology development and success rate of this type of pump in other countries and continents, the Nicaraguan case is quite remarkable. Regional and international interest in the application of the Nicaraguan rope pump is evidenced through the numerous reactions to recent articles (1993) in *Waterlines* and *IRC Newsletter* (see appendix no. 11). Response came from national organizations and External Support Agencies from all continents. Private initiatives on rope pump manufacturing have started on a small scale in Honduras. In Mozambique, the Royal Netherlands Embassy and UNICEF intend to support the introduction and pilot-testing of the rope pump in rural areas.

This evaluation assessed the potential of the "Nicaraguan" rope pump as a sustainable technology for wider dissemination in other countries in Latin America and other continents. At present most of the experiences of successful commercialization of the rope pump come from Nicaragua. Limited information is also available on its development and introduction in Asia (a.o. Indonesia, Sri Lanka), Africa (a.o. Cameroon, Zimbabwe and Zambia) and Latin America (Bolivia).

1.2 Objectives of the evaluation

The overall objective of the evaluation is to assess the short- and long-term performance of the rope pump in Nicaragua in view of its potential for wider application and active promotion outside Nicaragua.

The specific objectives of the evaluation are:

- to assess the technical functioning and performance (efficiency) of different rope pumps developed over the last five years in Nicaragua in relation to the quality of materials used and quality of rope pump manufacturing;

- to assess the technical functioning and performance of different rope pumps in comparison with reported performance of other ground water lifting devices both for application as a family pump and as a community pump;

- to identify environmental factors (e.g ground water table; ground water quality), institutional conditions (technical capability; marketing; competition), and other factors influencing the success of the rope pump introduction in Nicaragua;

- to measure the long-term sustainability of different rope pumps (also wind-powered) in Nicaragua, in particular as related to issues of the required maintenance and repair capacities, and production and availability of spare parts;

- to assess the affordability and financial sustainability of different rope pumps in terms of investment and operation and maintenance costs;

- to measure the cost-effectiveness of the rope pump as viewed by the users (both men and women) in terms of social, gender, economic and public health benefits;

- to identify the cultural and gender acceptance of the rope pump versus other ground water lifting devices;

- to review the achievements of private sector involvement in technology development, manufacturing, installation and repairs of the rope pumps and spares in Nicaragua, including a cost/time analysis of the production, marketing and after-sales costs of the rope pump in Nicaragua;

- to identify the conditionalities of the reported success of private sector involvement in the rope pump business and the potential for replication of this approach in other countries;

- to make recommendations for improvement regarding the rope pump in Nicaragua on aspects covered in the evaluation including technical design, private sector involvement, cultural and gender acceptance.

1.3 Evaluation methodology

The IRC International Water and Sanitation Centre was asked by the Royal Embassy of Costa Rica and the SNV-supported PASOC Program in Nueva Guinea (Nicaragua) to evaluate the Nicaraguan rope pump, and to measure the technological, socio-economic and institutional sustainability and replicability of this ground water lifting technology in other countries. The detailed terms of reference are appended (Appendix 1).

Evaluation period

The evaluation was conducted in Nicaragua between 8-14 March 1995.

Evaluation team

The multi-disciplinary evaluation team was composed of two members of the IRC, one Dutch external consultant and two consultants of CICUTEC, Managua, Nicaragua. During its work in Nicaragua permanent coordination was maintained in order to be collectively responsible for the results. However, taking into consideration the profiles and different experiences, each member assumed a specific emphasis on each of the different dimensions to be evaluated. The Team was composed of:

. Socio-cultural issues and team leader	Marc Lammerink	Economist/Social Scientist
. Institutional issues	Antonio Belli	Industrial Engineer
. Water supply technological issues	Maarten Bredero	Agricultural Engineer
. Pump mechanical issues	Boris Engelhardt	Mechanical Engineer
. Financial and economical issues	François Brikké	Development Economist

Each member of the mission designed and applied the most appropriate evaluation procedures, according to the specific subject area to be evaluated, giving attention to the participatory character of the mission.

Overall coordination of the evaluation was done by Jo Smet, Sanitary Engineer at the IRC.

Desk review

Prior to the field evaluation a literature study was conducted which was funded by the IRC. This review was based on information from several documentation centres including IRC's Documentation Centre, Technical Universities of Delft and Enschede, and databases as Aqualine and Pascall. Subjects covered in this review are developments of different types of rope pumps, technical functioning and performance, manufacturing and O&M costs, replicability of technology, private sector involvement, and technical, social and cultural acceptability. A literature study report in Spanish has been produced which served as a briefing document for the Evaluation Team on present world-wide rope pump experience.

Evaluation approach

A pre-evaluation questionnaire was sent to Nicaraguan government, donor and private organizations to collect general data and experiences on the rope pump in Nicaragua. The questionnaire is attached as appendix 3.

The activities of the evaluation mission in Nicaragua included:

- review of the data from the pre-evaluation questionnaires
- SWOT workshop held in Managua on evaluation issues with representatives of the National Water Institute at national and regional level and donors active in the water sector in Nicaragua (see appendix 6);
- technical evaluation of different rope pumps at the manufacturers' production facilities and in the field;
- discussions with private manufacturing organizations and companies;
- interviews with ESAs and members of the National Water Institute;
- SWOT workshop in Juigalpa with regional members of National Water Institute and PASOC-SNV (see appendix 7);
- meetings and discussions with communities and individual users;
- review and analysis of all collected data;
- participatory workshop (half-day) to discuss preliminary evaluation findings and recommendations involving SNV Nicaragua, PASOC, the National Water Institute, ESAs and manufacturing companies (see appendix 8);

The detailed programme and itinerary of the field evaluation is attached as appendix 2. To get the maximum result in the short period available (seven days), the Evaluation Team was split in two teams. The evaluation programme gives the activities of each team member.

A SWOT[1] workshop was conducted prior to the field visits with ESAs, NGOs and the National Water Institute. In this workshop brainstormings were done on strengths and weaknesses of the rope pump and its introduction approaches in Nicaragua, and potentials and obstacles for further development of this water lifting device for both family and communal use. The workshop results include a lot of information about the experiences of different organizations and the wishes on this device from different points of view (see appendix 6).

The use of participatory approaches was supplemented with more conventional approaches, involving the review of documentation on the rope pump beforehand, and meetings and discussions with staff of both workshops and programmes involved in the production and

[1]. In a SWOT workshop the Strengths, Weaknesses, Opportunities and Threats of the object under consideration, in this case the rope pump and its introduction approaches/strategies, are analyzed.

installation of the rope pump. Observations and discussions in the field were held with many users of rope pumps: women and children at family level, farmers, neighbourhood groups and technicians.

During the field visits the Evaluation Team was supported by different resource persons and guides, in order to be able to visit a large variety of rope pumps in various areas, of different ages and designs, and used by family and neighbourhood (community). Those resource persons were provided by Bombas de Mecate S.A.; Post-Chinorte; Don Pompillo; Henk Holtslag; UNOM-INAA Region V; and PASOC-Program. They also could help the Team to make quick reference of existing rope pumps available in the field and to prevent a too strong 'road bias'.

In all, some 51 rope pumps and several workshops (talleres) were visited in the northern, central and eastern regions. A list of family and communal pumps visited is attached in appendix 5. The team had discussions with a variety of NGOs, ESAs and state water organizations, at central level and in the visited regions. In total, more than 65 interviews were held with key informants with different profiles. A list of persons met during the evaluation study and mission is attached (appendix 4).

At the end of the field evaluation a half-day participatory workshop was organized to discuss the preliminary findings, conclusions and recommendations with staff form ESAs; the National Water Institute; PASOC Program; SNV; workshops and some individuals. Valuable feedback and synthesis of the key issues was given by those present (see appendix 8).

Constraints

An evaluation carried out in such a short period of time, seven days in the field, must inevitably be somewhat selective and cannot cover all issues and regions in depth. With more time the Evaluation Team would have liked to have seen also some good examples of self-constructed rope pumps and some private rope pumps in agriculture land in the Eastern region and to have visited other regions in the North and South (Rivas area).

Result

The principal purpose of this evaluation was to assess the short- and long-term performance of the rope pump in Nicaragua in view of its potential for wider application and active promotion outside Nicaragua and to formulate recommendations for improvements including technical design, private sector involvement, cultural and gender acceptance. This report attempts to provide a broad background for those who will be involved in future in the promotional activities outside of Nicaragua in order to learn from both the strengths and weaknesses of the rich experiences gained in Nicaragua.

Follow-up

IRC plans to use the evaluation results for the production of a promotional document on the rope pump. This state-of-the-art document will combine the desk review and the evaluation results. It aims to promote the rope pump to decision-makers and (project/programme) planners in ESAs and sector departments in developing countries. The document will indicate the potential, criteria and conditions for successful introduction of the rope pump technology in other countries, based in the experiences in Nicaragua. Funding for this follow-up and other recommendations is still to be sought. In chapter 4 recommendations for further follow-ups and possible funding sources are given.

2. FINDINGS

2.1 The history of the rope pump in Nicaragua

Introduction of rope pump
The first rope pump was installed in 1983 in the area of Santa Cruz. The prototype was based on a design of DEMOTECH Holland and further developed by CITA-INRA (Research Centre for Appropriate Technology)[2]. CITA-INRA used the rope pump technology as a methodology to bring the staff of the Centre closer to the beneficiaries of the social sectors interventions. By introducing the rope pump, the Centre did not aim in the first instance to develop, promote and introduce the specific technology but rather demonstrate the potential for rural communities to solve their water supply problems using their own capacities.

Within a month, the people in the demonstration village started building their own rope pumps. CITA-INRA organized the farmers in two groups, and provided training and institutional support. The simplicity of the rope pump and its ease for self-manufacturing with locally available materials led to a good relationship between the promoters (CITA-INRA) and the community. This example of sound appropriate technology raised the desire for development and promotion of other useful, simple technologies and methods which are socially appropriate and acceptable.

Technology transfer
The technology transfer within the immediate environment of CITA-INRA in Estelí, was achieved through action-oriented information workshops with the residents of the community of Santa Cruz. Don Pompillo, a now well-known manufacturer of self-made rope pumps, participated in one of these workshops.
The majority of the persons trained manufactured their own pump, and in many cases, with tailor-made adaptations to meet specific individual requirements. Interesting modifications included metal supports of pulley instead of timber, and including ball-bearings for the pulley axle. CITA-INRA provided support through the supply of PVC pipes and pistons. Institutional support was given through informing the farmers the theoretical aspects of the rope pump technology (Van Hemert et al., 1991).

Technology acceptance by NGOs
CITA-INRA states in her annual reports of 1983 and 1984 under technology transfer that rope pumps had been manufactured and installed in San Nicolás and El Sauce (municipality of León), and in other municipalities north of Chinandega. These results were achieved through technology transfer from family to family. In 1984, a workshop was organized for INAA extension officers and staff. The conclusion at the end of the workshop was that the rope pump was an "interesting technology", but that it did not adequately meet INAA's technical requirements.

In 1985 MIDINRA (Ministry of Agriculture and Agrarian Reform) opted for the mechanization and application of larger scale economy in the agricultural sector, away from appropriate technology and decided to close down CITA-INRA. The NGOs took over the

[2]. Although in general no names of individuals involved in the development of the rope pump in Nicaragua are mentioned in the report, an exception is made for Mr Jan Haemhouts, a Belgian engineer who was very much involved in the early stages of the development between 1983 and 1990.

role of promoting the rope pump. Initially the CITA-INRA staff moved to development projects in other state branches, in universities, and in public and private companies. Later on they continued with the development of the rope pump in NGOs and private workshops.

The 'industrialised' production
On the request of the SNV/INAA project, HULETECNIC[3] started in 1985 the serial production of rubber pistons of different sizes. From 1989 HULETECNIC manufactures hard plastic (poly-ethylene) pistons using the injection technology of thermo-moulding plastics. This initiated a more 'industrialized' production of the rope pump with a 'standard' quality of two important components: pistons and PVC pipes.

In 1987, the National Engineering University and the San José Cooperative started the development of an improved version of the rope pump. The metal pulley plus support frame was introduced as the next step in self-manufacturing.

These two initiatives, the plastic pistons and PVC pipes; and the metal pulley plus support frame, made the rope pump attractive for industrial, larger-scale production. The product should be a reliable, easy-moving, efficient, durable rope pump which is easy and cheap to operate and maintain. These factors were conditions for an interesting market potential under the then prevailing socio-economic conditions in Nicaragua.

After developing 50 prototypes still no attempts were made to start production or marketing/selling of the rope pump. This situation changed in 1988 when the hurricane Juana caused great damage in communities at the Atlantic Coast. The University and the San José Cooperative sold 200 rope pumps to ESAs involved in emergency aid. In 1990, however, the cooperation between the University and the San José Cooperative came to an end because of conflicting interests (Sandiford et al., 1993).

Another large scale implementation plan was initiated by INAA to help communities that had been hit by the hurricane. INAA decided to install 300 rope pumps in the town of Bluefields. Two years after installation, 67% of the rope pumps checked on their functioning, were still in operation. This high number of functioning rope pumps is a remarkable result, considering the fact that the technology was still under development, and that there had been no quality control, no training or information on how to maintain the rope pump, and no attention to community participation (Van Hemert et al., 1991).

In 1988, the DAR Region V (Directorate of Rural Water Supply) decided to improve the design of the rope pump. After two years of experimenting the rope pump technology was adopted as a standard technology. Apart from rope pumps, DAR Region V sold also construction materials to repair wells and latrines. DAR gives also technical advice, hygiene education and credit (Van Hemert, et al., 1991). At the same time the PASOC Program started with SNV support, to address the difficult situation of water supply and sanitation in Nueva Guinea and Boaco. The second phase of the PASOC Program concentrates in Nueva Guinea in collaboration with INAA. The programme has a strong component on promotion and installation of rope pumps for communal use, with an emphasis put on maintenance by the community. The rope pumps with a metal structure were manufactured by a workshop in

[3]. A Nicaraguan factory that produces all types of rubber and plastic pistons

Juigalpa and used the improved PE (poly-ethylene) pistons and improved ceramic guide block from Bombas de Mecate SA.

In 1990, the enterprise Bombas de Mecate SA was set up. The company wanted to further improve the efficiency of the rope pump by using better designs and materials than the older versions of the rope pump. They concluded that those models were inefficient and not appreciated by users, as they were manufactured by using materials available in the communities and regions (Alberts et al., 1993). Bombas de Mecate started with an extensive promotion at industrial and agricultural fairs, advertising on radio and in newspapers, and travelling through the country to promote their rope pump. They also produced a manual for clients and staff on the installation and repair of the rope pump (Alberts and Gago, 1994). The company has been very successful. In 1990, about 80 rope pumps were sold in one year, and by the end of 1994, this number of rope pumps sold had gone up to 80 pumps a month (Van Hemert, et al., 1991; Alberts et al., 1993; Bombas de Mecate SA, 1995). Bombas de Mecate SA sold in the period 1990 to March 1995, more than 3,000 rope pumps. Only 3% of the pumps were installed on boreholes while the others were installed on hand-dug wells. Most of the pumps (95%) were family wells, and 75% of the pumps were installed by Bombas de Mecate SA, and the others by clients and projects.

It has been estimated that since the introduction of the rope pump in Nicaragua, up to March 1995, a total of 5030 pumps have been installed, of which some 300-400 of the self-made type mainly with a wooden structure.

Institutionalization
The institutionalization of the rope pump in Nicaragua is a process that started at CITA-INRA, and developed into a product for self-manufacturing which was adopted by the grass-root development sector. However, the institutionalization had limited impact in Nicaragua until the rope pump was adopted by DAR, INAA, and the Fifth political-administrative region of Nicaragua (one of the poorest regions of the country). ESAs as UNICEF, COSUDE and SNV and others have contributed significantly to this institutionalization.

Since 1987, DAR install rope pumps, produced by local workshops, as one of the communal technologies for groundwater supply in their water supply and sanitation programme. The success of this approach now finds its reward in the general acceptance of the rope pump as the first option for groundwater pumping in communal water supply without electrical power at INAA and DAR levels (1992). The rope pump has gradually substituted other handpumps earlier installed although some ESAs continue to provide handpump models such as AFRIDEV, MONITOR, MAYA, and Indian MARK II.

Conclusions of the process
The rope pump has been enthusiastically adopted by the "innovative" sector agencies and organizations that showed interest and courage to successfully try this new technology for both family and communal use in rural groundwater supply.
The Nicaraguan experience has increased the technical "credibility" of the rope pump through the successful industrial serial production of specific parts of the pump.

The Nicaraguan rope pump case indicates the main factors important for the success of introduction of appropriate technology:

- a technology must be appropriate, that is, it must be easy to operate, cheap, simple to maintain and spares must be readily available (Sandiford et al.,1993; Alberts et al., 1993).
- the technology must be reliable; the workshop version with metal parts improved the reliability of the pump;
- promotion of the suppliers increases the familiarity of the pump; particularly Bombas de Mecate SA contributed to this promotion of the family pump;
- a high acceptance of the technology by the users;
  in the Nicaraguan context the family rope pump was well accepted which made INAA consider to use the rope pump also for communal wells.
- adoption and promotion by the national water supply agencies, in the Nicaraguan case INAA. They were very much supported in philosophical, financially and technical terms by NGOs and the private sectors to adopt the communal rope pump after the success of the success of the family rope pump.

2.2. Institutional Aspects

Although the Evaluation Team did not have enough time to get to know all organizational and institutional options that coexist in Nicaragua for the development, promotion, manufacturing and transfer of the "**pumping technology with multiple pistons and continuous movement**", the Team learned about the most characteristic actions of the Nicaraguan rope pump experience.

The most important and widely known workshops in Nicaragua involved in the manufacturing of 'industrial' rope pumps and rope pump parts were visited. An inventory of equipment and machines was made, and there manufacturing process was analyzed. Different models, designs and technical problems were studied during these visits.

2.2.1. The manufacturing workshops

Don Pompillo, Santa Cruz

General
Don Pompillo is an illiterate self-made craftsman. He has been manufacturing rope pumps since 1983. He has manufactured and installed some 500 pumps over the last twelve years. His pumps could be considered as a self-made version. He is the only one who makes the pump with wooden parts and does not have a standard model. He makes every part himself including the pistons (rubber of car tyre) claiming that these are more efficient than the new PE ones. The Evaluation Team includes him in this report since his work is considered as an important aspect of the development, promotion, and institutionalization of the rope pump in Nicaragua, and perhaps because he still has much to offer to the consolidation of this technology in the world.
His workshop has a few tools for cutting, carving wood and old tires, and materials that he uses to make the pistons, the guide, the pulleys, and the pump's frame.
He has in his house the country's oldest rope pump. Despite its twelve years, it functions perfectly without major repairs, except for the replacement of pistons, rope, and guide, parts which usually wear the most in all models. The pump that is installed at his house is unique. It was manufactured with strong metal and wooden elements. The design is basic (no welding), and easy to reproduce, but its mass production has not been considered.

This is the pump that is the oldest, the simplest and functions the best. Could it be that its simplicity denotes a touch of genius? Following investigations, chiefs of other workshops candidly admitted that they had never seen this model.
Don Pompillo's rope pump costs C$ 300 (US$ 40) including the installation. The owner of the well has to provide some basic materials depending on the type of well.

Self-made rope pump with timber

Taller Castilla, Juigalpa

General
Taller Castilla, known as Medio Bollo, is one of the pioneers in the industrial production of the rope pump. It is a typical blacksmith workshop with capacity for moulding and welding; it has manual and electrical tools, such as an emery and a drill. The great advantage of this workshop is its creative capacity as well as the training received by the owner. He has had formal training as a technician/mechanic in different metal-mechanical areas. He is especially qualified in welding and in thermal treatment of ferrous materials. At present the workshop produces the most durable pump, designed in simple manner, and has an excellent welding quality that reduces the impact of corrosion.

Taller Castilla started manufacturing rope pumps since 1984 "to round off the wages"; four years later, the pump became a reliable secondary activity that makes up 15 to 30% of the total work capacity. Although it is difficult to precise the quantity they have produced, the workshop claims to have sold an average of 20 pumps per month during the six summer months, and half of that in the winter, which totals 180 pumps annually since 1987-1988. An accumulated total of 1200 units have been produced until now; however, no registers can confirm this data.

In Nueva Guinea, rope pumps from this workshop installed by INAA in 1988 were found. This partially confirms their information/data and the quality of their product. The workshop focuses almost entirely on the private sector's market; i.e., livestock breeders and ranchers of the region who know the workshop since it is strategically located in front of a bus stop on an important street of Juigalpa. They attract people's attention by placing some pulleys in front of the workshop so that individuals passing by see them.
They make models according to the clients' preferences and specific requirements to meet local conditions. They manufacture most of the parts and purchase only the pistons and raw material.

Technical aspects
A typical regional-town workshop producing everything that is technically possible. Their equipment and tools are limited (a welder, a guillotine, a forge, and small tools), but the owner (and an assistant) have a great capacity for innovation and improvisation. Rope pumps are not their only work and source of income.

The oldest rope pumps installed in the Nueva Guinea zone and in Juigalpa were made by Taller Castilla. These pumps confirmed the quality of their work, as could be observed when they were in operation. Most of the installed pumps are communal wells that appear to last much longer than individual pumps.

Taller Castilla has made some remarkable innovations and improvements. For example, they invented a new guide with a cylindric glass embedded in concrete to avoid the use of ceramics. For the support structure they only use plain iron bars, not corrugated (construction steel), avoiding as much as possible, the excessive use of electric welding. This extends significantly the useful life of the pumps (less corrosion). The pistons are of high quality. They are bought from a specialized workshop in Managua. They use rope imported from Costa Rica, highly resistant to wear and tear and to the sun's ultra-violet rays.

Besides their own production, and the installation of pumps, they offer a do-it-yourself "kit" (rope with pistons and a guide with a cylindric glass embedded in a block of concrete) to any client.

The owner and its assistant of the workshop have constructed and installed a set of pumps for INAA, and approximately 600 pumps more in the private sector (family wells and livestock sectors) in the Juigalpa zone. Presently, they sell an average of 20 rope pumps per month. They make a rope pump in four hours and they install it in one hour. The do not have their own transport facilities but use their clients' or public transportation to go to the place of installation.

Taller López-Erlach, Managua

General

Taller López-Erlach is a moderately technically developed metal-mechanic company. It is well-equipped with machines and tools, (electric generators, emeries, drills, winches, industrial cutting machines, welding, etc.), and is comprised of highly qualified staff.

Its main activity is the repair and installation of submersible pumps in boreholes, but they also specialize in other types of mechanical repairs and technical installations such as well-drilling and engine/motor maintenance. Rope pump manufacturing is a secondary activity. In terms of time invested and income obtained, **it is a profitable activity in the sense that it is carried out during periods with a low work and order load** (e.g. during power cuts and other pauses in the main activities of the workshop).

Even though rope pump manufacturing is a secondary activity, it is well organized in a sequence or production chain that is adapted to the regular periods of low workload on other activities in the workshop. The production chain is designed for the construction of the different models commercialized by Bombas de Mecate S.A.

This workshop has the largest production of pulleys for rope pumps in Nicaragua. Its production capacity is 70 units a week, and it operates with four non-skilled labourers (workshop assistants). In case of greater demand, they take on extra hands in order to complete special contracts/orders on time. The workshop follows the strategy to regularly produce parts of the rope pump. Bombas de Mecate S.A. gets its supplies only from this workshop because a reliable client/supplier relationship guarantees supplies for client and jobs for workshop. This is the basis for an interesting enterprise symbiosis.

Even though their product is sold most widely, it is not the best on the market. In several cases, the Evaluation Team found cracks in parts of the welded joints, and damage caused by rust and sediment. The average price of each pulley is C$ 140 (approximately US$19). More than 3000 pulleys have been produced sofar.

This workshop also developed and produces rotors for windmills used in combination with rope pumps.

Technical aspects
This workshop manufactures the pulley and the metal support structure for Bombas de Mecate S.A. The production of the pulley counts for approximately 20% of López-Erlach's production capacity.
Its main line of business is the installation of boreholes for agro-industrial purposes which have larger diameter and greater depth. They developed, using Dutch expertise, windmill technology to be used in combination with the rope pump. This technology is mainly used for livestock watering. Some 50 units have been sold over the last 2.5 years (March 1995).
They have made some improvements to the design of the pulley, and it can be said that compared to other workshops in the country, López-Erlach is a technically highly developed workshop. Its equipment (two electric generators, a welding machine, industrial cutting machines, etc.), and its highly qualified employees (two qualified technicians and four assistants), enables them to manufacture and give maintenance to almost any product in the metal-mechanic branch.

Taller López Erlach has the technical infrastructure, the necessary knowledge, and the experience for large-scale production that can guarantee technical standards at the lowest possible price. They have produced around 3,000 pulleys and support structures for Bombas de Mecate S.A., and they also supply other companies like Palo de Hule, in Nueva Guinea.

Taller Gil, Juigalpa

General
Taller Gil, is a medium-size company within the context of the metal-mechanic national sector. The Taller has a total of five labourers.
It started as a company specifically for the manufacturing of rope pumps. Since the owner works for INAA as a promoter/extension worker, and his family is traditionally in the metal/mechanic sector, he believed it was possible to make his business profitable by working in one line of production only.
Presently, he is compelled to manufacture beds, metal gates, and fences to raise his income, as the sole production of pumps is not enough to cover the costs of the workshop.
He does not do any promotion, but he relies on the support of the local offices of INAA; most of his production of pumps find their way to their projects. It is the "official" supplier for INAA's Fifth Region, and since 1991 to this date, it has produced some 400 pumps. Their design is different from the rest of the designs that exist in the country, and it is more expensive (C$ 600 = US$ 83).

Technical aspects
Taller Carlos Gil is a blacksmith. Beside the rope pumps, it has a supplementary line of production. It is a workshop equipped with good machines and tools. Most of these pumps are still functioning, despite the wear and tear of the bearings or even if they are absent.

The design still has several problems. The pulley's design has too many welded joints; they use corrugated iron bars (corrosion problems); the wheel is not mounted in the centre in wells of greater depth. The weight of the water column tends to wear the bearings unilaterally; the frame of the support structure is very fragile; and the bearings that can be dismantled, have too much clearance. This increases the friction and the wear between the axle and the bearing.

As a sales package, the workshop offers a concrete cover for the well that comes as a feature with the pump. This workshop could use technical help to improve the design of its model.

Taller Las Planetas, Sebaco

General

Taller Las Planetas is a typical workshop for the production of metal gates and fences. It manufactures rope pumps only on order and it does not keep a stock. When the project funded by the Austrian Cooperation got started and specially requested rope pumps, Taller Las Planetas thus began their production.

The only model the workshop produces was chosen and designed with the advice of a development programme worker (mechanical engineer). He also trained personnel of the workshop to manufacture rope pumps. They have the necessary equipment to manufacture the pump's pulley in a consistent and systematic way. The guide made of timber covered with plastic from old containers is produced by craftsmen, particularly carpenters who are subcontracted for this job. The pistons are bought from a company that specializes in their production. According to information from the workshop, they charge only C$ 100 (US$ 13,50) for the manufacturing of each pump (pulley and support structure), but the client has to supply the required materials.
The workshop has produced more than 400 pumps (200 for a small project financed by KAP of the Netherlands Embassy, 150 for a project financed by Austria, and some for private individuals).

Bombas de Mecate S.A., Los Cedros

General

Bombas de Mecate S.A. is an assembly plant, and a company for promotion, sale and rope pump installation. At present, the company produces some of the pump's parts; until recently all parts were obtained from companies specialized in that line of production. These companies continue to produce these parts.

Organization

The organization of this company is relatively voluminous. The company has four sections, each of them coordinated by a director.
The *Director General* (DG), the promoter, is in charge of (i) sales promotion throughout the country, and of (ii) the installation of rope pumps for clients. The Director General has the support of three promoters busy who have two vans at their disposal for their work.
The DG's work is organized by two teams in charge of sales, installation of ordered rope pumps, after-sales visits, identification of potential distributors, and supervision of present distributors (individuals, hardware stores, and commercial establishments) who offer complete rope pumps or parts of them.

The *Administrative Director*, a bookkeeper divides his time between the company and a non-profit foundation that is housed in the same office. He has two female assistants who receive clients, do secretarial work, and keep record of purchases and sales, inventories, payrolls, travel allowances, and so on.

The *Technical Director*, a Dutch consultant (physics engineer), is the leading spirit of the company as he gives his support to all areas. He does not have any support staff. He divides his time between the company and the non-profit foundation. He is in charge of promoting the rope pump with ESAs, government agencies, and national NGOs. He also keeps correspondence with a great number of organizations of different nature around the world. He wrote also articles in specialized journals including "Waterlines".

The *Production Director* who is empiric, is supported by several staff. He is in charge of the production of PE-pistons of five different sizes and ceramic guiding blocks. These parts are assembled to one unit of rope pump with the PVC parts, a concrete cylinder, knotted ropes and pistons.

The production efficiency of each part could not specifically and adequately be assessed. Although the activities of the company, as a whole, are profitable according to the accountant's registers, the accounts do not include investments in equipment and their replacement.

The main factor for the success of the company's sales is according to its directors, the constant promotion of the product. It is important to note that an important part of the sales is contracted at the premises of the Taller López-Erlach, strategically situated along a main road in Managua, where also one of the distributors of the company is located. This emphasizes the importance of both the location of the Taller López-Erlach, the display of different machines and models at the same premises (for demonstration), and synthesizes the efforts of the technology's development. Furthermore, the demonstration models presents a wide range of products and potential clients can assess their ease of use.

Technical aspects

This is primarily an assembly workshop for rope pumps, and a manufacturing workshop for some parts like the ceramic guide, and the pistons for the rope.

The main equipment and tools the workshop has, are:

- one 225 amp/110V welder
- two pressers for pipes
- one pipe roller
- one guillotine
- one hand drill
- one emery
- one small plastic injector for 5 moulds
- one electric oven to bake the guides
- small tools (such as saws, hammers, etc.)

Its potential productivity is limited due to the lack of adequate equipment and lack of proper organization of the production. For example, its own pistons production, which is done with outdated equipment, reduces the quality of the total product, while they have the option of buying the pistons from a workshop specialized in plastic injection.

The same problem arises with their own production of ceramic guides which is done in a craft furnace, while there are a number of experienced ceramic workshops in the country that could be contracted for the fabrication of the guides. The pulley and its support frame are made by Taller López-Erlach, contracted for this purpose.

This is the only workshop in the country that runs solely on the production of rope pumps. The potential and strength of Bombas de Mecate S.A. lies in its promotion, distribution, and installation of the pumps in most parts of the country, except in the Chontales region.

Conclusions on the workshops

In general, most workshops manufacture the rope pump or its parts as an added-on activity; as the only product, the rope pump is not lucrative for the company as the only product of manufacturing.
In this context, Bombas de Mecate S.A. is an exception. Bombas de Mecate S.A. buys parts manufactured by other workshops and assembles them, and then the pump is brought on the market. They have a good promotion programme as well as a good distribution and installation service. They are more of a commercial company than a manufacturing workshop.
The main source of technical developments of this technology has been the capacity of innovation in small workshops. Among them Taller Castilla stands out.
The team concludes that it is necessary to establish quality norms and designs, adequate to the technical capacities of the workshops to increase the useful life span of the products.
The organization of the production in Taller López-Erlach is the most recommendable for the introduction and implementation in other countries.

The Nicaraguan experience shows that separating production activities from sales activities gives more stability to each of the companies involved.

4.2.2. Government institutions and organizations of external support

Instituto Nacional de Acueductos y Alcantarillados - INAA

INAA (National Water Supply and Sewerage Institute) is the principal institution for household water supply at national level. Therefore, its decision has resolute has a direct bearing on the technology options for water supply and sewerage.
Traditionally, INAA functioned as a public utilities company with its areas of attention limited to the periphery cities. The first institutional change, which eased the development of the rope pump, was the creation of the DAR (Directorate for Rural Water Supply).
DAR's original intention was to construct water supply systems for rural villages but the dispersion of the country's population, and the frequency of programmes and international trends in water supply development have contributed to the present orientation. This is to provide access to potable water to 73% of the rural population that do not have this service at present.
In this context the Fifth (V) Region, and specifically the PASOC Programme, presented a very interesting methodology for tending to the people's problems, especially in the municipality of New Guinea where the programme is developing with success.

It is not a coincidence that the municipality has adopted the rope pump as the first choice for pumping water in communal wells.

The Municipalities

The municipalities will become important actors in the immediate future for the increase in coverage of rural potable water supply both in number and in quality (system reliability and service level).
PASOC, in New Guinea, and other programmes of the Fifth Region are developing a good approach for implementing the present tendency of decentralizing the state's water supply services in the regional governments. The Evaluation Team did not have the opportunity to analyze these regional institutions, nor to study these activities regarding decentralization in depth. It seems to be an alternative with great potential for both the production of the rope pump and for its mass-introduction to these groups in the society which can not afford to buy a rope pump.

National Water Commission

The National Water Commission is an organization for the coordination of water supply programmes and exchange of programme experiences between different organizations that have significant role in planning and implementation of water supply projects.
This commission makes it possible that the national and regional government, as well as the ESAs (NGO's, governments or multilateral organizations) harmonize strategies, and reflect on the implemented and/or available options, to confront these agencies with the challenge of supplying drinking water of good quality and adequate quantity to the country's rural communities. In this commission, several organizations are represented that have programmes in Nicaragua, Central America and other parts of the world.

It therefore creates an interesting forum for the promotion and institutionalization of the rope pump technology in other countries.
Most of the organizations that participate in this technology endeavour already include the rope pump in their programmes in Nicaragua. On the other hand, some have still some doubts regarding the "trustworthiness" of this technology. Therefore, they demand the establishment of production "standards", and the normalization of the technology's application that can help overcome this lack of confidence.

ESAs

The ESAs that participate in the National Water Commission Water have expressed that they are interested in supporting the funding, transfer, and implementation of the rope pump. However, they find it necessary to further define quality of product and standardize technology and its parts.
In fact, the ESAs have supported firmly the activities related to training and community organization that raise the index of the social and organizational sustainability of the technology. However, the technology selection procedure still lack definite clear parameters to choose the best product. This makes them cautious about this "new" technology.

General conclusions

The general conclusion on the role of the institutions for the success of the communal rope pump technology in Nicaragua, is that it has been of great importance that INAA, the principal institution for water supply in the country, has chosen the rope pump as first technology option for water pumping in communal wells in rural areas. INAA's confidence in this technology has encouraged other organizations, including national organizations, local NGOs, and ESAs multilateral, to apply it more in their water programmes.
Another reason for success is the interest of the private market, i.e. family well owners. Some 70% of the rope pumps are of the family type used for family wells. The private users accepted the rope pump as a reliable and appropriate technology which also influenced the national organizations to study the appropriateness for application of the rope pump as communal pump.

In general, the local sustainability of the pump, unlike other technologies, is based on the fact that the maintenance and repair work can be done by the users. To be able to do the required maintenance, only a minimum investment in training (one day only) are needed. No special tools are required; a rope and a knife are sufficient. Therefore, the communities or families can assume full responsibility of the maintenance of the water supply systems.

The future development of this technology will be more socially acceptable and sustainable if it is designed according the capacities and expectations of the users, and not according to institutional expectations. Therefore, the workshops should determine the capacities and expectations of their clients, i.e. the users. The ESAs can play an important role in the future development of the technology in the region, and in the world, just as the institutional promotion by INAA has determined the adoption of the rope pump as an appropriate communal pump and the further technological development of the rope pump.

2.3 Technical aspects of the design and manufacturing of the rope pump

In the workshops visited the following technical aspects are further investigated:

- organization of the production and supply of material
- quality of the work
- design of the pump
- quality of the installation

Sketch of industrial family rope pump

Organization of the production and the supply of materials

Quality of the materials
Cheap construction materials of poor quality (cheap) are often selected due to lack of experience, or to a lack of information on the quality of the materials on the local market. For instance, this has been observed in the case of pistons and ropes.

It is not advisable that the workshops produce parts that require high quality, as the pistons and the ceramic guides, when there are workshops that specialize in the branch. A problem may be the price of the products from these specialized workshops. Price-quality ratio and also general quality control of parts is needed.

Pistons
The quality of the pistons observed shows great variety. The majority was worn out due to poor production. The best ones, the Evaluation Team saw, are those produced by HULETECNIC; these are made of poly-ethylene.

Rope
There are many rope qualities. A good rope needs to have a low elasticity and be resistant and have a diameter wide enough to make good contact with the pulley. The ultraviolet rays of the sun can do a lot of damage to a rope. In most cases, the pistons are fixed to the rope with knots. Also, good experiences in fixing pistons exist with short pieces of thinner rope that are intertwined with the thicker rope.

Rising pipes
The pipes through which the rope pass, are always made of PVC, in sizes of 0.5", 3/4", 1", 1.5" and 2". The inner diameter of a pipe of nominal size can vary a lot according to the quality of the product, and the manufacturing company. When heated by the sun they can

change in size. Presently, Bombas de Mecate S.A. places a lot of emphasis on the quality and sizes of the PVC pipes of Costa-Rican make. Higher pipe prices are justified only when also the pistons are of good quality, and when they are changed before they are too worn out.

Guides
We have seen different types of guides that are used in workshops:
- wooden guides (pochote)
- combined guides of wood and plastic
- porcelain guides (electric insulators)
- glazed ceramic guides embedded in concrete
- guides with a glass bottle embedded in concrete

All these guides function, but there are no studies or information available on their performance and/or influence on the wear of the rope.

Quality of the work product

The enemy number one of the pump's metal support structure is corrosion caused by the contact with water, which seriously reduces its useful life. Due to a lack of experience, the slug in the welded parts is often not cleaned with chisel and wire brush. This is a definite source of accelerated rust.

Improvement in anti-corrosion protection is found in workshops that use an adequate system for painting: good cleaning of the welding, double paint of the welding, and a final coating with oil paint.

The quality of support structure assembly depends on the use of moulds and fixing devices for cutting and welding.

The design of the pump

The support structure
The support structure of the rope pump from workshops is made of metal. This support structure holds de axle, and secures the position of the pump on the well. In the case of self-manufacturing, strong support structures can be made of timber. The best metal support structures are made of plain steel or galvanized iron, with few, but not so thin pieces, and few weldings.

The use of corrugated reinforcement iron bars, which is the most economical solution, causes many problems to the pump support structure. The origin of the steel nor its properties are often unknown. Sometimes it is of Korean origin and the standards are old. For example: UST 34 or UST 37-1 with a tensile strength of 370 N/mm^2 (according to an old DIN 17100), and with a high percentage of carbon that causes accelerated corrosion and reduces its tensile strength.

Some workshops use plain bars (UST 37 according to old standards still used in Korean material; 370 N/mm^2 tensile strength, produced by extraction) that are slightly higher in price than the corrugated bars, but they have many advantages. Smooth bars react less aggressively to corrosive rust from the welding process, and loses less tensile strength. This effect could be observed in older pumps in the Juigalpa zone that were manufactured by Taller Castilla. This is probably one of the best that have been developed in the country.

The brake

To avoid that the rope returns through the pump's pipe, some workshops fit them with metal brakes that propel the cogs on the axle or pulley. There are many models of brakes, but none are really good. Frequently, the brakes are too tied or torn, and the female users complain of the noise they make: "That rattle ... the noise gives me a headache". In some pumps the pulley is immobilized by tying the grip with a rope.

Bearings

The bearings come in different types and qualities. One type of bearings consists of two half metal cylinders in order to be able to replace them. Especially this type has caused many problems because they got loose, then lost, and then the axle was damaged by wear. Even though these problems are well known, one workshop is still selling them to owners of private pumps that are equipped with these bearings. To projects, they sell another type of pump. The bearings made of steel pipes or galvanized iron are better. Lately, a system of traditional wooden bearings soaked in oil with a metal axle, is being used and proved to be strong. A good combination seems to be an axle of a 3/4" galvanized pipe and wooden bearings of "guayabón", an indigenous timber.

Welding

Unnecessary over-designing has been found, as well as excessive welding to save material. Metal pulleys have been found where weaker parts of the support structure are reinforced with inadequate materials. Only some workshops use adequate material such as plain bars.

Wheel

The wheel or pulley made of sidewalls of used car tires, works well for turning the rope and the pistons. There are many models and in general, the models with less welded parts are stronger. The wheel models that are self-manufactured have a wooden support structure. This works well and has no corrosion problems and can be repaired without welding. In the countryside, problems were found frequently with the workshop wheels that left a gap between the two rubber parts where the rope has to pass. Often this is simply solved by mounting a strip of inner tube in between.

Some users fixed the two rubber rings with nails passing through the part that have no metal wiring. This seems to be a good solution especially when galvanized nails are used.

Axle/crank

There are axles made of 1/2" and 3/4" plain and galvanized iron pipes, solid steel bars, and some are made of wood. The handle and axle sometimes are welded but mostly bent out of one piece of pipe. Since the bending of 90 degrees sometimes caused cracks, most designs have now angles up to 120 degrees. There are also handles made of threaded pipes connected with elbows. Especially, the axles and handles made of 1/2" pipe have a short life. In the 'self-made' rope pump, the axle and handle are also made of wood. These joints are less strong but one has tried several types of connections to improve the quality.

Handle

To turn the axle around, a bigger pipe (grip) is mounted on the handle. The users do no lubricate the grip/handle because the grease and oil dirties the hands. In practice, many grips are fixed since they have rusted to the handles. This doesn't seem to be a great problem although some users did mention it. In Nueva Guinea the Evaluation Team also saw PVC pipe grips on a metal handle. The PVC pipe has been cut longitudinally to be placed around the handle.

Quality of the installation

Industrialized rope pump installed

(iii) Many times it was observed in the field that the rope rubs against the pipe's outlet and inlet.
With family pumps the support structure is in most cases nailed onto wooden beams on an open well.
On most communal wells, the pumps are fixed with nuts and bolts that are embedded in the concrete cover. There are often problems because the pipe outlet is not centred with the wheel and the guide and rope not centred in the pipe which causes that the rope rubs against the tube outlet and/or inlet.

Exposure of the pump and the users to the sun is prevented by making a roof over the well site. This extends the lifetime of the rope as the rope is very sensitive to the sun's ultraviolet rays.

When the wells are sealed with covers (lids), well-head (head wall) and aprons with drainage channels, the quality of the water was found to be generally better. The well protection done in the PASOC Programme was found to be the best.

2.4 Technical aspects of functioning and performance

Quantity of water production and pump efficiency

Quantities of water produced by rope pumps used at family level was found to be up to 6 m^3/day at a pumping head of 7 metres. It was found that several pumps at communal level had a daily production of more than 2 cubic metres.
Some pumps were used by more than 12 families. One pump is used by eight families and a school of 75 pupils.
Among the rope pumps studied, the pumping level varied from one to approximately 60 metres.

The water production of the pumps varies among other factors by the static pumping head. Field measurements gave volumes of 0.9 l/s with at a static pumping head of 10 metres, to 0.15 l/s at a static pumping head of almost 60 metres (the latter pump with two handles). The power of the needed for the rope pump for the specific conditions ranged between 24 and 86 watt depending on the person[4]. The power required for long-term use with pumps of regular quality was around the 45 watt. In general, people are happy with the quantity of water obtained.

Efficiency

Volumetric efficiency
Within the frame of evaluation estimates were made of the volumetric efficiency of 17 pumps in the countryside. The volumetric efficiency is the relation between the water that is actually produced and the water that theoretically should be produced (see appendix 9).

For the calculation a velocity of pumping of 50 pulley revolutions per minute was assumed. By varying the number of pulley revolutions per minute users can influence in great measure the volumetric efficiency of their pump: the quicker the pulley turns (more revolutions per minute), the higher the efficiency is.

The volumetric efficiency, measured in the field by the Evaluation Team, ranged between 37 and 82 per cent with an average of 71%. A low volumetric efficiency is generally caused by wear of the pistons.

Energetic efficiency

[4]. The power required to pump water is defined as: $P_w = 9.81 \times H \times Q$ with P_w in Watt, H (total pumping head) in metres, and Q (volume of water pumped) in litres per second

The energetic efficiency of the pumps was not measured. Great differences of friction were noticed depending on the quality of the pulley, the lubrication of the axle, the tension of the rope, the relation between the pistons and the pipe, the quality of the guide, etc.

It seems that for the users the efficiency of a pump is not so important, at least, they do not take the necessary measures to improve it, like replacing worn pistons. More important are the source, a reliable service, the initial costs, and the operation and maintenance costs.

Hygiene

A common remark made by those using the rope pump for the first time, is that it is not hermetic. In other words, the possibilities that the water in the well/borehole becomes polluted or contaminated by agents entering the well/borehole via the rope and the pistons, exposed to the open.

Information from surveys shows that the risks can be reduced with success. The UNOM-INAA programme in Nueva Guinea, monitors 39 communal rope pumps every three months. The pumps are covered with boxes that prevent contact with the rope. The water of these wells is of good bacteriological quality, frequently with zero faecal coliform per 100 me well water. The programme provides adequate follow-up support to users groups. If the well water appears to be contaminated, the well will be disinfected with chlorine.

Gorter et al. (1995) report that the installation of a rope pump on open wells reduced the geometric average of the faecal coliform density in the well water with 62%.

Nevertheless, the evaluation came across two stories of serious pollution of the well water by a dead small animal. The image of the rope pump being an unhygienic pump, is not good for its promotion, and particularly ESAs and government institutions may refer to this point. The experience indicates that the water quality is substantially improved with the use of a rope pump. A well installed rope pump may lead to a bacteriological quality of zero faecal coliform per 100 me.

Pump models

There are several 'industrial' rope pump models, addressing the different requirements, utilization and groundwater level. The great majority of the rope pumps are driven by manual labour, with a water outlet 70 cm above ground level.
There are (i) models with two handles for deep wells, (ii) regular models for family use, and (iii) stronger models for communal use.

Some workshops make special models with water outlet several metres above ground level to allow for water storage, and models operated by a small gasoline motor or by wind mills. There are also some developments on rope pumps activated by animal traction, pedals (bicycle) and by electro-motor. There are also experiments started on rope pump installation on a 2" borehole.

There are relations between the pumping head, the optimal diameter of the pulley, the optimal diameter of the pumping pipe, and the mode of operation. Theoretical research work on rope pumps established these optimal diameters (Van Hemert et al., 1991). In general, for pumps operated by one person, the diameter of the pulley is about 53 cm (20" tyre) for depths up to 40 m, and 13 to 14" for depths more than 40 m.

Not all pump manufacturers adhere to this relation. The Evaluation Team found that in some cases the rope pump designs did not follow these relations, resulting in pumps hardly being used.

Installation

The required installation time for a rope pump is about half a day for a team of two or more persons. This time does not include the construction of the well-head, well-cover and apron. The Evaluation Team observed different ways of installation the rope pump: sometimes rope and pistons were very tight but mostly well centred, while in other occasions those were loosely connected or badly centred. In many cases the crank was too highly positioned above the ground level for easy use.

Although installation of a rope pump is not difficult, it requires more and due attention, both of the institutions and individuals that do the installations.

Users training

In general, upon the installation, the supporting institutions give a short training on the use, maintenance and repair of the pump. Bombas de Mecate S.A. also gives courses to future pump users when they visit the company at the moment of buying it. The users also receive a users manual.

In general, users of pumps installed by third parties learn how to repair the underground system when they need to repair this part of the pump.

Local suppliers, technicians and mechanics

Bombas de Mecate S.A. has a network of ten suppliers of rope pumps for the private sector, projects and institutions such as INAA and Palo de Hule in Nueva Guinea. Throughout the country there are workshops that know how to produce the pumps and know how to repair the metal support structure. However, there is a great variation in the quality of their work. In general, it is difficult for an individual user family to assess the quality of the pumps, and the services and materials that are being offered. Therefore, it is advisable that the pumps, the spare parts, and the workshops have a kind of quality indication or quality "seal".

Operation and maintenance

The operation of the pump is easy: one just has to turn the crank in the direction that makes the pistons go up on the side of the pump's outlet. Depending on the groundwater level, the water starts to come out after several revolutions. When pumping is finished one must prevent the rope from returning through the rising pipe by holding the pulley an instant or with the brake.

The maintenance of the rope pump is simple but it must be done frequently. Every week the axle must be secured and the crank must be oiled.

The rope should last for at least two years, so replacement after two years is advisable. The Evaluation Team found that the frequency of changing the rope varied from once per two months to once per more than six years. The short lifetime of several months is probably due to poorly constructed parts that cause accelerated wear of the rope.

In areas with a humid climate or corrosive groundwater, it is advisable to paint the metal parts at least once a year.

The Evaluation Team found that the maintenance is usually limited to oiling and repairing the rope. It is recommended to promote cleanliness and to have more frequent painting. For private family pumps, and for communal pump that receive strong institutional follow-up support, it was found that the level of maintenance was better than in communal pumps with no institutional follow-up support. When there is less follow-up support, users tend to do more repairs themselves.

Generally, the time required to change the rope and pistons is less than an hour. If the old pistons are to be used again, it will take a little bit longer. Repairs to the metal parts are done in one day if there is a blacksmith within a distance of a couple of hours. This type of repairs still present problems in isolated areas.

Spare parts

The spare parts for the maintenance of a rope pump are few: rope, pistons, and sometimes guides or simple parts, like strips of tires, are needed. Cranks made of PVC pipe have also frequently to be replaced.

Rope

The rope must be made of plastic or nylon, and be resistant and have enough width. It is recommended to choose good quality, especially when the use of the pump is intensive or when the rope is exposed to the sun.

Pistons

Most of the pistons of bade quality wear very rapidly, and sometimes their dimensions is not uniform. The Evaluation Team observed in some recently installed pumps, differences of more than 0.8 mm between the inside diameter of the pipe and the exterior of the pistons. In another pumps some pistons had broken off, while in others the diameter of the pistons showed differences of more than 1 mm. All these pumps were still being used.

Guides

The first guides were made of timber or with moveable parts that needed to be changed frequently; these are not used any more. An improvement of the first guides was the plastic strip on the timber; it is unclear how long it will last. The first type of ceramic guides and the hollow ceramic type made by the SNV project broke easily when they hit a hard surface, for instance during repairs. The present type of ceramic guides embedded in concrete are more resistant against breakage.

Lifetime
The lifetime of the pump varies from three years for a communal rope pump of moderate quality and fairly maintained, to more than 12 years for a family rope which is well maintained. If the communal pump is made of more durable materials and well-manufactured, the lifetime could easily be eight years. It is then usually the metal support structure of the pump that fails but many other parts of the pump can still be used.

Spare parts supply
A common problem appears to be the lack of spare parts. In some zones in Nicaragua, there are few suppliers of spare parts. This can create serious problems, as in Bluefields where many guides broke and the pistons wore out. However, a big advantage of the rope pump is that, in case of emergency, worn-out pistons can be replaced by pistons made of rubber tires. And, if rope of good quality is not available, there will always be another sort of rope that will serve the purpose. The pipes can be bought everywhere, and the present guides are more resistant than the earlier models. The guides can also be self-made, as well as the pulleys and the support structure. It is important that the users are aware of the possibilities to substitute the commercial spare parts by alternative solutions as above indicated.

Market segment
According to the data provided by all those involved, the rope pump takes the first place among all manual and "hand" pumps in Nicaragua. Estimates indicate that at least 5,000 rope pumps have been installed against only hundreds of other types of handpumps. These estimates are confirmed by the Team's observations; only few pumps of other types were seen, and in many places people did not know about any other handpump than the rope pump.

Rope pumps with windmills
In Nicaragua, approximately 50 pumps driven by windmills have been installed. All except a few were built by Aerobombas, a department of Taller Lopes-Erlach in Managua. With assistance of a Dutch technician, the development of this windmill started in 1991 using experience s of a former windmill project. The windmill has components of a modern Dutch (CWD) design. It pumps the same amount of water as the traditional windpump, but is much cheaper and easier to maintain.
According to information from Taller López-Erlach and a user of a rope-windmill system, the system functions well. The rope needs to be changed every three to ten months. This seems frequent but it appears that due to continuous use of the pump it has pumped the same volume of water as other ropes during their lifetime.
An interesting detail is that water can be pumped by hand in case there is not enough wind. The experience with the combination of rope pump and windmill is fairly recent, and small-scale production started only two years ago. It seems to be a promising technology, especially due to the economic design of the windmill, and the high compatibility of characteristics between pump and windmill.

Rope pumps with gasoline and electro motor

The experience of rope pumps driven by gasoline motor is also recent. This option is a cheap alternative for more expensive pumps. It is possible to place the motor next to the well. Motorized pumping of water from wells deeper than 7 metres can only be done by motor using a submersible pump. Sometimes a gasoline motor-driven pump is lowered in a well of 8 to 12 metres. However, this option creates a danger of water contamination and there are usually problems due to insufficient air ventilation. The rope pump driven by a gasoline or electro motor seems to be a good alternative in such situations.

A good example is an electro-motor-driven rope pump installed at a cooperative, that run for five months producing more than 17 cubic metres a day at a pumping head of 11 metres. The users were satisfied with its performance.

Technical sustainability

Looking at the different elements and taking into account the present use of rope pumps in Nicaragua, it can be concluded that the sustainability in the aspects of operation and maintenance is good, but the sustainability is less in the aspect of durability.

The durable lifetime of communal pumps, estimated at three to four years, is a bit short. However, it could be easily extended by improving the structural design and the quality of manufacturing. In general, family pumps, have a longer life.

As the pump is easy to operate and produces a good volume of water, users are satisfied with its performance. The simple design of the pump allows the users to take care of maintenance and repairs themselves.

A clear indication of the general sustainability of the rope pump is that after more than twelve years since its introduction, the users are still very enthusiastic and a growing number of private persons buys it.

The following table gives a comparison between different handpumps used in Nicaragua. The table is based on information from INAA, COSUDE, Bombas de Mecate S.A., and information from literature (Banziger, 1982; Moy, 1984; Reynolds, 1992).

There are some important technical differences between the rope pump and "piston" pumps resulting in differences in O&M:

- as the rope pump has a rotating movement, the dynamic forces are less wearing than in 'piston" pumps;
- absence of foot valve, piston, piston valve and pump rods, which makes maintenance simpler;
- as there is hardly water pressure in the rope pump tube, this can be material (PVC);
- materials below ground are so light that dismantling of the rope pump is easy;
- installation of the rope pump in non-straight boreholes is possible as the pump tube is flexible.

The comparison below is indicative of the five main handpump types used in Nicaragua.

	Mecate	Maya	Afridev	MarkII	Dempster
Number of pumps installed[a]	5000	8	50	30	56
Price of pump in US$[a I]	70	100	375	475	700
Max. pumping head (m)[a]	50	15	50	>60	35
Expected lifetime (years)[a]	>4	?	?	?	>8
Local manufacturing	yes	no	no	no	no
Installation level	++	?	-	--	--
Operation level	++	++	+	+	±
Maintenance level	++	+	+	--	-- Corrosion
potential	++	?	±	--	--
Repair level	-	+	+	±	±
Spare parts availability	±	--	--	--	--
Lifetime of spare parts[a]	-	++	+	++	-
Price level of spare parts	++	?	?	?	--
Frequency of breakdowns	2)	1)	1)	1)	1)
Level of hygiene	±	++	++	++	++
Standardization	--	?	++	++	++
Quality stability	--	?	-	++	++
Retains H_20 after pumping	no	yes	yes	yes	yes
Local acceptability[a]	++	++	++	++	++

++ = good; + = sufficient; ± = fair; - = insufficient; -- = poor; ? = unknown
1) = damaged seals; 2) = worn-out rope

Sources of data:[a] INAA;
Additional Information: [I] Price of AFRIDEV and India Mark II is excluding cost of pipes

Conclusions on technical aspects of use

- The technology of the rope pump is reliable. All models of the rope pump that were observed in the field by the Evaluation Team were functioning although some pumps were old and very worn-out.

- The volumetric efficiency of the pumps examined varied approximately between 40 to 80 % with an average of 70%

- The power required to lift with a rope pump a certain volume of water from a certain depth is around 45 watt per person, for prolonged use of regular pumps.

- The quality of pistons have an effect on the lifetime of the pump, and to a smaller extent the efficiency of the pump.

- For family use, the rope pump is a good alternative for other types of handpumps. It functions well down to 50 metres, it is easy to maintain, and it is cheap, but the workshop or 'industrial' type is not accessible to the poorer section of the population in Nicaragua without some kind of subsidy because of its initial investment.

- For communal use, the rope pump can function well but it is sensitive to incorrect use. Stronger models and good institutional maintenance support would improve the situation.

- The lifetime of the pumps depends more on operational care and maintenance than on the quantity of water pumped. The average lifetime of a communal rope pump is now some three years, but this could be improved. Family wells have a lifetime up to 12 years and more, but a typical lifetime is eight years.

- The pump needs frequent but relatively simple maintenance. Among the users of the great majority of the pumps visited, there were always several persons, men and women, that could maintain and repair them.

- The down-the-well/borehole parts of the rope pump are made of non-corrosive materials. Thus the taste of the water is not altered.

- Also the sensitivity for abrasion by groundwater containing mud with very fine sand seems to be low. Further investigation is needed.

- Even though the pump is not completely hermetic, the quality of the pumped water is significantly of higher quality than from open wells.

- The long-term sustainability of the family-used rope pump is good. This applies both to many self-made models as to workshop models. The sustainability of communal-used rope pumps is reasonable by improvement of design and manufacturing process.

- The combination of a windmill and a rope pump seems to be successful. Within the framework of this evaluation, it was not possible to visit enough windmills to analyze this option sufficiently to draw strong conclusions.

2.5 Economic and financial aspects

Prices

Prices of rope pumps vary according to the models and the workshops. Prices vary from 350 C$ at Taller Castilla to 500 C$ at Taller Gil, and 575 C$ at Bombas de Mecate S.A.
The average price of a family rope pump is 500 Cordobas or US$ 69.[5] The difference in price is due to the usage of different types of materials and designs.
The following table gives a comparison of costs (in US$) of various rope pumps versus various handpumps. The indicated costs do not include installation costs.

Rope pump (Bombas de Mecate S.A. prices)	Maya pump	India Mark II	Afridev	Dempster
Family type US$ 80 Extra strong US$ 96 Super strong US$125	US$ 100	US$ 475 without pipes	US$ 375 with pipes	US$ 700

The above table shows that the price of the rope pump (normal family model and the extra strong type) is remarkably lower than the price of other types of handpumps.

As an indication, the cost of windmills/rope pump systems manufactured in Taller López-Erlach (appendix 10) including the rope pump, foundation, tower with wind propeller, etc are:

Model H8 US$ 370
Model H10 US$ 470 (with 7 m tower)
Model H10 US$ 600 (with 10 m tower)

Don Pompillo and Taller López-Erlach have made several intents to produce a cheaper rope pump, using basic materials for the manufacture of a self-made model. Without taking the labour into account, the price of self-made rope pump could vary between US$ 12 and 30 depending on depth of the well and materials used. The quality and lifetime of these pumps does not reach the standard of the others yet, except with rare exceptions, and more investigation is needed on its technical sustainability.

The composition of costs

The rope pump is manufactured with materials and locally available know-how. The cost composition does not vary significantly by workshop if only materials are considered. However, some manufacturers, especially Bombas de Mecate S.A., include in their prices the important component of promotion activities.

5 Rate of exchange March 1995: 1US$ = 7.25 Córdobas

In general, profit seems to be less important for the manufacturers and remains therefore low! That is why the income from the sale of rope pumps is not a primary incentive to workshops and industry, except when substantial bigger sales are foreseen.

The following table and graph give a breakdown of the cost of a family rope pump.

The composition of the material cost for a rope pump (depth 10m) in US$ in March 1995 (Bombas de Mecate S.A.)

The total cost of the material is US$ 44.23. This excludes the labour costs which is estimated at 4 hours of a semi-skilled person, and does not include installation costs, nor costs of well protection, masonry etc.

Furthermore, this US$ 44.23 price can be reduced, by using cheaper alternative materials for the wheel and the guide.
An experimental prototype made by Taller López-Erlach managed to reduce the material costs to US$ 20, using timber for the wheel instead of iron. However, besides the fact that the quality is not satisfactory yet, this "self-made" version requires some assistance of a craftsman. This undermines the concept of the "self-made" model.

It is very clear that the rope pump could be manufactured anywhere in the world, since materials and basic equipment are generally available, even in rural areas. However, the quality of the pump will always depend on the quality of the craftsmanship, although this does not require highly qualified personnel.

One of the main advantages of this technologies that it does not depend on imported goods; this greatly contributes to the high degree of availability of spare parts.

Indeed, the rope pump is a low cost technology that can be manufactured using resources and skills available in nearly any developing country.

Operation and maintenance costs

The lifetime of the rope pump varies from 5 to 12 years (and more) depending on the quality of the preventive maintenance, and the frequency of its use, and the corrosiveness of the water. It has been observed in some villages that rising pipes can last very long. However, most of the pumps visited have shown some signs of wear already after three to four years of use, particularly on the support structure and wheel.

Preventive maintenance will help to ensure the lifetime of the rope pump. It consists mainly of:
- regular oiling of the bearings
- using the break after each use
- removing rust and painting the support structure and the wheel regularly

Besides the preventive maintenance, other maintenance activities, are required which are given with frequency and cost indication (estimated by the Evaluation Team) in the following table.

Maintenance Activity	Frequency of maintenance	Estimated cost of maintenance
Preventive basic maintenance including lubrication	continuous	US$ 0.5/year
changing the rope	every two years	US$ 4
changing pistons	every two years	US$ 2
paint	quarter gallon every two years	US$ 3.5
changing the guide	after 6 years or longer	US$ 4.2
changing the wheel	after 5 years	US$ 20
changing PVC parts	after 6 years or longer	US$ 13.2

From the graphic below and based on the estimates of the above given lifetime of spare parts, it is concluded that maintenance costs (excluding labour) are rather low during the first four years, although every 6 months they can reach up to US$ 2-4. This depends very much on the intensity of using the rope pump. As an indication the annual cost for O&M may be some 25% and 15% for respectively a workshop-made family rope pump and a 'self-made' family rope pump. Individuals, families and communities do have to make a financial provision to cover these costs.

In the fifth and sixth year the major parts may have to be changed, that is the wheel, the guide, and the pump pipes. Such an overhaul may cost for parts some US$35-40. All these maintenance activities do not require specialized input and can be done by the communities, provided they are aware of the importance of maintenance for the lifetime of the pump and motivated to do the maintenance.

WASH (1992) states that the average annual maintenance costs of handpumps (for a community of 400 inhabitants) can be up to US$ 25. The annual maintenance costs of the rope pump are much less compared to this amount.
In case the rope pump system should have to be replaced completely after a period of 6 to 10 years, the investment on a new pump, US$ 80, would be significant.

The issue for communal rope pumps of who will pay for the major repairs and replacements after some six years, is still to be addressed.

Besides, in general it is accepted that the costs of water supply represent may account for 3 to 5% of the family budget. For low-income rural groups with a monthly income of around 200 Cordobas, this means 6 to 10 Cordobas or 36-60 Cordobas per half year (US$ 5-8/half year). Furthermore, the capacity-to-pay does not necessarily imply the willingness-to-pay. It is, therefore, essential to organize a information campaign on the benefits of the new systems of water supply.

The amount proposed by INAA to the communities that own a communal pump is 2 Cordobas per month, that corresponds to the capacity to pay of the households. However, this amount can be adapted according to the size of the communities

The maintenance of the rope pump is low during the first years but can be relatively high after 3 or 5 years, and the communities and the private users should be aware of this fact.

Financial sustainability from the users point of view

Affordability or capacity-to-pay
The rural population of Nicaragua is estimated at 2 million or about 50% of the total population of 4.4 million inhabitants (1994).
In 1994, Nicaragua's GNP was US$ 421.5 (Banco Central de Nicaragua).

> *As a reference: a teacher earns a monthly salary of 359 Cordobas (US$ 50), and the minimum salary in rural areas is 7.5 Cordobas a day (US$ 1).*
> *Prices of basic goods such as milk (3.75 Cordobas a litre), sugar (2 Cordobas), and gasoline (18 Cordobas per gallon) are relatively high.*

Incomes vary considerably according to activities and social position. Farmers and cattle-holders buy the pump at their own expense and for private use. However, the income of a great number of people in rural areas is very low and irregular. They rely on the sale of fruits, vegetables, tortillas, eggs and poultry. Family incomes can reach up to an average 150 to 200 Cordobas a month. Despite the low price of the rope pump, for these groups of people, it is impossible to invest 500 Cordobas in an industrial rope pump, even if several users would share the costs.

Initially, maintenance costs are low, and many users have no expenses at all during the first years. But problems arise when parts have to be replaced.

Willingness-to-pay
In general, the rope pump is well accepted. A large number of rope pumps are installed on private wells, and users feel concerned and responsible for their pump. This is the same for communal pumps used by groups of families. Problems arise in communal pumps when social cohesion within the community is poor. Tensions in the community, or poor initial mobilization, can result in poor willingness-to-pay.

Financial management
INAA, PASOC, and COSUDE have initiated a system of communal pumps, where a committee is created and made responsible of all operation and maintenance costs. A pump can serve up to 30 families, and each family is asked to pay 2 Cordobas per month. Such a system requires confidence in the registration of the payments made by users, and of expenses incurred.
However, not all communal pumps are managed in such a way. In many cases, there is virtually no management, and the users will be confronted with the expenses when they arise.

The manufacturers

One of the main advantages of this technology is that it can be produced locally, and spare parts are locally available, although was mentioned before, the pistons are not always easy to find.

Several manufacturers are involved in the manufacturing of rope pumps: Taller López-Erlach and Bombas de Mecate S.A. (Managua), Taller Castilla and Taller Gil (Juigalpa), Taller Don Pompillo (Esteli), Taller Los Planetas (Sebaco).

The production figures of rope pumps in Nicaragua during the last 15 years is given in the table below.
(Data provided by manufacturers and projects)

Projects	Production Period	Number of rope pumps produced
Don Pompillo; Estelí	1980-1995	500
Cooperative San José; Monte Fresco	1987-1989	300
SNV Programme, Juigalpa	1990-1993	500
San Miguelito	1993	20
PASOC; Nueva Guinea	1993-1995	350
Sebaco	1993-1995	350
Campesino a Campesino Project		300
Taller Gil and Taller Castilla (manufactured for non-mentioned projects/private people	1985-1995	800
Bombas de Mecate S.A. (wheels supplied by Taller López-Erlach)	1990-1995	3030
Total	1980-1995	6150

It must be noted that designs have changed during the years.

Organizational sustainability

Bombas de Mecate S.A. is the largest producer of rope pumps in Nicaragua. The company has a share of 57% of the total sales of rope pumps throughout the period. Thanks to a dynamic and effective promotion it sells the pumps mainly to private individuals. It is interesting to note that several manufacturers are involved, although the quality and standard of the pump varies from one pump to anther.

The presence of small manufacturers in remote places of the country assures the wide availability of the pump. The use of local resources and craftsmanship seems to be beneficial for its technical sustainability.

At this moment, of all workshops only Bombas de Mecate S.A. has capacities to produce a substantial number of rope pumps, that is some 100 pumps per month. The company buys the wheels from Taller López-Erlach, the PVC pipes and the rope from distributors in Managua, and its own workshop manufactures the pistons. Then the parts are assembled into one pump. The company can also install it, if requested so.

From an organizational point of view, it is a good decision not to produce all parts but buy those from several suppliers. In this way, Bombas de Mecate S.A. does not have to invest in equipment and skills, for example, for welding. As the quality of the present pistons needs to be improved, Bombas de Mecate S.A. should consider buying these pistons from other specialized manufacturers.

In general, a small workshop of rope pumps needs some basic tools, raw materials, a welder, a guillotine, an oven (for ceramics), moulds for plastics, and a workshop. Depending on its additional, rope pump installation related activities, it will also need a vehicle for installation, equipment for well-digging, concrete casting and well protection. A small workshop visited had a corporate capital of 18,000 Cordobas (US$ 2,500), while Taller López-Erlach's corporate capital is some 75,000 Cordobas (US$ 10,500).

However, the workshops involved in rope pump manufacturing generally have to rely on other activities to sustain their business. For Taller López-Erlach, the pumps represent only 10% of its activities. For Taller Castilla and Taller Gil, pumps represent 10 to 20% of their activities. It seems not feasible and sustainable for a workshop to produce only rope pumps. Bombas de Mecate S.A. is a notorious exception: its business is only manufacturing and selling rope pumps. This can be explained by the following factors:

- Bombas de Mecate S.A. does not only produce the rope pump, but it is also engaged in promotion activities of the pump; this active promotion is not taken up by the other manufacturers.
- Bombas de Mecate S.A. has a rigorous administration and accounting system that permits to analyze the financial situation of the company at any time.
- Bombas de Mecate S.A. personnel is motivated, not only commercially, but they have a corporate and participative spirit of social development.
- Bombas de Mecate S.A. receives partial support from Fundacion Desear, a local development foundation strongly linked to Bombas de Mecate S.A. which is also involved in non-profit commercial activities of the rope pump.

The experience of Bombas de Mecate S.A., and other small workshops is of particular interest. It is important to know how sustainable the production and technology of the pump is when using local means and organizations.

Two fundamental lessons can be learned for other countries that wish to spread this technology using local means only:

- A big company can assemble and distribute pumps on commercial basis, using a net of manufacturers for different parts. Organizational sustainability, however, will depend on dynamic promotion activities, and on a solid financial administration.
- Small companies can be involved in the production of pumps, however, in order to survive, they need to get engaged in other activities. Attention must be paid to the quality of the pumps produced. In remote areas, it is preferable that these workshops respond to the specific requirements and conditions of their clients.

Financial sustainability of Bombas de Mecate S.A.

Bombas de Mecate S.A. started in May 1990 and sold only 32 pumps that year. In 1994, it sold 904 pumps. The costs for the last three months of 1994 are given in the following table.

Costs Bombas de Mecate S.A. during the last three months of 1994

The total costs in the last three months of 1994 were 160,268 Cordobas versus a total income of 177,478 Cordobas. The income is composed of the sale of 176 pumps (168,721 Cordobas), and spare parts and repairs (8,747 Cordobas).

It has been estimated that Bombas de Mecate S.A. could start recovering its fixed costs, if it would sell 50 pumps every three months. The situation is financially sound. Bombas de Mecate S.A. employs a total of 12 persons while Taller López-Erlach employs only seven people, and Taller Gil only two. The only justification for this high number of employees lies in its important promotion activities. However, the productivity of the manufacturing activities could be improved.

It should be noted that promotion costs, as shown in the table above, seem low (2.8%). But per diem costs are included in the "personnel" costs, while transportation costs are included in "vehicle" costs, which should all be added to promotion costs to give a clear picture.

Reviewing the sales and incomes of Bombas de Mecate S.A. throughout the years (1990-1995) shows that in some periods incomes were not sufficient to cover the costs (1993). However, it proved that it can adapt itself to the situation when personnel accepted the fact that salaries should be lowered during financial malaises. This flexibility proves to be a strong element of the financial and organizational sustainability of the company.

Market

The present coverage of adequate rural water supply is only of 27%; excluding the autonomous region at the Atlantic and many zones along the Pacific Ocean. 90% of the rural water supply water utilizes groundwater resources. Moreover, of the approximately 230,000 wells, some 80 to 90% are family wells. The majority of the people uses a bucket with a rope to lift the water, and in a few cases a windlass. This number of wells increases steadily with the fast growing population. Although family wells will continue to take the lion-share of the demand, communal wells are also a feasible alternative solution for the rural water supply needs.

In Nicaragua, the potential market for the rope pump seems to be quite high. The actual demand for the rope pump depends on the sustainability of the technology for the specific conditions including groundwater level; the social acceptance of the rope pump; and the capacity of the population to pay for the investment and O&M of the pump.

Several local organizations and ESAs have indicated that they would chose the rope pump as their first rural water supply technology option if some technical improvements were made to the design and manufacturing of the pump.

The market for wind-powered rope pumps is estimated to be between 1000 and 3000 depending on the economic development in Nicaragua[6]. Wind-powered rope pumps' market is mainly the large farms and agricultural cooperatives, and to a lesser extent also small scale irrigation and communal pumps.

As indicated above, there will be a market for both the family (private) and communal rope pumps. The demand for private wells is made up of farmers and middle-class rural population who prefer to have access to water supply as near as possible to their houses. Their demand may count for 95% of the rope pumps.

The market for communal pumps consists mainly of very poor communities in the countryside, as well as schools and markets.
Most rural people having groundwater supply cannot afford to buy a rope pump. Solutions to improve their water supply could be:

- manufacturing of low-cost pump (problems of quality and of design)
- establishment of rural credit schemes (problems of repayments)
- cost sharing (users, INAA, ESAs)
- donation (government, ESAs)
- communal pumps

Another aspect of the market is the supply of rope pumps. The total supply capacity of all workshops is some 20 pumps a day. If the demand would increase significantly, the present supply capacity need to be increased as well.

There is also a market potential in other countries. This potential could be further assessed through information from projects and in development institutions. Bombas de Mecate S.A. has received many requests from countries all over the world for information on the rope pump; a large part of these came as a response to the publication of articles on the rope pump in technical sector journals and newsletters.

2.6 Social and cultural aspects of the rope pump

[6]. Estimates by DEA 1994

The context

Of all rope pumps manufactured in Nicaragua, 40% have been installed for or through organizations as COSUDE, INAA, UNICEF, CEPAD, CARE, SNV, Medics and Vets without Frontiers, and some development programmes of the Spanish, Austrian and Netherlands Government. These projects are both community- and family-oriented and always have a donation component.

Capacity of payment

Most of the pumps sold until 1995 were bought by the better-of people. Typical rope pump owners are medium or large farmers and cattle-owners (e.g. a rancher with 50 "manzanas" (= 1.75 acres)) and shopkeepers. Also lower class people having access to credits or rotation funds have bought industrial rope pumps. The Team did not come across any poor family that had bought a pump without such a financial arrangement. If low-income families had a private rope pump, it was always of the self-made type.

A typical cost figure many people may find affordable for a rope pump is 300 Cordobas (US$ 41), which is three times the price of a windlass. The workshop manufactured family-type rope pump costs about US$ 80. The self-made types will costs US$ 20-30, excluding the labour costs.

Users and uses

The water from the rope pump is both at community and family level mainly used for household purposes. In many cases, water from communal rope pumps is only allowed to be used for drinking and cooking. The water from both communal and family rope pumps is often used for productive purposes such as watering fruit trees or sugar cane, and watering cattle.
Women and children (from 8 years up) are the ones that use the rope pump most frequently to pump the water for household use. If men use it, the water is mainly for watering at the farm and the cattle. It is an advantage that children can so easily use the rope pump. However, in some communal wells, it were the kids who most frequently caused damaged by not using the brake.

Prioritization and comparison to other pumps

When PASOC introduced the rope pump they had in their training workshops demonstrations of different types of pumps: Monitor, Indian Mark II, Afridev, Dempster and the rope pump. They explained the different characteristics of each pump with regard to operation and maintenance, needed spare parts and required tools for repairs. Then the project asked the workshop participants about their views and pump preferences. The men said they preferred the painted and most representative, while the women preferred the rope pump, because it was easier to operate and maintain.

In Region V, there existed already some experience with other handpumps. The Evaluation Team came across remains of Monitor pumps (Evansville, Wisconsin). The users did not like the iron taste of the water and stopped using the pumps after some time. As the pumps were not used, they got soon completely out of order.

The 1990-evaluation of the Chinorte project where Dempster pumps were installed since 1983, revealed that 73% of the pumps were not functioning. Five years later, in 1995, only five (8%) pumps out of 66 installed were still functioning.

The Evaluation Team interviewed several persons in Chinorte to learn about their views and experiences on the handpumps they had first and on the later installed rope pumps.

A remarkable statement:

"We only want a Dempster if they give us three years guarantee, because the rope pump has been functioning well since a long time".

In a community where the Dempster pump broke down after 10 years of use, people said:

- *"The Dempster was prettier, but we could not give it proper maintenance".*
- *"The Dempster was more difficult to use for children up to 8 years, and it was easily damaged. However, the rope pump can already be used by children of eight year and older, and it becomes very easy for children above twelve".*
- *"The spare parts for the rope pump are easier to find than for any lift pump types or suction pump".*
- *"This pump is better than the Dempster, and it pumps more water".*
- *"The Dempster has nuts and bolts that the people, and especially the children, remove",*
- *"The seals have to be changed regularly and they are very expensive".*

The problems reported by institutions that had Dempsters installed are:

- *many parts breakdown easily, including the seals;*
- *spare parts are expensive and difficult to find in the whole country.*
- *it is difficult to ensure maintenance at community level.*

In the Development Fund for the Chinandega Norte Zone, it was said:

- *that the Dempster requires tools and technical skills that are difficult to access by the communities, and this results in poor sustainability.*
- *the technology of the rope pump is appropriate for the technical and economical possibilities of the rural population, it is a simple technology, of low-cost and guaranteed sustainability.*

A peasant in another region with a rope pump at his farm and a simple suction pump elsewhere, stated *"....with the suction pump I kill myself and nothing comes out".*

Other remarkable statements are:

- *A peasant stated how he learnt about the pump: "I used to see the rope pump in Leon, and I liked it; then I heard that they sold it to Los Cedros. So I went there to buy one. Now I am very happy with my 'bombita' (little pump)".*

- *"If our pump breaks down we have to buy another one; we have to find the money somehow because we do not want to go back to the old bucket system".*
- *Regarding preferences of different pumps, female users expressed that the pump with rectangular grip was prettier than the other one with 120 degrees grip. "This one it too 'clumsy'", they said. Apparently until now aesthetics has not been taken into account by the designers.*

Acceptance

As a matter of fact, there is no handpump tradition at family level in Nicaragua. The common system in the rural areas is a rope/bucket system, and the windlass/bucket system, and at the farms a horse and bucket system.

Both the communal and family rope pump are well accepted as the pump is easy to operate and the volume of water lifted is sufficient. The lifting of the water by the rope pump is found easier than with a bucket and rope. The level of technology used in the pump is comprehensible for most of the rural population. Therefore, the acceptance is wide and it increases confidence among the users, which is absent for other pumps.

Wide social acceptance of the rope pump began particularly after 1990. Actually, it were the people who promoted the pump. They gave their views to the state institutions in charge of water affairs. The support of INAA was determinant. Firstly, INAA rejected the rope pump because it was seen as just craft industry. But since 1992 they include the rope pump as a mature rural water supply technology alternative in their national policy. This changed the exotic image of the rope pump into an accepted water supply technology.

The rope pump developments in Nicaragua were favoured by the severe macro-economic conditions including the national economic adjustment policy and the lack of economic resources.

Still, the biggest problem is the question how to respond to the huge demand of the people for improved water supply.

Also other programmes and institutions, such as COSUDE, SNV-PASOC, and Netherlands, Spanish and Austrian-supported programmes, have shown interest for the pump as an alternative to communal shallow wells. Now, rope pumps are also installed on boreholes of a depth of up to 50 metres.

Some sector organizations still do not fully accept the pump as a first rural water supply technology option; their reasons include insufficient protection against water contamination; need for standardization; and quality control of product. An important positive argument for several ESAs is the availability of the rope pump on the local market. For other pumps, the delivery period is up to six months. With the present drilling capacity (three drilling rigs) 80 boreholes can be drilled per months. It appears difficult to have that number of pumps supplied within a short period. Information from the manufactures show that they could meet this demand for pumps. Furthermore, organizations such as INAA, UNICEF and COSUDE, require standardization of the pumps, based on a technically sound analysis on pump selection criteria including reliability in relation to pumping head.

In fact, the appreciation of the rope pump has changed from a folklore (pump for the poor), to a reliable pump of acceptable standard, that can compete even with handpumps such as AFRIDEV and DEMPSTER. Now, also extra strong rope pumps are being installed.

The institutions present in the debriefing workshop agreed on the fact that the problem of acceptance lies more with the technicians and bureaucrats, than with the population. The institutions that have accepted the rope pump, opt rather for the extra strong communal pump than for the family type.

A programme donated rope pumps to families in San Isidro after they had requested them. The people have shown acceptance and trust in the rope pump's reliability and sustainability.

Other benefits

Taste of water
Because PVC pipes are used in the pump, the taste of the water is not changed as in case of pumps with iron or metal parts and pipes under water.

Better water quality and more care
The use of more water for household cleaning and personal hygiene always has a positive effect on health. In certain parts in Nueva Guinea different sources of water are used for different purposes. The river and the creek for washing clothes and to have a bath; the well at home with bucket and rope for washing dishes and cleaning the house; and the communal well with a rope pump for drinking water. In many cases the people (owners or water committee) added regularly chlorine to family or communal wells to improve the quality of the water. Sometimes the concentration of chlorine was that high that it is questionable whether the water is potable. Very often the pump for family or communal use was only meant for drinking water, and in some cases chlorination took place.

More protection of water source
Many of the projects that have had rope pumps installed, now consider to include in the old and new models a cover, proper fixing of the cover, and a concrete apron. Also, many ESAs- and government-supported projects demand that the users build a roof over the pump, mostly to prevent the negative effects of the UV sun rays on the rope. In Nueva Guinea the boreholes with rope pumps have very often a wooden structure, that is a small house, often painted with pretty drawings indicating the importance of getting potable water from the rope pump.
For family pumps such protective structures are also seen. According to an owner who repairs his 12 year-old pump himself, it is not necessary to change the rope so regularly if it is not in contact with direct light.

Increased water use for economic activities
More water means more watering activities, and other activities outside the house; e.g. water for cattle and husbandry, for the garden or trees, etc. This has a direct economic effect on the users through increased income.

Operation and maintenance

Operation and maintenance of rope pumps is easier than of other handpumps. The official parts or local alternatives needed to repair the rope pump can be found on the local market. Especially, in areas where projects or programmes had installed communal pumps and people had received some training, the expression "anybody can repair it" is often heard. The women members of the CAPSs could explain perfectly how the rope pump works, and how to change the rope or the guide.

In some cases users created problems where CAPSs began to charge a monthly rate to the users. For boreholes with rope pumps, being used by up to 50 people, 300 Cordobas need to be collected monthly for maintenance. According to INAA-DAR region V, this is about 80%

of the total amount required for maintenance. This required payment caused some conflicts; some people did not want and were not able to pay because their incomes were too low, but they used the well. Therefore, some CAPSs accept also payments in kind, for instance spare parts, oil, paint etc.
In other 'emergency' situations, where urgent repair of damages was needed, decision on ad-hoc financial arrangements were taken in a users group meeting. The Evaluation Team came across one situation where the pump had been dismantled because the users could not reach an agreement over who had to pay what rate. Some people used the water for their cattle, others only for household purposes, and they did not want to pay the same rate. The pump was replaced by individual buckets with rope.

In communal wells or wells shared by several families, the communities understand perfectly that the project is a donation, a gift. In such situations many people do not feel the obligation to pay. The present economic crisis in Nicaragua does not help the people to make them more capable to pay. This makes effective financial management of the CAPSs difficult and may result in poor maintenance of the pumps and a gradual decline in pump condition. Under such socio-economic conditions, people live from day to day, looking for survival strategies; they are used to solve the problems when these arise. Few people think along the lines that preventive maintenance of the pump have an eventual economic effect. The Evaluation Team observed that an ambulant population has negative influence on a community organization that tries to be participatory and sustainable.

For some communal wells, one user or a small group of users claimed the pump to be theirs. Although this situation caused problems and tension in the user community, it resulted in better maintenance.

With regard to communal wells it is important to mention a project that has a very effective model of community management: PASOC Programme which is supported by SNV. The establishment of CAPSs in neighbourhoods, areas, and other population groups, has shown to be a useful and effective approach to facilitate the installation and to guarantee the maintenance of the pumps. These CAPSs, together with the programme's promoters, and ministries as Ministry of Health (MINSA), Ministry of Natural Resources (MARENA), INAA and Ministry of Education (MED), have played an important role in the promotion and implementation of educational activities on water supply and sanitation. These water and sanitation promoters, who act as facilitators and catalyst of communities' activities, are strategic and fundamental for the success of the programme. In these cases the participation of women was also achieved through the CAPSs approach. In a community visited, a wide and voluntary participation of the population was achieved for the actual manufacturing of the rope pumps and the well constructions. This very much contributed to the population's feeling that the rope pump was theirs. They decided to decorate it.

These CAPSs also served to find more equitable roles for men and women, since very often women formed the great majority of the CAPSs, and they had worked in gender-oriented PASOC-programme activities. In this way, the CAPSs have contributed to the improvement of women's situation. Women are considered the main beneficiaries of drinking water supply projects. These achievements were the results of an intense campaign of visits, training, and exchange between CAPSs in different communities in the PASOC-SNV project. "We didn't even want to see those people of PASOC again ...!", said a women with affection.

Also the operations of UNOM (INAA Unit for Operation and Maintenance) have helped much in the viability for the sustainability of operation and maintenance.

However, according to bibliographic information (PASOC, 1995) more inter-institutional coordination is needed with other organizations that have influence in sanitation education CAPSs also created a certain dependency of the community on the promoters and on their support to solve problems related to the rope pump. The CAPSs may depend on support from outside in terms of technical and organizational support, particularly if the problems are beyond the capacities of the CAPSs. In family rope pumps maintenance is done directly by the owner who decides what to do when. The Evaluation Team observed different approaches to the maintenance problems. Some owners wait long before replacing the rope and the pistons, while others replace those more regularly and some do strengthen the pump. We did not find these self-improvements in communal wells. Nevertheless, it was not possible to measure these benefits.

It is concluded that CAPSs substantially contribute to the maintenance of the rope pump and well, and to the sanitation education. These activities both contribute to the benefits of the rope pumps on the well-being and health of the people. Nevertheless, in several communities difficulties exist with the cleaning of the wells, and the monthly financial contributions from the users, although these rates were agreed on previously in the community in a meeting between the community and the programme.

Conclusions on socio-cultural aspects

Users and uses

- In general, women and children are the main users of the rope pump.

- Rope pumps are used for different purposes: drinking, household use, watering for cattle, and for irrigation.

- Where institutions give training and financing, the pump stands over the well, is closed, with a box or protective roof, with a cement apron, and more attention is paid to cleanliness. If there are also other water sources (e.g. a home well, creek), many people prefer to take their drinking water from the rope pump.

Acceptance

- The rope pump is widely accepted by the people because of its easy operation and maintenance. Spare parts are cheap and repair costs low. These factors contribute to confidence and affection among the users. They fully appreciate and accept this technology.

- The investment in communal rope pumps is relatively low, it generally does not generate financial worries among the families to establish a monthly rate.

- The water is easily extracted and it costs less energy to operate the rope pump than a bucket/rope system. The quantity of water, efficiency and costs of maintenance are much appreciated by the users.

- Most users have no problem with its maintenance: "anybody can repair it".

- There are gender preferences on pumps: men prefer the nicely painted and more representative (e.g. the Dempster), while women prefer the rope pump, for reasons of easy operation and maintenance.

- The use of PVC pipes does not affect the taste of water, as some other pumps with iron pipes and parts.

- Even though the women prefer rope pumps over other manual pumps, it is understood that the most appreciated water supply technology are the gravity-fed piped supply systems.

- The technicians and bureaucrats, are the ones that have had, or still have, a certain resistance to adopt this technology.

- More and more ESAs and government institutions are convinced of the usefulness of the rope pump within the Nicaraguan context.

- Since 1992, INAA has installed rope pumps in communal wells within its national policy.

- The maintenance of family pumps is in general, better done than in communal pumps, but with an adequate follow-up support the communal pumps are kept in good condition.

Other benefits

- More water means, normally, more health.

- A significant decline of faecal coliform density has been found, in comparison with traditional wells.

- Many communal wells managed by Water Supply and Sanitation Committees (CAPSs) are cleaned every day. Committees of Potable Water also play an important role in the promotion of health and household cleanliness.

Others

- The rope pumps for communal use require the training ('learning-by-doing') of the people to establish a community organization for the operation and maintenance part.

- Users have ideas about possible improvements of the rope pump, both in technical and design aspects.

- A large-scale application is foreseen as the technology offers many advantages.

- In view of differences in needs, uses and/or affordable investments and O&M, it is not wise to opt for a standard model, since the fundamental characteristic of the rope pump is that of being an appropriate technology.

2.7 Acceptance of the rope pump by Government and External Support Agencies

Representatives of the agencies and organizations replied to the Pre-Evaluation Questionnaire by expressing their opinion over the rope pump.

INAA The rope pump is a local product, easy to maintain. The costs of investment, and of operation and maintenance are low. It is accepted by the communities, favourable for poor regions. They wish to see the rope pump further developed.

COSUDE The rope pump is a good technology; it can be locally manufactured; it is affordable and accessible to the community. But there is a need to standardize designs and put a trademark. The technology is easy to instal and repair, although there are some technical problems.
The rope pump is suitable for lifting groundwater from different depths. This is a strong point in comparison to other low-cost pumps. For family use it is an excellent product at low-cost.

UNICEF The rope pump must be used and adopted. The protection against environmental influences is limited. The technical characteristics must be identified. There is need for quality control of the manufacturing (for the workshops in Managua this is not a problem), but there are no standards to be adhered to by the rest of the workshops. There is some resistance to communal pump. The rope pump is not very strong and the attitude of the communities has to change to treat it with more care.

PASOC There are many advantages but also some disadvantages. The average lifetime is only 5 to 10 years. It is difficult to convince the people that after 5 years it is necessary to change the pump's wheel which is about 25% of total costs. There are some technical parts that need to be improved.

O&M tasks of different types of rope pump and the possible actors in the maintenance tasks

Maintenance activity	Self-made pump	Family pump	Communal pump
Repair wheel; axle	owner	owner; workshop	CAPS; workshop
Replacement wheel	owner; private sector	owner; workshop (wheel from shop or workshop)	CAPS; workshop (wheel from shop or workshop)
Repair Support structure	owner	owner; workshop	CAPS; workshop
Replacement support structure	owner; private sector	owner; workshop	CAPS; workshop

Replacement rope	owner (rope from shop)	owner (frame from shop or workshop)	CAPS; workshop (frame from shop or workshop)
Replacement pistons	owner (pistons self-made or from shop)	owner (pistons self-made or from shop)	CAPS; workshop (pistons from shop)
replacement guide	owner (guide self-made or from shop)	owner; workshop (guide from shop)	CAPS; workshop (guide from shop)
Replacement rising pipes	owner (pipes from shop)	owner (pipes from shop)	CAPS; workshop (pipes from shop)
Repairs cover	owner	owner	CAPS; workshop

3. CONCLUSIONS

This chapter compiles the main conclusions on the central issues of the evaluation of the rope pump experiences in Nicaragua:

- efficiency
- functioning
- sustainability: general aspects, financial aspects, production aspects; commercialization, and institutionalization;
- affordability
- acceptance
- replicability of the experience in other countries and regions.

3.1 Efficiency

- The technology of the rope pump is reliable. Almost all models of rope pumps seen, even the very worn-out ones, were functioning.

- The volumetric efficiency of the pumps inspected varied between approximately 40 and 80% with an average of around 70%.

- The performance, measured in volume and pumping head, was around 45 watts per person, for prolonged use of pumps of average condition.

- The water pumped by rope pumps is used for multiple purposes: drinking, general household purposes, cattle, irrigation etc.

- The combination of windmill and rope pump seems to be successful. Within the frame of this evaluation, it was not possible to visit enough windmills to analyze this option.

3.2 Technical operation

"Industrialized" rope pump frame

Support structure

- The best metal support structures are made of plain steel or galvanized iron, with durable parts that are not too thin and few weldings. The use of corrugated reinforcement bars, which is the cheapest solution, causes many problems to the pump's support structure.

- The metal support structure of the type manufactured by Taller Castilla is one of the best that has been developed in the country.

- The quality of the assembly of support structures depends on the use of moulds and clamps for cutting and welding.

Welding

- Unnecessary over-designing has been found, as well as excessive welding to save material. Metal rotors have been found where weaker parts of the support structure are reinforced with inadequate materials. Only some workshops use adequate material such as plain bars.

- Due to lack of experience many workshops do not clean the slag formed on the welded parts with chisel and wire brush, leaving a definite source of rust acceleration.

- Improvements to the anti-corrosive protection were found in workshops that use an adequate paint system: proper cleaning and double painting of the welded parts, and a final oil coating.

Wheel

- The wheel or pulley made of used tires works well for turning the rope and the pistons. There are many models, and in general the models with fewer welded parts are stronger. The self-made wheel models are made of timber and tires, and they also deliver good results.

Axle/crank

- Almost all the pumps have axles and cranks made out of one piece of pipe that turns around an axle. The users do not lubricate the handle because the grease and oil dirties the hands.

- The grip is frequently a weak point of the pump, especially when it is made out of 1/2" pipe.

Bearings

- The split bearings (bushings) made of two metal half cylinders cause problems of loss and fast wear. The bearings made of steel pipe or galvanized iron are better. So are the very traditional bearings made of wood, saturated in oil with a metal axle; these appear to be very resistant.

Brake

- To prevent the rope from returning through the rising pipe, the workshops fit their pumps with metal brakes that propel the cogs on the axle or pulley. There are many brake models but none of them really work.

Rising pipes

- The interior diameter of the nominal-sized pipes can vary a lot depending on the quality and the factory. However, no major problems with the quality of the pipes were observed. The higher price of the Costa Rican PVC tubes is only justified when the pistons used are of good quality, and they are replaced before they are too worn out.

- The susceptibility to abrasion by muddy groundwater containing very fine sand seems to be very low. Further investigation is needed.

Guides

- All the recent guide models function, but there are no data on their performance and their influence on the rope's wear.

Pistons

- An improvement on the quality of the pistons could increment their useful life, and in lesser measure, the efficiency of the pump.

- The quality of the pistons found varies a lot. The best pistons we found are those produced by HULETECHNIC.

Installation

- For proper installation of the rope pump on the well, three aspects are important: (i) the rising pipes are properly fixed; (ii) the support structure is screwed on instead of embedded in concrete (which enables later repairs), and (iii) the guide and the wheel are well aligned with the pipe.

- In projects and programmes receiving external finances and with a training component, the pump is placed on the well, it is properly covered with a box or protection roof, and it has a cement apron.

3.3 Sustainability

General aspects

- The sustainability of the pump, like other technologies, depends on proper operation and maintenance. Almost all repairs can be done by the users themselves with a minimum investment in training (one day only), and without special tools (rope and a knife). In this way the institutions can transfer the maintenance responsibility to the users of the pump.

- In communal use the rope pump can function well, but it is susceptible to rough handling. Stronger models and good institutional follow-up can improve this situation.

- The pump needs relatively frequent but simple maintenance. Among the users of most of the rope pumps visited there were always many men and women, who knew how to maintain the rope pump, and how to do repairs.

- In general, most users often find maintenance rather easy: "anybody can repair it", is widely heard.

- In general, the maintenance of family pumps is better, but with good follow-up support communal pumps also can be kept in good condition.

- The rope pumps for communal use require training ('learning-by-doing') of the people in order to establish and organize a committee responsible for operation, maintenance and hygiene promotion.

- When the pump has a roof, even if it is a primitive one, both the pump and the users are protected from the sun, which results in longer life for the rope. When the wells are protected with cover and head-wall, and when they have an apron, the quality of the water is better protected. The best installations of communal pumps were found in the PASOC Programme, supported by SNV.

- The lifetime of rope pumps depends more on maintenance and care than on the frequency of pumping.

Financial aspects

- The financial management of the communal wells was found to be inefficient wherever the users have not been mobilized prior to installation, or where there is a lack of communal cohesion.

- Substantial subsidies and donations for the development of communal wells may have a negative influence on the communities' financial responsibility, if there is no good conscientization prior to installation.

- The first years after installation maintenance costs are low, but after four to five years these can go up to the level of the initial investment. However, the O&M costs are still lower than those of other handpumps.

- The average investment and O&M costs of communal rope pumps per family is relatively low, therefore fixing a monthly contribution fee does not arouse worries among the families.

Production aspects

- The technical concept of the rope pump is so simple, that a local workshop can produce it using basic technical know-how, local materials, simple tools, and some parts produced at semi-industrial level (guides, pistons and PVC tubes).

- The country-wide manufacturing rate in Nicaragua at this moment is not sufficient to cover an eventual envisaged large demand.

- Reliable and efficient production of rope pumps can be achieved by an extensive network of small workshops that, apart from the rope pump, also produce other equipment and products.

- In Nicaragua the pump is manufactured by a workshop as an extra activity; the rope pump's low price and the low annual turn-over does not result in high profits. Therefore, larger private companies may not become interested in this product. This may not be the case for the production of parts, for which specialized production processes are sometimes required, and for the distribution of the industrial rope pumps.

- If there are workshops specialized in parts that require high quality and precision, like pistons and ceramic guides, it is not efficient and attractive for the common workshops to also produce these parts.

- The innovative capacity of small workshops has been the main source of technical contributions in the development of this technology. Among these workshops Taller Castilla stands out.

- In Bombas de Mecate S.A. the production of some technical elements (pistons and ceramic guides) could be more efficient if, as in the case of the wheels, they would be manufactured by another workshop.

- Taller López-Erlach's organization of production of the wheel is most highly recommended for the implementation of production in other countries.

- Taller López-Erlach and Bombas de Mecate S.A. have developed an interesting enterprise symbiosis through the manufacturing of certain rope pump parts at Taller López-Erlach with guaranteed demand by Bombas de Mecate S.A.

Commercialization aspects

- The separation of the production activities from those of commercialization and promotion give to each of the companies involved more stability.

- The company Bombas de Mecate S.A. is more a commercialization company than a production workshop. It buys parts produced by other workshops, assembles them, and it markets the pump as a whole. To back its activities, Bombas de Mecate has a good promotion, distribution and installation programme. This company has an advantage over other workshops, with an active promotion of their sales which is recovered in the sales price.

- Promotion is one of the main conditions for the sustainability of the company.

- Profits from the sales of rope pumps are not enough to attract big companies to produce them.

- The majority (90%) of the wells are private since it is the users rightful desire to have direct access to water. Therefore, private sales form a major market segment for the rope pump sector. But, there is also a growing market for communal wells, especially in the poorer zones of Nicaragua, and in zones where groundwater wells are unprotected and groundwater quality appears to be poor.

- The potential of the international market in neighbouring countries lies more in technology transfer than in production.

Institutional aspects

- The success of this technology in Nicaragua is predominantly due to the fact that INAA, the leading institution for potable water in the country, has chosen the rope pump as the first option for pumping water from communal wells in rural areas.

- The confidence of INAA in this technology has induced other organizations to use it more often in their water programmes: national organizations, ESAs, governmental organizations, and NGOs.

3.4 Affordability

- The rope pump is a low-cost technology cheaper than other technologies.

- The costs of investment are still too high for the poorer segments of the population.

- The pump is used by rich people, by the middle class in rural areas, and also by rural development projects. The poor people use it only when there is a communal pump installed with external support.

- The potential demand is high, but an effective demand depends on the capacity for payment.

3.5 Acceptance

Cultural and gender acceptance

- In general, the women and children are the ones that use the rope pump most.

- The use of plastic pipes in the rope pump does not affect the taste of the water, as with other pumps that use underwater parts susceptible to corrosion.

- There are gender preferences on pumps: men prefer the nicely painted and more representative (e.g. the Dempster), while women prefer the rope pump, for reasons of easy operation and maintenance.

- Even though the women prefer rope pumps over other manual pumps, it is understood that the most appreciated water supply technology are the piped gravity supply systems.

- The technicians and bureaucrats, in particular, are the ones that have shown or still show, a certain resistance to the adoption of this technology.

- At the same time, more and more ESAs are convinced of the usefulness and appropriateness of the rope pump in the Nicaraguan context.

Appropriate technology

- The rope pump is widely accepted by the people because of its easy operation and maintenance. Spare parts are cheap and repair costs low. These factors contribute to confidence and affection among the users. They fully appreciate and accept this technology.

- The water is easily extracted and it costs less energy to operate the rope pump than a bucket/rope system. The quantity of water, efficiency and costs of maintenance are much appreciated by the users.

- The future development of this technology will be more socially sound if it is produced with the user in mind, rather than based on institutional expectations. This is why the role of the workshops that are in direct contact with the environment of the users is of crucial importance. Users have constructive views on possible improvements to the pump, both in technical and aesthetic aspects.

- For family use, the rope pump is a good alternative to other types of handpumps. It functions well down to 50 meters, it is easy to maintain, and it is cheap, but the 'industrial' rope pump is not yet accessible to the poorer sections of the Nicaraguan population.

Benefits to health

- In spite of the fact that the rope pump is not completely hermetic, the quality of the water of wells without a pump can benefit much from the installation of a rope pump.

- If people have other water sources (well at home, a creek), for health reasons users prefer to use water from the rope pump for drinking purposes.

- A significant reduction in the faecal coliform density has been found in wells with rope pumps as compared to traditional water wells.

- Hygiene behaviour and cleanliness get attention in the programme and project interventions of ESAs which usually have a hygiene promotion and education component.

3.6 Replicability and application in other countries and regions

The experience with the rope pump in Nicaragua is unique in the world. The rope pump has proven its viability through the production and installation of more than 5,000 pumps. Rope pump experience goes back more than a decade; the pump has strong and weak elements. The Nicaraguan experience is a rich source of "learning" and consultation for other countries.

The potential of replicability of the rope pump in other countries is great, provided that:

- the initial low investment costs are important to future users (if owners have to pay themselves)
- the initial costs are not too high for them (affordability)
- the pump is adopted and promoted by leading state sector institutions/organizations, and ESAs
- the pump can be manufactured with local materials and know-how
- the pump is produced by small, local workshops

The ESAs and the leading sector institutions, together, can play an important role in the future development of the technology in the region, and in the world. In Nicaragua the institutional promotion has been a determining factor for the adoption and technical development of this technology. On the other hand, the private sector can play the primary role in the production and promotion; the Nicaraguan experience has shown this successful role.

Because of the different requirements, uses and costs, it would not be advisable to opt for one single standard model, since the rope pump's fundamental characteristic is to offer a flexible and sound appropriate technology for rural water supply.

4. RECOMMENDATIONS AND ORIENTATIONS

To further increase the health and well-being of the people in the rural areas of Nicaragua and of other developing countries, it is recommended to promote the rope pump as an affordable and sustainable low-cost technology, which could significantly increase the water supply coverage in areas with feasible groundwater exploitation.

In order to start a process of transfer of this technology and to facilitate the promotion and development of this technology in other parts of the world, a series of recommendations and orientations are recommended.

These recommendations are followed by more specific recommendations for Nicaragua which could enhance the efficiency and sustainability of the development and promotion of the rope pump in Nicaragua. Each of the proposed recommendations could be further developed into projects.

4.1. Technology transfer to other countries

Nicaragua is the only country in the world that has manufactured and installed the rope pump on such a wide scale. An important aspect of the success of the rope pump's development in Nicaragua is the fact that it has the support of the National Water Agency of Nicaragua (INAA). Up to now, some ESAs including COSUDE, UNICEF and SNV are positively inclined to the development of the rope pump, but the support and commitment of ESAs could be strengthened. The positive experiences in Nicaragua should be used in order to disseminate these "lessons-learned" to other countries.

The rope pump is a relatively simple technology which can be manufactured with local means, and it is therefore viewed as easily replicable.

The main element of the technology transfer concerns the mobilization of different groups. These include within a country: national water agencies, other government departments (at different administrative levels), sector institutions including technical and professional institutions, local NGOs, local manufacturers and workshops, and the users themselves. At the international level there are the external support agencies including UN agencies, World Bank, regional development banks, bilateral donors, and NGOs.

The Mission recommends activities at both the international and country level. Indications for actors and potential funders have been indicated in tables, but it must be stressed that these are only indicative and certainly not definite.

The Mission recommends the following activities at international level:

- disseminate the results of the evaluation mission;
- publish and disseminate a promotional publication in Spanish, English and French;
- enter technology information and references into international technology networks;
- make a promotional video;
- publish articles in international sector journals and magazines on rural water supply technology and development;

- promote the technology at international conferences, seminars and workshops on sector developments and strategies;
- organize a workshop for Central American institutions to exchange experiences, and to further raise awareness among ESAs active in the region and the national sector organizations.

Indicative table with recommended activities at international level and potential actors as far as interests have been indicated.

Activity	Potential actors
Dissemination of evaluation results	IRC, SNV, CICUTEC, SKAT/HTN
Publication and dissemination of promotional publication on rope pump in English, French and Spanish	English: IRC, SKAT French : IRC, GRET, SKAT Spanish: IRC, CICUTEC, SKAT
Production and dissemination of promotional video	CICUTEC (?) DEMOTECH Holland (?)
Publication of articles on rope pump in international journals	IRC, CICUTEC
Entering technical information/ documentation into networks	IRC, DEMOTECH, SKAT/HTN
Increase profile of rope pump at international conferences etc	all sector agencies all technical institutions involved
Organization of workshop for Central American institutions on rope pump experiences and strategies	COSUDE, SNV, IRC

The Mission recommends the following activities at country level (except Nicaragua):

- promote technology to national water agencies, other government departments (at different administrative levels), sector institutions including technical and professional institutions, local NGOs, local manufacturers and workshops, and the people, and to sector supporting ESAs and NGOs;
- publish promotional articles in local sector journals, development newsletters, and newspapers;
- assess the suitability of technology considering the technical capacities and the economic situation in the country;
- assess the feasibility for the involvement of private companies and workshops;
- assess the social acceptability;
- install locally-produced prototypes of rope pumps for demonstration
- promote the concept of commercialization, and a step-by-step strategy to further introduce the rope pump technology in the country;
- exchange experiences with Nicaragua;
- formalize the structure, including workshops and companies, that will be involved in the production and promotion;
- monitor the development, control the quality, and facilitate and support local efforts.

The potential actors for the above country-level activities will be local sector agencies (government), ESAs, local NGOs, technical institutions, private sector, and international sector-supporting organizations (such as IRC, SKAT, etc.). These groups can be brought together through a consultation.

4.2 Recommendations for Nicaragua

4.2.1 Consolidation of technical aspects

It has been observed that in Nicaragua several types of rope pumps, using different designs and materials, offer a wide range of quality. Furthermore, while there are no technical standards, some designs are of good quality.

Three main categories of rope pumps can be found in Nicaragua:
• the industrial rope pump, with models for family use and communal use;
• the "self-made" rope pump mainly for family use;
• other models such as rope pump with gasoline motor, wind-power, animal traction, etc.

Based on the findings and conclusions of the evaluation in Nicaragua, the mission recommends the following activities for each category of rope pump:

For the *industrial rope pump (both family and communal pump):*

- establish standards for parts and design, and have drawings made of this public domain pump;
- further investigate the use of different material for the pistons, their wear and their efficiency of pumping;
- investigate the effect of pistons-pipe tolerance on the efficiency of pumping;
- investigate the limits of pumping with the rope pump in wells deeper than 50 meters;
- investigate different types of guides;
- investigate how to improve the lifetime of the materials, particularly to make these more corrosion resistant;
- take into account in the design some minimum aesthetics norms that will not affect the price or quality, but that make people be more proud of their pump.
- investigate more durable constructions, specifically wheel and support structure;
- further develop more sustainable community organizational structure for management and maintenance;
- develop a sustainable follow-up support structure for the agencies to the communal rope pumps;
- develop a kit for a durable self-made pump;

Indicative table with recommended activities at national level (Nicaragua) and potential actors as far as interests have been indicated.

for the industrial rope pump (both family and communal type):

Activity	Potential actors
Establishment of standards and designs, incl. technical drawings	Nicaraguan technical institution with INAA, SKAT/HTN
Improvement of different rope pump parts (piston, guide, corrosive resistance, wheel, support, etc.)	private workshops, local technical institutions local sector agencies, ESAs
Development of model on sustainable community organizational structure	national sector agencies, INAA ESAs
Development of sustainable support structure for communal pumps from sector agencies	national sector agencies, INAA, ESAs

For the *self-made rope pump* the recommendations are:

- investigate the reasons for failures and successes in promotion and projects of self-made rope pump;
- evaluate the cheapest and most reliable designs of the self-made rope pump in Nicaragua (and possibly in other countries);
- further exchange experiences of organizations and individuals working with this technology;
- institutionalize organizational and technical support to local organizations interested in the dissemination of this technology, e.g. through training local craftsmen;
- support local demonstrations of different rope pump options at village level;

for the self-made pump:

Activity	Potential actors
Investigation on reasons for success and failures in self-made rope pump activities (promotion/projects)	rope pump workshops ESAs, national sector agencies CICUTEC
Determination of cheapest and most reliable self-made rope pump	CICUTEC ESAs, national sector agencies rope pump workshops
Development of a kit for self-made rope pump	private workshops (Taller Castilla?)
Exchange of experiences with self-made pump	CICUTEC ESAs, national sector agencies
Institutionalization of organizational and technical support on technology	national sector agencies ESAs
Support local demonstrations	ESAs, rope pump workshops, CICUTEC

For *the other models including rope pump with gasoline motor, wind-power, animal traction*, it is recommended:

- develop design criteria and standardization to ensure quality and sustainability of the other models;
- consider a separate evaluation on appropriateness, replicability, sustainability, and possible transfer of technology to other countries.

on the other models including rope pump with gasoline motor, with wind-power, animal traction

Activity	Potential actors
Development of design criteria and standardization including technical drawings	local technical institutions international technical institutions HTN/SKAT
Evaluation of technological options	SNV, COSUDE, CICUTEC

4.2.2 Large-scale production

In Nicaragua the present manufacturing process and assembly system could be made more efficient in order to improve the production capacity and be able to respond to an important potential demand. It has been observed that different types of manufacturers could serve different types of clients, such as important manufacturers and local artisans. They are both essential for the effective production, distribution and repair of the rope pump.

In order to raise the rope pump-manufacturing sector's effectiveness, the following activities are recommended for the production of each of the three pump categories:

- reinforce the support of institutions (INAA, ESA, NGOs) on promotion aspects, training, mobilization, community management, and supplies;
- establish quality standards for family and communal pumps;
- develop and introduce quality control systems for 'industrialized' and local workshop production;
- establish a certificate of quality for the product;
- evaluate and promote 'industrial' production at large-scale of ceramics (guides), plastics (pistons), and metal axle/crank, brakes, bearings (bushings));
- support existing small-scale companies for the assembly, promotion and installation of rope pumps, and distribution of spare parts;
- promote the development of local workshops that can produce rope pumps according to the local conditions, requirements and preferences, and the use of industrial and local spare parts;
- study the possibility of introducing in the market a 'kit' that includes : ceramic guides, pistons, axle/crank pipe, fixing brakes, bearings (bushing) and possibly a wheel; an installation manual; and an operation and maintenance manual for self-repair purposes.

The actors for the activities related to the above recommendations are the local sector agencies, ESAs and the workshops active in Nicaragua.

4.2.3 Training

An adequate production quality for the different pumps needs to be ensured at 'industrial' and at local workshop level. Therefore standards for design and technical parts have to be established which have to be communicated and taught to manufacturers at the two levels: 'industrialized' and local workshop level. Furthermore, communities should be involved in the selection of technology, and have the capacity to operate and maintain their pump.

The following activities are recommended for each category of pump described in 1):
- further determine and develop the required training support the families and CAPSs need for adequate management and maintenance; and develop guidelines for this follow-up support;
- develop a course on production and distribution of the rope pump;
- develop a course on O&M, management and follow-up support from agencies;
- further develop an approach to allow users' participation in the selection of their rope pump;
- offer thorough training and follow-up to the CAPSs and private mechanics/local workshops in order to develop capacities for repairs and adequate maintenance;
- ESAs should contribute and support the efforts made for capacity building.

The actors for the activities related to the above recommendations are the local sector agencies, ESAs and the workshops active in Nicaragua.

4.2.4 Dissemination to the poorer segments of the population

Despite the fact that the rope pump is a low-cost technology, the majority of the rural population in Nicaragua cannot afford the investment and O&M costs. Both the self-made and the communal rope pump could be considered for promotion. Both are feasible and affordable options. The best choice depends on the local conditions including settlement pattern, social cohesion, socio-economic conditions, technical capacity etc.
Therefore some activities aiming at more rope pump coverage are recommended:

- determine and develop suitable financing systems (low interest loans; subsidies; cost-sharing; donations);
- increase mobilization of poor communities and introduction of communal pumps, when the using private wells is not affordable.

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APPENDICES

1. Terms of Reference
2. Evaluation programme and staffing
3. Pre-evaluation questionnaire
4. List of persons met during evaluation mission
5. List of individual and communal pumps visited
6. Output of SWOT workshop in Managua
7. Output of SWOT workshop in Juigalpa
8. Output of participatory debriefing workshop in Managua
9. Efficiency rate of rope pumps evaluated
10. Illustrations of windmill/rope pump system
11. Articles on rope pump experiences from *Waterlines* and *IRC Newsletter*

APPENDIX 1: Terms of Reference

PROPOSAL

EVALUATION OF THE NICARAGUAN ROPE PUMP

Measuring the technological, socio-economic and institutional sustainability

and replicability of a groundwater lifting technology

January 1995

1. INTRODUCTION

Water supply for drinking water purposes and other household uses is generally viewed as one of the most basic needs for hygiene, health and development. A reliable and safe water supply lays the foundation for improvement of living conditions and for general development. In rural areas water is often also the key factor for subsistence and development of commercial activities including small scale farming and livestock.

The International Drinking Water Supply and Sanitation Decade has greatly increased the attention international organizations pay to water supply and sanitation. Despite this, the overall water supply situation in many countries is still deplorable. The major problem behind this bad situation is <u>not</u> primarily, as is often said, the limited financial resources, but more often the insufficient consideration in planning for the long-term sustainability of the water supply facilities. The common experience is that handpumps break down within a couple of years after installation, and diesel engine-powered water supply systems stop functioning because spare parts are not available or fuel supply is too intermittent. The sustainability of the installed systems is low for various reasons, including high operation and maintenance costs, unclear division of responsibilities between the users and the water agency, poor management structures, inappropriate technologies, etc. The water agencies' role is changing from provider of services to promoter and facilitator of community-based water supply improvements. The sector institutions are now realizing that involvement of the users in selection of service level and technology is a crucial aspect in reaching sustainable systems. This implies that agencies have to provide a range of technology options to the community and users of which they can choose the most appropriate. Only through sustainable systems that are properly functioning and used by all, can a strong foundation be laid for achievement of the higher goals of improved water supply, i.e. better health and a higher standard of living.

Where the preference for more family or neighbourhood-based water supply systems is expressed or where circumstances make groundwater supply through handpumps unfeasible, additional technologies must be offered. The criteria for selection of these technologies include hydro-geology, affordability, durability, operation and maintenance (O&M) requirements (technical and financial), availability of local repair capacities and spares, social acceptability etc.

The Nicaraguan rope pump seems to fulfil the criteria for an appropriate groundwater lifting device. Various organizations in Nicaragua, both locally and externally supported, report on promising technological developments, local manufacturing, applications and installation of the Nicaraguan rope pump. Even wind-powered rope pumps are being installed in Nicaragua. Compared to the limited technology development and success rate of this type of pump in other countries and continents, the Nicaraguan case is quite remarkable. Regional and international interest in the application of the Nicaraguan rope pump is evidenced through the numerous reactions to recent articles (1993) in *Waterlines* and *IRC Newsletter*. Response came from national organizations and External Support Agencies from all continents. Private initiatives on rope pump manufacturing have started on a small scale in Honduras. In Mozambique the Royal Netherlands Embassy and UNICEF intend to support the introduction and pilot-testing of the rope pump in rural areas.

This proposed evaluation must assess the potential of the "Nicaraguan" rope pump as a sustainable technology for wider dissemination in other countries in Latin America and other continents. At present most of the experiences of successful commercialization of the rope pump come from Nicaragua. Limited information is also available on its development and introduction in Asia (a.o. Indonesia, Sri Lanka) and Africa (a.o. Zimbabwe and Zambia). The evaluation will also identify criteria and conditions required to have the technology successfully introduced in countries.

A phased approach will be followed in the review, evaluation and dissemination of findings on the rope pump experiences.

Phase 1: Desk review of rope pump experiences (already funded by IRC)

A literature review has been made using several documentation centres including IRC Documentation Centre, Technical Universities of Delft and Enschede, and databases as Aqualine and Pascall. Subjects covered in this review are developments of different types of rope pumps, technical functioning and performance, manufacturing and O&M costs, replicability of technology, private sector involvement, and technical, social and cultural acceptability.

A draft literature study report has been produced. The final output will be a brief but comprehensive document, supported by appendices of key literature, which will be of use to the evaluation team as a briefing document on present world-wide rope pump experience.

Phase 2: The evaluation proper of the rope pump experiences in Nicaragua

This phase is described below. Funding for this evaluation is being sought from the Royal Netherlands Embassy in San José (Costa Rica) and the SNV programme PASOC in Nueva Guinea, Nicaragua.

Phase 3: Development, publishing and dissemination of rope pump publication (separate project)

Provided the results of the evaluation are positive, these have to be made known to a wider audience of decision-makers and (project) planners in ESAs and sector departments in developing countries. Under a separate project a state-of-the-art publication on the rope pump will be developed. This brief, easy readable, promotional document will combine the desk review and the evaluation results. The major part of the publication will be to indicate the criteria and conditions that are needed for successful introduction of the rope pump technology in other countries.

2. OBJECTIVES OF THE EVALUATION

The overall objective of the evaluation is to assess the short- and long-term performance of the rope pump in Nicaragua in view of its potential for wider application and active promotion outside Nicaragua.

The specific objectives of the evaluation are:

- to assess the technical functioning and performance (efficiency) of different rope pumps developed over the last five years in Nicaragua in relation to the quality of materials used and quality of rope pump manufacturing;

- to assess the technical functioning and performance of different rope pumps as compared with reported performance of other groundwater lifting devices both for application as family as well as community pump;

- to identify environmental factors (e.g groundwater table; groundwater quality), institutional conditions (technical capability; marketing; competition), and other factors influencing the success of the rope pump introduction in Nicaragua;

- to measure the long-term sustainability of different rope pumps (also wind-powered) in Nicaragua, in particular as related to issues of the required maintenance and repair capacities, and production and availability of spare parts;

- to assess the affordability and financial sustainability of different rope pumps in terms of investment and operation and maintenance costs;

- to measure the cost-effectiveness of the rope pump as viewed by the users (both men and women) in terms of social, gender, economic and public health benefits;

- to identify the cultural and gender acceptance of the rope pump versus other groundwater lifting devices;

- to review the achievements of private sector involvement in technology development, manufacturing, installation and repairs of the rope pumps and spares in Nicaragua, including a cost/time analysis of the production, marketing and after-sales costs of the rope pump in Nicaragua;

- to identify the conditionalities of the reported success of private sector involvement in the rope pump business and the potential for replication of this approach in other countries;

- to make recommendations for improvement regarding the rope pump in Nicaragua on aspects covered in the evaluation including technical design, private sector involvement, cultural and gender acceptance.

3. OUTPUTS

The results of the evaluation will be given in an evaluation report. The draft (in english) will be sent to Mr J. Blom (DGIS/DST/TA), Dr K. Wit (Royal Netherlands Embassy, San José), SNV-Nicaragua, and PASOC Programme in Nueva Guinea, Nicaragua. Comments will be incorporated in the final version, which will be produced in both the English and Spanish language.

An article covering the major results of the evaluation of the rope pump in Nicaragua is envisaged to be written for the journal *Waterlines*.

4. METHODOLOGIES

The evaluation will field a mission to Nicaragua with a multi-disciplinary team to evaluate the technical, socio-economic, cultural and institutional criteria. The evaluation team will make use of the report of the desk review on world-wide rope pump experiences, recently produced by IRC.

<u>Evaluation Mission in Nicaragua</u>
The evaluation will be done at three levels: (i) sector organizations at national and district level; (ii) private organizations and companies involved in manufacturing and installation; and (iii) community and user level.

The activities of the evaluation mission include:
- collection of general data on the rope pump through a pre-evaluation mailing of questionnaires to the Nicaraguan government, donor and private sector organizations;
- discussion on evaluation issues with government sector organizations and donors active in the water sector in Nicaragua and review of the data collected from the questionnaire;
- technical evaluation of different rope pumps at the manufacturers' production facilities and in the field;
- discussions with private manufacturing organizations and companies;
- participatory meetings and discussions with communities and individual users;
- review and analysis of all collected data;
- submission of overview of preliminary findings, conclusions and recommendations to RNE, SNV Nicaragua and PASOC Programme one day before the workshop;
- participatory workshop (0.5 day) to discuss preliminary evaluation findings involving key organizations and companies, and representatives of user groups;
- debriefing of evaluation findings to Royal Netherlands Embassy.

<u>Reporting</u>
- final drafting of the report and recommendations at IRC;
- draft report to be sent for comments from DGIS, RNEs in San José and Managua, SNV-Nicaragua, and the PASOC Programme in Nueva Guinea;
- submission of report and recommendations (English and Spanish version) to DGIS, RNEs in San José and Managua, SNV-Nicaragua, and PASOC Programme in Nueva Guinea, Nicaragua.

5. ORGANIZATION

The overall organization of the evaluation will be done by an IRC staff member, Mr Jo Smet - sanitary engineer. The evaluation team (both local and external) has been identified and is presented on in part 7. Staffing.

The team is composed of experts of different disciplines to ensure sufficient coverage of the different evaluation issues. Most team members have a good command of Spanish.

The IRC staff will prepare the pre-evaluation data collection through mailing. Furthermore, evaluation checklists for all subjects will be drafted and brief descriptions will be made on participatory community discussions and workshop methodologies which will be made available to DGIS, RNEs, SNV-Nicaragua, and PASOC Programme in Nueva Guinea, Nicaragua.

The local partner organization in Managua (CICUTEC) will be requested to assist in the identification of ESAs active in the rural water supply sector, water supply programmes and projects, and local manufacturers of rope pumps.

The SNV-supported PASOC Programme in Nueva Guinea has agreed to provide local transport to visit the organizations and evaluation sites.

The draft evaluation report (in english) will be submitted within 3 weeks after the end of the mission. The final report will be sent to DGIS, RNEs, SNV-Nicaragua, and PASOC Programme in Nueva Guinea within two weeks after the reception of the comments. The final report will also be made available in spanish. The article for the *Waterlines* Journal will be submitted soon after the end of the completion of the final report.

6. TIME SCHEDULE

An estimated time schedule is shown below:

• Desk Review	September/October 1994	4 weeks
• Evaluation preparation	February 1995	2 days
• Evaluation in Nicaragua	March 1995	14 days
• Reporting	March/April 1995	1 week

7. STAFFING

The evaluation team will be composed of the following persons:

Mr Jo Smet IRC sanitary engineer
overall coordination and backstopping of evaluation;

Mr Marc Lammerink IRC sociologist, team leader
social and cultural acceptance; health issues; appreciation;

Mr. Francois Brikké IRC economist
economic benefits; O&M costs; financial issues; cost-effectiveness; financial analysis of companies and their activities;

Mr Maarten Bredero Private consultant from The Netherlands
water supply and sanitation engineer
water supply issues; sustainability; O&M; support levels required; comparison with other available and non-available groundwater lifting technologies; ESA appreciation; replicability

Mr Boris Engelhardt Local Consultant from Nicaragua
mechanical engineer
technical issues on functioning and performance of rope pump; private mechanical workshops; technical capacities; spare parts distribution; repair requirements; cost aspects of rope pump and parts manufacturing;

Mr Antonio Belli Local consultant from Nicaragua
institutional/private sector expert
institutional and private sector issues; replicability; and their sustainability

APPENDIX 2: Evaluation Programme and staffing

DATE	Consultants					Location	Activities
	Lam	Belli	Bred	Engel	Brik		
9 Feb	x	x				Managua	- discussions with RNE and SNV on programme - organize briefing meeting with organizations (write letter containing mission goals + aim of briefing) - distribute pre-evaluation survey - arrange logistics - arrange fieldtrips and visits to field-based organizations - arrange guide: from Bombas de Mecate, for region Esteli, Chinorte, Juigalpa and Nueva Guinea - leave specific questions for Bombas de Mecate, SNV, Cosude etc. - collect project-specific documentation
10 Feb	x					Managua	- continuation of above
6 Mar		¼				Pre-evaluation (Managua)	- follow-up logistics/organization briefing - collect responses to pre-evaluation survey - analyze responses - follow-up COSUDE: guide & group meeting - Bombas de Mecate: guide (familiar with location old and new pumps),
7 Mar	x		x		x		Travel to Managua, Nicaragua
8 Mar	x	x	x	x	x	<u>Managua</u>	a.m. • Briefing SNV • Briefing workshop SNV, SNV-PASOC, UNICEF, COSUDE, INAA, CEPAD • Briefing lunch RNE p.m. • visit Bombas de Mecate S.A. and Taller Lopez
9 Mar	x	x	x	x	x	Los Cedros, Leon, Chinandega, Somoto - <u>Chinandega</u>; Brik & Engel to <u>Managua</u>	• visit to sites along Route Direction Chinorte with "guide" • Meeting with COSUDE programme activities/outputs: La Parana, Los Lomones, La Flor, La Danta, Santa Ana • Visit COSUDE community groups/households c. rope pump/other pumps
10 Mar	x	x	x		x	Chinandega, Esteli, <u>Juigalpa</u>	• Visit to Taller Don Pompillo in Santa Cruz • Visit community groups/households rope pumps in surrounding Santa Cruz, Esteli with "guide" • Fielsvisits along the road to Juigalpa

11 Mar	x	x	x	x	x	Juigalpa, Nueva Guinea; Brik and Engel to Juigalpa and back to Managua	• Visit to Taller Gill and Taller Castro in Juigalpa • Fieldvisit to community groups/ households rope pump sites Juigalpa • Fieldvisit to rope pump sites along the road to Nueva Guinea
12 Mar	x	x	x	x	x	Nueva Guinea	• Meeting with SNV-PASOC programme activities/outputs in Nueva Guinea • Visit with "guide" from SNV-PASOC different household and communty rope pump sites
13 Mar	x	x	x	½	½	Nueva Guinea, Managua; Travel of Brik	Analysis, reporting and team discussion; Group Meeting Organized? Team members possibly individual to Bombas de Mecate?
14 Mar	x	x	x	½	½	Managua	Participatory workshop with organizations (½ day) Debriefing RNE and SNV; report writing
15 Mar	x		x			Travel to Holland	

legend: Lam.= Lammerink; Bred.=Bredero; Engel=Engelhardt; Brik=Brikké

APPENDIX 3: Pre-evaluation questionnaire

The rope pump, as developed over the last fifteen years in Nicaragua, seems to fulfil the criteria for an appropriate groundwater lifting device. Before wider promotion and application is being stimulated, it was suggested to have the present rope pump experiences in Nicaragua evaluated. The Royal Netherlands Embassy and SNV/Nicaragua and the PASOC Programme in Nueva Guinea were willing to financially support this evaluation. The evaluation mission is planned for the period 8 to 15 March 1995. If the evaluation results are positive, the intention is to publish a promotional document (apart from the evaluation report) to inform agencies active in the water sector on the rope pump's potential.

The overall objective of the evaluation is to assess the short- and long-term performance of the rope pump in view of its potential for wider application and active promotion in and outside Nicaragua. In short the evaluation will measure the technological, socio-economic and institutional sustainability and replicability of the rope pump in comparison with other pumps. The evaluation will also look into the factors that lead to the reported success, the institutional (workshop) conditions, and other conditionalities of the private sector involvement that may have potential for replication in other countries.

Prior to the evaluation mission we would like to ask you to answer some questions on your and your organization's experiences with the Nicaraguan rope pump and other mechanical handpumps.

- What are your and your organizations' experiences with different rope pumps, both older models and newer models, including the type from "Bomba de Mecate SA"?
    - could you elaborate on installation (year); project/private context; who installed; how promotion; training; how do they functioning; O&M aspects (preventive maintenance; repairs; spare parts supply; required input from pump mechanic) ; use (household/ community); purposes (drinking water/irrigation etc.); appreciation by users.
    - what are the strong points of these pumps (old and new types of rope pump) and what are the weak points and the commonly reported problems (by users; mechanics);
    - where should the rope pump be further improved?
    - is there a further market in Nicaragua for the rope pump?

- Do you or your organization have experiences with other types of handpumps, e.g. Maya, India Mark II or III, AFRIDEV, Demster etc
    - if yes, see same sub-questions as for rope pump (above)

- Is there potential for replication of the rope pump technology in Nicaragua?

    - could more workshops be established;
    - what would be the technical/organizational requirements for success of new workshops;
    - could rope pump technology further be improved in Nicaragua?

APPENDIX 4: List of persons consulted or met during evaluation mission

Eduard Zeledon Guillen, Director DAR Region I
Carmen Pong Wong, Director of Rural Acueductos, INAA
Xiomara Arguëllo Vanegas, INAA
Mario Antonio Rocha, INAA-DAR VI
Santos Gomez Castellon, DAR PROMICU-COSUDE, Region II
Eduardo Zeledon Guillén, INAA-DAR 10
Mario A. Cajine R., INAA-DAR region VI
Gustavo Montiel Calero, INAA-DAR region V

Concepcion Mendoza Castro, social promotion UNOM-INAA, Chontales
Gustavo Ernesto Montiel Calero, director DAR, region V
Carlos Rivas Nravaez, responsable of INAA-DAR in Nueva Guinea
Fernando Flores Aquilar, manager of INAA regional, Juigalpa

Henk Alberts, Advisor to Bombas de Mecate SA
René Meza, Bombas de Mecate SA
Danis Solis, Bombas de Mecate SA
Juan Gago, Bombas de Mecate SA
Rafael Diaz Diaz, UNICEF
Ignacio Lopez, Taller Electromecanico Lopez
Reynaldo Erlach, Taller Electromecanico Lopez
Rafael Castilla Castro, Taller Castilla in Juigalpa
Henk Holtslag, CESADE, Aerobombas de mecate
Don Pompillo, Taller in Santa Cruz
C. Jill, Taller Jill

Rafael Diaz Diaz, UNICEF
François Munger, asesor COSUDE
Gilbert Bieler, asesor PROPAR/COSUDE Honduras
Oscar Sanchez, director PASOC-SNV Nueva Guinea
Nieke Bosma, PASOC-SNV Nueva Guinea
Osmundo Solis Orozco, social promotion PASOC-SNV Nueva Guinea
Nelson Laguna, CEPAD
Ariel Montesdeoca, SNV
Rene van der Poel, SNV
Paul Borsboom, Region VI
Karel van Kesteren, Embajada de los Paisos Bajos
Kenny Espinoza, Post-Chinorte project, Somotillo
Donald Rios, responsable of Palo de Hule

The following institutions and workshops were visited:
PASOC-INAA, Nueva Guinea
INAA-DAR region V, Juigalpa
Post-Chinorte, Somotillo
Bombas de Mecate SA
Taller Electromecanico Lopez, Managua
Banco Central de Nicaragua
Taller Castilla, Juigalpa
Taller Gill, Juigalpa
Don Pompillo, Santa Cruz, Esteli

Taller Las Planetas, Sebaco

APPENDIX 5: Individual and communal pumps visited

8-3-1995:
- Los Cedros: different demonstration rope pumps;
- Taller Lopez, Managua: different demonstration pumps (cycle, aeromotor etc.)

9-3-1995:
- Carratera Vieja Leon km. 67, family and on farm use;
- Oro Verde, Carratera Vieja Leon km. 68, familiar use;
- Carratera Vieja Leon km. 84, family use;
- Cooperativa COPINIM, use in agriculture;
- Farm house, family use and for cattle;
- Cooperativa COPAPO, two motor rope pumps for use for forestry nursery;
- Colonia Graca, Chinandega, four in four family houses, emergency family use;
- Post-Chinorte, Comarca La Pavana, 2 communal pumps for 7 and 4 families;
- Post-Chinorte, Comarca Los Limones, comunal use;
- Post-Chinorte, Los Balcones, comunal use;
- Post-Chinorte, comunal;
- Post-Chinorte, Sector 1 La Danta, comunal use;

10-3-1995:
- Km 148 via Chinandega-San Isidro, at the side of big farm house, family use;
- Km 154 via Chinandega-San Isidro, family use, out of order;
- Don Pompillo, Santa Cruz, family use;
- neighbourer of Don Pompillo, Santa Cruz, family use;
- neighbourer of Don Pompillo, Santa Cruz, family use;
- Santa Cruz, comunal use;
- Santa Cruz, in big garden of owner Hotel el Meson, two pumps for family and agricultural use;
- Santa Cruz, small farm house, two pumps on platforms for irrigation;
- Santa Cruz, in small farm house, pump with bicycle wheel for family and agricultural use;
- Santa Cruz, Agustine Monks, on platform for comunal use;
- Esteli, self constructed in family house;
- San Isidro, various families, family use;
- Near to Dario, road to Sebaco-Managua, comunal pump out of order;
- Bomba familiar en comunidad
- Puerta Vieja no. 2, comunal use on perforated well;
- Road to Sebaco-Managua, in cattle farm pump with wind mill;
- on lake shore (represa) road to Juigalpa, wind mill with rope pump for irrigation;

11-3-95:
- Llano Grande, comunal use on perforated well
- LLano del Higo, comunal use on perforated well
- La Rinconada, comunal use on perforated well
- San Diego, comunal use
- Los Santos, comunal use on perforated well

- El Triunfo, comunal use
- San Juan, comunal use
- San Juan, comunal use

12-3-95:

- urban area of Nueva Guinea, wooden ropepump, family use
- El Paraisito, comunal use
- La Esperanza, comunal use
- Nuevo Leon, comunal use
- Nuevo Leon, comunal use
- Pozo el Malinche 4, comunal use
- Los Angeles, comunal use
- Lavandería, urban area of Nueva Guinea
- Nueva Guinea, tree experimental rope pumps in INAA

APPENDIX 6: Output of the SWOP Workshop in Managua

Evaluation Mission of the rope pump in Nicaragua

Meeting held on Tuesday, 9 March 1995

Present:
Mr Santos Gómez Castellón (DAR-PROMICU-COSUDE,RII)
Mr François Munger (COSUDE)
Mr Nieke Bosma (PASOC-Nueva Guinea)
Mr François Brikké (IRC)
Mr Marc Lammerink (IRC)
Ms Xiomara Arguëllo Vanegas (INAA)
Mr Marteen Bredero (IRC)
Mr Mario Antonio Rocha (INAA DAR VI)
Mr Eduardo Zeledón Guillén (INAA DAR I0
Mr Boris Engelhardt (CICUTEC)
Mr Antonio Belli (CICUTEC)
Mr Ariel Montesdeoca (SNV)
Mr Rene van der Poel (SNV)
Mr Rafael Díaz Díaz (UNICEF)

1. Interventions

INAA : Willingness to develop the rope pump because it is a local product, easy to maintain, and the investment and operation and maintenance costs are low. Acceptability by the communities; low-cost technology, advantageous for low-income areas.

COSUDE : The rope pump is a reliable technology; it is viable and exists through the empowerment of the people; it is necessary to define norms and standardize the trade mark. It is easy to instal and repair but there are still some technical problems to be solved.

UNICEF: The rope pump has to be used and adopted; there is too little environmental protection; technical characteristics must be identified; quality control of the construction is lacking (in Managua, this is not a problem but elsewhere there are no norms for workshops); there is hardly any opposition from the community. The rope pump is very resistant; communities' attitude has to change.

PASOC : There are many advantages but also disadvantages; the pump's useful life varies between five and ten years only; it is difficult to convince people that after five years they must change the pump; some technical elements must change.

2. Workshop:

Strength :

. easy to install and maintan
. low-cost
. easy to construct
. can be produced with local spare parts
. accessible with level of knowledge
. adaptability of use, depth

Weakness :

. fragility of the material
. short average useful-life
. few investigation of alternatives
. availability of spare parts (Bluefield)
. production control is lacking
. semi-industrial
. needs follow-up
. too little environmental protection
. untidy installations
. to what extent can it compete with other pumps

Possibilities:

. important market for the pump
. export experience to other countries
. large-scale production
. improve quality of materials
. needs designing
. research
. wooden rope pump
. low-cost investment and maintenance communal pump

Threats:

. short useful-life compared to other models
. preventive maintenance is lacking
. tendency to complicate the design and centralize production
. spare parts markets can disappear
. lack of spare parts
. lack of institutional interest
. standardization

APPENDIX 8: Output participatory de-briefing workshop in Managua

Minutes of the Meeting
Evaluation mission of the rope pump in Nicaragua
SNV Offices in Managua, 14-3-95, 9.30-13.30

present

Mr. Marc Lammerink (IRC)
Mr. Maarten Bredero (IRC)
Mr. Henk Alberts (Fundación DESEAR/ Bombas de Mecate S.A.)
Mr. Juan Gago Gonzales (Bombas de Mecate S.A.)
Mr. Boris Engelhardt (CICUTEC)
Mr. Antonio Belli (CICUTEC)
Mr. Eduard Zeledón (INAA Región I)
Mr. Mario A. Cajine R. (INAA-DAR Región VI)
Mr. Gustavo Montiel Calero (INAA-DAR Región V)
Ms Xiomara Argüello Vanegas (INAA-DAR Región I)
Mr. Osmundo Sólis Orozco (INAA-PASOC Nueva Guinea)
Mr. Niek Bosma (PASOC Nueva Guinea)
Mr. François Brikké (IRC)
Mr. Henk Holtslag (Consultant CESADE/Taller López/Aerobombas)
Mr. Gilbert Bieler (Consultant PROPAR/COSUDE Honduras)
Mr. François Munger (Consultant Agua y Saneamiento COSUDE)

Agenda

- Summary of the mission's journey;
- Presentation of preliminary conclusions;
- Questions and observations;
- Presentation of recommendations;
- Discussion.

Route followed by the evaluation Mission

For the evaluation the Mission followed this route: Los Cedros, León, Chinandega, Somoto, Santa Cruz, Estelí, Juigalpa and Nueva Guinea. This included visits to various rope pump manufacturers, as Taller de Bombas de Mecate S.A. in Los Cedros, Taller López in Managua, Pompillo in Santa Cruz, Las Planetas in Sébaco, and Gill y Castilla in Juigalpa. Many pumps were visited and users in charge of maintenance were interviewed, as well as representatives of ISAs. Also, institutions as the Banco Central de Nicaragua in Managua, INAA-DAR in Juigalpa and Nueva Guinea, and PASOC in Nueva Guinea were visited.

Preliminary economic conclusions

The rope pump is cheaper than other pumping technologies but it is not accessible to the poorest segment of the population. At the beginning maintenance costs are low but after four or five years they can amount to the initial cost. When the pump has been donated the users feel less responsible for it. Workshops cannot subsist by producing rope pumps only. The price of the pumps is determined by Bombas de Mecate S.A. and the rest of the workshops adapt their prices to it. The potential demand of the rope pump is high; the effective demand is low. There is a market both for private pumps as for communal pumps. The present production structure could not supply the potential demand. There is no export market for the pump, but there is a market for its technology.

Preliminary institutional conclusions

The pump got off to a bad start: at MAG instead of INAA. Commercial production was important but more important was the fact that INAA adopted it. The market for communal pumps is limited but from the point of view of institutions it is important. The pump is appropriate for people to venture into maintaining and repairing it themselves. Where there is strong institutional presence these initiatives were not taken. The promotion of the pump undertaken by a company is a very important pioneering initiative. It would be possible for one workshop to satisfy the local demand. Also it would be worthwhile to introduce a do-it-yourself "kit". Production norms are important but it is not the only thing that must be undertaken.

Preliminary social conclusions

The pump has vast acceptance within the population and often opposition comes from technicians and bureaucrats. In general the users of the rope pump are women and children. The men use it at farm level. The users appreciate the amount of water, the initial low cost, the low cost of operation and maintenance, and sometimes the good taste of the water. Health is an additional benefit emphasized by institutions. The pump is still too expensive for poor people. Maintenance is easy, usually better in familial pumps but with sufficient institutional follow-up it is also good in communal pumps. The costs of the rope pump are low but there is little will among the people to make monthly payments. Women prefer rope pumps above all other hand pumps; mini aqueducts are appreciated more.

Preliminary mechanical conclusions

All workshops work on their own and do not interchange experiences. Corrugated steel bars are not convenient for the pumps. The best pumps are those that use less welding. If the life of the pumps would be doubled it would mean an increase of 10% to the initial price. Quality and normalization of the rope and pistons are lacking. The minimum "kit" for self construction should consist of rope, guides and pistons. The designs used need improvement. The ideal combination would be: a pump that could be distributed and promoted as Bombas de Mecate S.A. does it, with the technical design of Taller Castilla and with the production quality of Taller López. The most resistant pistons found are those produced by Huletecnic. For private clients the maximum price is approximately 600 Córdovas.

Preliminary technical and operational conclusions

Almost all the rope pumps that were seen, even some very wornout, were working. They need frequent but simple maintenance. Many of the pistons found did not have optimal measures due to bad quality or excessive use. The life of the pumps depends more on the maintenance and care given to them than on the quantity of water lifted. The volumetric efficiency of the pumps varies between 40 and 80%. For the users this efficiency does not seems to be important. The useful life of the pumps varies between three and more than twelve years. The maximum depth of pumping found was 60 meters but there is information of greater depths. The quality of the pump could benefit from the standardization of technique, material and sizes. The availability of the spare parts varies according to the region.

Observations

After each presentation there was room for questions and observations:

- Considering that the greater quantity of pumps are of familial use, there is relatively too much emphasis at communal level.
- Monthly fees of communal users are established by the communities themselves, but INAA gives them advice. There are various systems of self-financing.
- Organizational problems with communal pumps are not only of training order but also of social order.
- The initial low-cost of the pumps allows institutions to install them for less families.
- Operation and maintenance training is important to lower the costs of O&M.
- Bombas de Mecate S.A.'s promotion has had influence in the success of the pump but there are also other factors.
- Self construction should not be underestimated.
- Users learned to repair the pump not only from Bombas de Mecate S.A./COSUDE's folder but also through their own experience.

- The attitude of the people after the useful life of the pump depends on the institutional presence and their method of work: if their presence was low, people will consider paying for a new pump themselves.
- It is important to be able to replace the pump in parts.

Recommendations

A preliminary document containing the mission's recommendations was handed over.

Main points:
- Consolidation of technical aspects;
- Conscientization at national and international levels;
- Large scale production;
- Training;
- Dissemination to poor population.

Discussion

- The recommendations are very general. We need to study the market, have proposals of models, producers, community users, disperse population, etc.
- This is not an action plan, besides it is clear to whom the recommendations are directed.
- The recuperation of costs is an achievement if it is accomplished by the community, but if it is achieved by the State, people's confidence is less and it is very expensive (ex. Honduras).
- With a million dollars a year and a State subsidy of 50%, the coverture of 70% of the rural population could be achieved.
- To improve the pump, the cover, the design and an promotional programme must be considered.
- The final goal is health, but the convenience it offers to families is also important.
- In order of effectivity for the health are: the pump, the cover, the head wall, the hygiene seal.
- Self construction would allow expenses of the head wall, cover, etc.
- There is much space for saving with self construction.
- A specific technology must be focused to disperse population.
- There will be self construction and semi-industrial production but among these there will always be the workshops.
- Self construction does not mean a return to basics. Norms are needed for the pistons, the guide, the head wall's design and the axel's fixation Pipes are already standardized, even though they do not function very well.
- It is very important to set norms for the "kit" and for the semi-industrial production.
- Norms are very important for workshops; to be truthful they have not experienced it yet.
- There are at least two markets for different types of pumps. Cooperation between different actors is very important.

APPENDIX 9: Efficiency rate of rope pumps evaluated

We define the volumetric efficiency as the relation between the real flow and the theoretical flow. The theoretical flow is the flow that a pump could lift without losses. We calculate it as the velocity of the pistons multiplied by the interior diameter of the lifting pipe. In this simplified calculation we do not take into account the volume of the rope and the pistons.

The volumetric efficiencies indicated in this report are estimates based on the measurement of the number of revolutions per minute that a pump makes to produce some drops of water. This rotating velocity of the pulley and its diameter gives us the piston's velocity which in this case is equal to Vp; the relative velocity between the pistons and the surface of the water above in the lifting pipe is Vr. In normal use the pulley will make 50 revolutions per minute and the pistons will go up at a Vp velocity, faster than the Vr. Assuming that the Vr does not vary much with the velocity of the pistons between 0.1 and 2 m/s, the volumetric efficiency is calculated as (Vp-Vr)/Vp.

The Vr velocities found varied between 0.16 and 0.69 m/s, and mostly between 0.25 and 0.45 m/s. The volumetric efficiencies found varied between 0.37 and 0.84, with an average of 71%.

Besides volumetric efficiency there are other efficiencies that could be measured. Energy efficiency, for example, indicates the relation between the energy that represents the elevation of the water lifted, and the energy applied to set the pump working. We have not carried out this type of measurements within the frame of this evaluation.

In general, technicians put a lot of emphasis on the different types of efficiency of the pump. Nevertheless, the users do not seem to care much whether the efficiency is 70 or 80%.

APPENDIX 10: Illustration of windmill/rope pump system

APPENDIX 11: Articles on Rope Pump Experiences from *Waterlines* and *IRC Newsletter*

Terms of Reference

Evaluation Programme and Staffing

Pre-evaluation questionnaire

List of persons met during evaluation mission

List of individual and communal pumps visited

Output of SWOT workshop in Managua

Output of SWOT workshop in Juigalpa

Output of participatory debriefing workshop in Managua

Efficiency rate of rope pumps evaluated

Appendix 10

Illustrations of windmill/rope pump system

Appendix 11

Articles on rope pump experiences from *Waterlines* and *IRC Newsletter*