



AFFORDABLE
SMALL-SCALE
IRRIGATION
TECHNOLOGIES



**INTERNATIONAL
DEVELOPMENT
ENTERPRISES (IDE)**

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1. Introduction

Using Appropriate Small-scale Irrigation Technologies

As a Tool for Poverty Reduction

Since its inception in 1981, International Development Enterprises (IDE) has pioneered a market-based approach to poverty alleviation and smallholder farm income generation through purchase and use of affordable small-scale irrigation technologies. Innovation of low-cost, small-scale irrigation technologies including: hand and treadle pumps, drip and mini-sprinkler systems, and water storage units, have dramatically improved the lives of millions of poor farm families in developing countries. These technologies are produced and sold to smallholders using the local capacity in the private. This enables large numbers of small farmers to increase their livelihoods through use of these income-generating technologies.

The majority of the rural poor are subsistence farmers with limited access to productive assets, credit sources, and markets. As a result, their agricultural productivity and income are low, and they are highly vulnerable to climatic extremes, price variations, environmental degradation, natural calamities, family illness, and other economic shocks. Scarce water resources and/or a lack of control over water are pervasive constraints facing a large number of the rural poor worldwide. Appropriate, affordable, and accessible irrigation technology can provide a basis for increased agricultural production and income generation.

Low-cost drip irrigation and treadle pumps are suitable for small plots and ideally suited for use by poor, smallholder farmers. These technologies are of less interest to more wealthy farmers with larger landholdings. As a spin-off benefit, micro-irrigation technologies stimulate the rural economy as financially empowered smallholders begin purchasing goods and services from rural markets. Local small enterprises are engaged in the production, distribution, and installation of the micro-irrigation equipment, creating employment in the rural non-farm sector. Small-scale irrigation technologies also contribute to gender equity by reducing women's workloads, improving family nutrition and providing a source of independent income for women.

IDE has taken up the challenge of spreading and intensifying the use of appropriate small-scale irrigation technologies in developing countries through a process that IDE calls PRISM (Poverty Reduction through Irrigation and Smallholder Markets). It envisions the smallholder as a micro-entrepreneur who transforms natural resources (land and water), human resources (labor and know-how) and purchased inputs into high value agricultural products that can be marketed at economically rewarding prices. IDE has proposed a simplified methodology to assist in the creation of pro-poor rural market systems based on: a) identification and exploitation of market opportunities, and b) water control. Since water is an important factor in all agriculture production systems, affordable micro-irrigation technologies play an important role in integrating smallholders in the market system and improve their livelihoods.

2. Affordable Drip Irrigation

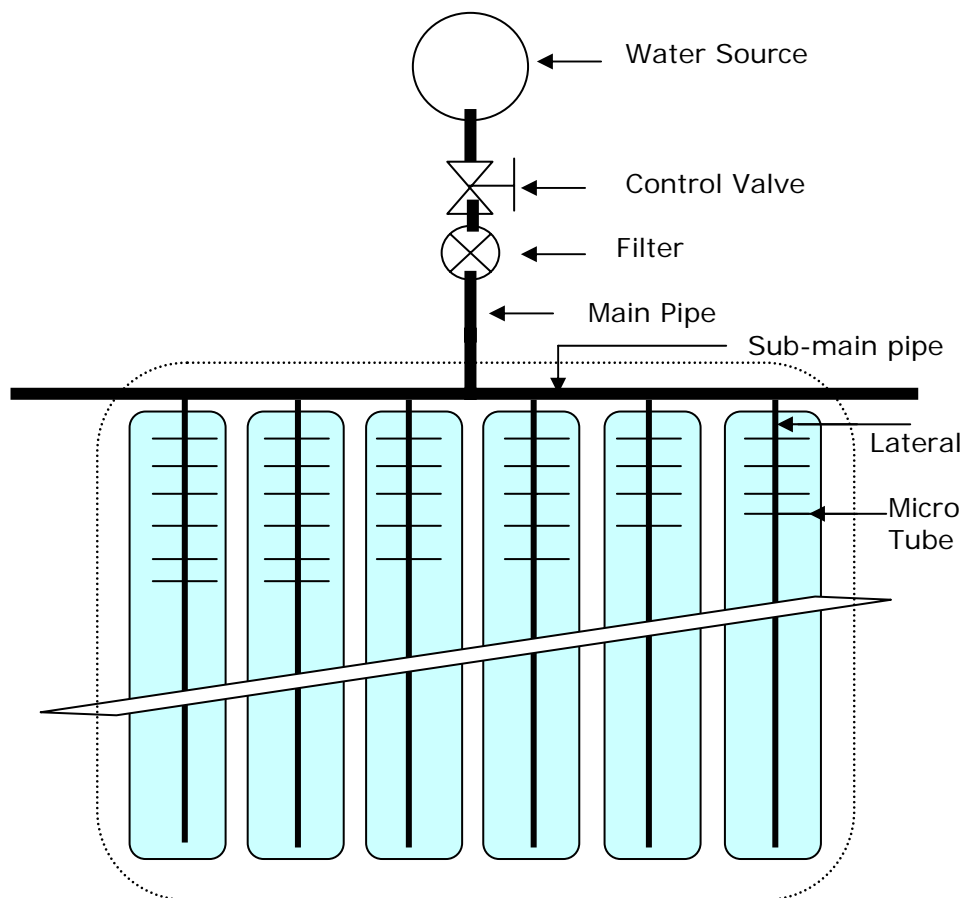
IDE has been conducting research and development of low-cost, low-pressure drip irrigation systems since 1990. Our primary objective is to develop and promote systems that are affordable for farmers with very small land holding (smallholders). Key to our success has been the development of low-cost drip systems based on components that can be profitably produced by small local manufacturers and distributed through the private sector without subsidies.

Advantages of Drip Irrigation

1. **Affordability:** The irrigation systems are available in affordable sizes at low price as compared to other costly irrigation systems.
2. **Improved Yield:** Slow, regular and uniform applications of water and nutrients to the plants increases productions and improved quality.
3. **Water Saving:** There are applied water savings of from 50 to 80 % compared to most traditional surface irrigation methods, thus a larger cropped area can be irrigated from a given supply of water. But of even greater importance the production per unit of water consumed by crop evapotranspiration is typically increased by 10 to 50 %.
4. **Labor Saving:** Less labor is required for irrigation, weeding, and fertilizer application as compared to traditional irrigation methods.
5. **Fertilizer Saving:** By placing soluble fertilizer directly in the irrigation water, which is delivered to the root zone, fertilizer losses are minimized.
6. **Energy Saving:** Drip systems operated with gravity pressure or with low-pressure low horsepower pumps.
7. **Difficult Terrain:** Drip systems can be used on undulated terrain (hilly area) where irrigation using open channels is difficult.
8. **Tolerance to Salinity:** High yields can be obtained even with high salinity water because the slow and regular application of water decreases the concentration of salts in the active root zone.
9. **Uniform Application of Water:** Since water is applied uniformly to all the plants, there is uniformity in growth and the crop quality and yields are high.
10. **Improved Pest Control:** Regular irrigation ensures timely inter-culturing operations and spraying etc., which provides better pest control and prevents spread of diseases that would occur under traditional surface irrigation methods.
11. **Reduced Cultivation Costs:** Less land preparation and weeding is required.

Drip irrigation is the slow and regular application of water, directly to the root zone of plants, through network of economically designed plastic pipes with low-discharge emitters.

Basic Components of Drip System



A typical affordable small-scale drip irrigation system has the following components:

1. **Water Source:** The packaged systems, which are referred to as a “drip kits” are low-pressure system that uses gravity to provide the necessary water pressure. For small systems, the water source can be an overhead tank placed at a minimum of one meter above ground level. For larger systems, the height of the tank should be increased. If the height of the tank cannot be increased the system can be connected to a manually or mechanically powered pump that lifts water from a source, such as a well, farm pond, storage tank, a stream or canal and pressurizes the distribution system.
2. **Control Valve:** The control valve is made of plastic or metal and sized to fit the flow rated of the system. It is used to regulate water pressure flow into the system.
3. **Filter:** A strainer or filter is required to ensure that clean water enters into the system. The size of the filter is determined according to the flow rate of water in the system.
4. **Mainline:** A poly vinyl chloride (PVC) or polyethylene (PE) pipe is used to convey water from the source to the sub-main. The size of pipe depends on the flow rate required.
5. **Sub-main:** PVC or PE sub-main pipe is used to supply water to the lateral lines, which are connected to the sub-main at regular intervals.
6. **Laterals:** Lateral pipelines made of low Density PE are placed along the crop rows and microtube emitters are installed along then to provide water to the plants. For

most drip systems, the lateral pipe ranges from 10 mm to 16 mm. Their wall thickness is either thick enough to keep them round in shape even when empty, or thin-walled so they lay-flat when empty.

7. **Emitters (see microtube emitters below):** These are the outlets through which water is discharged to the plants.

Microtube Emitters for Precision Water Control

IDE has experimented with many options for low cost precision water delivery for resource poor farmers. The simplest configuration was perforated plastic tubes (which are still being used by IDE-Nepal). We have also reviewed and tested sophisticated on-line emitters. However, we found that using short microtubes for the emitters provides the best solution for addressing cost, flexibility in use, uniformity in water application, and ease of maintenance. Some of the reasons IDE has chosen to use microtubes (they were used in the earliest precision drip irrigation systems in the 1950s) as opposed to on-line emitters are:

Low Cost:

1. The lay-flat lateral tubing (see *KB Drip* below) with microtube emitters is very low-cost and thus affordable for smallholders without subsidies;
2. The lateral tubing can be manufactured locally using simple low-cost extruders, are compact, and easy to transport; and
3. The microtube is also easy to manufacture and transport.

Flexibility and High Uniformity of Application:

1. The spacing between On-line emitters is fixed at the factory while microtube emitters are inserted in the field where spacing can match the plant spacing, for example, the crop spacing may be different in various parts of the farmer's plot and they may even have some tree crops;
2. Emitters made of short lengths (20-cm) of microtube provide excellent uniformity in water distribution at low pressures (as good as any on-line emitters); and
3. It is not possible to achieve good hydraulic performance with a simple perforated tube (instead of emitters), while on-line emitters requires high precision manufacturing using very expensive and sophisticated extruders.

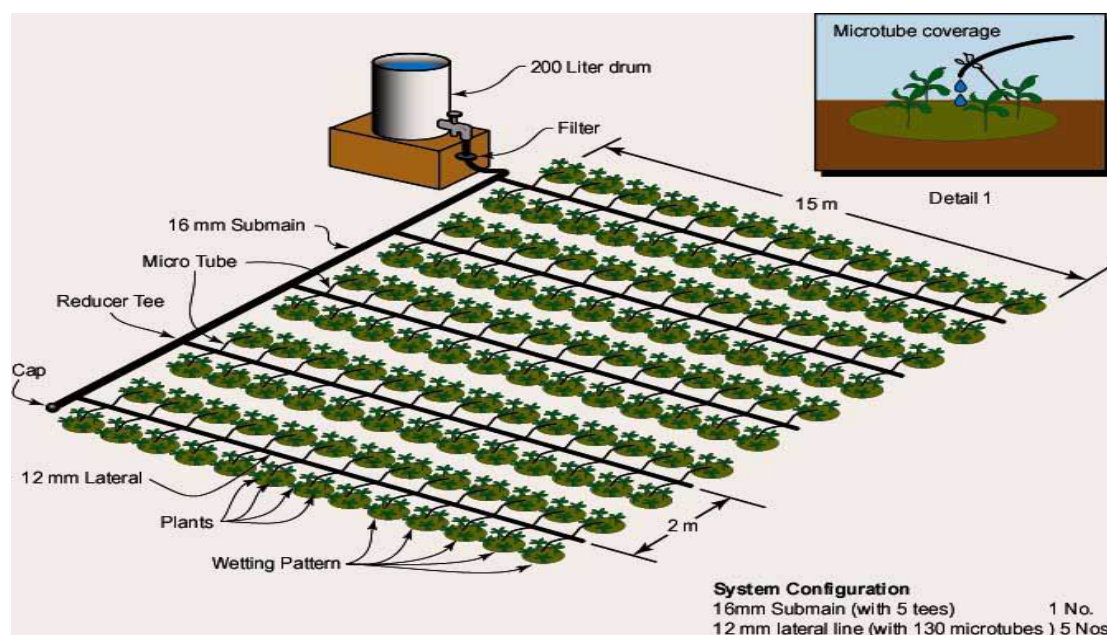
Ease of Operation and Maintenance:

1. Farmers with very little training can understand how to install and operate microtube systems and monitor their performance;
2. Pressure testing of the distribution system is simple and intuitive using a clear plastic tube, this is not possible with on-line emitters;
3. The water filtration required for microtube emitters is much simpler than what is required for typical on-line emitters; and
4. When a microtube emitters become clogged it can usually be cleaned or inexpensively replaced, which is impossible to do with on-line emitters.

3. *KB Drip* – A New Innovation In Low-Cost Drip Irrigation

The cost of microtube based drip systems is proportional to weight of the plastic material required. Regular drip systems have laterals with round cross section and larger wall thickness (1 to 1.5 mm). A major breakthrough in low-cost drip came with the development of *KB Drip*. (“*KB*” stands for the Hindi words “*Krishak Bandhu*”, which means “farmer’s friend”.)

KB Drip utilizes lay-flat laterals (that looks like tape when it is in a roll) with a wall thickness of only 125 micron (0.125 mm) or 250 micron (0.25 mm) and is 16-mm in diameter when filled with water. The *KB Drip* lateral was developed from thin plastic tube used to sell cold candy (Freez-it). The machine to produce *KB Drip* is also less costly as compared to the regular plastic pipe extruder. Microtubes are used as emitters with *KB Drip* to provide uniform water application. The cost of an installed *KB Drip* system in India is around US\$ 600 per hectare for closely spaced crops like vegetables or cotton. The inlet pressure head for the *KB Drip* systems can range from 0.5 to 3 meters. In view of the severe water scarcity and very low purchasing power of small farmers the performance of *KB Drip* systems are very satisfactory.



Schematic Drawing of 100 m² *KB Drip* Kit

Advantages of *KB Drip*

KB Drip has all the advantages of regular drip irrigation mentioned above. It differs from commercial state-of-the-art drip irrigation systems in having significantly lower in cost, is available in small packages, operates at very low pressures, and is easier to understand and operate. *KB Drip*'s low initial cost removes the entry barrier for small farmers to adopt drip irrigation. Even with its low-cost and low pressure operating characteristics, *KB Drip* performance with respect to uniformity of water distribution is as good as the most expensive commercial systems. As farmers earn profit from irrigated agriculture they can switch to more durable systems if desired.

The following table shows the salient features and the costs of different sizes of *KB Drip* kits. The costs given are ex-factory and they do not include taxes, duties and transportation or markups for dealers and the cost of instillation and any after sales service.

Salient Features and Prices of *KB Drip* Kits*

| Specification | <i>KB Drip</i> Kit (EDK 20) | <i>KB Drip</i> Kit (EDK 100) | <i>KB Drip</i> Kit (EDK 500) | <i>KB Drip</i> Kit (EDK 1000) |
|--|---|---|--|---|
| Area Coverage | 20 m ² | 100 m ² | 500 m ² | 1000 m ² |
| Microtubes | 60 | 300 | 91500 | 3000 |
| Number and Length of Laterals | 4 laterals 5.0-m long | 10 laterals 10-m long | 40 laterals 12.5-m long (to each side of the sub-main) | 40 laterals 25- m long (to each side of the sub-main) |
| Sub-Main OD and Length | 16-mm OD 3 m | 16-mm OD 9 m | 32-mm O.D. 20 m | 50-mm O.D. 20 m |
| Screen Filter Size | Screen Filter (12 mm inlet & outlet size) | Screen Filter (16 mm inlet & outlet size) | Screen Filter (25 mm inlet & outlet size) | Screen Filter (32 mm inlet & outlet size) |
| Operating Head (Height of Tank) | 1 meter | 1 meter | 2 meter | 2 meter |
| Emitter Flow | 2.5 liters/hour | 2.2 liters/hour | 2.4 liters/hour | 2.2 liters/hour |
| Water Storage | 20-liters | 200-liters | 1000 liters | 2000 liters |
| Price (US\$)** | 3.00 | 12.00 | 38.00 | 60.00 |
| Crops | Vegetable crops like: Tomato, Egg Plant, Onion, Cabbage, Rape Seed, Paprika, Cauliflower, Garlic, Water Melon, Cucumber, Lettuce etc. The larger systems are also short duration fruit crops like bananas and papaya etc, with only a few modifications. | | | |

*Basic specifications: microtube emitters 0.3 m long 1.2-mm ID; emitter spacing 0.30-meter intervals; *KB Drip* tape laterals of LLDPE material; row spacing at 1-meter intervals along LLDPE sub-mains.

**Prices ex-factory (contact IDE for quotations)

4. Micro/Mini-Sprinkler System:

Micro and Mini sprinkler kits are available in sizes from 100 to 1000 m². Systems more than 1000 m² can be customized to suit specific requirements. Micro-sprinklers are spaced at 3m x 3m mini-sprinklers are spaced at 6m x 6m in order to produce uniform wetting. Micro-sprinklers requires 5 m to 10 m operating pressure whereas mini-sprinkler requires 10 to 15 meters of operating pressure. Micro and Mini sprinklers can be shifted from one place to other to cover larger areas.

| Micro Sprinkler System (Shiftable) | | |
|---|-----------------------|------------|
| Type of Kit | Area m ² | Cost US \$ |
| Micro- Sprinkler Kit (MS2) | 125 with five shift | 6 |
| Micro- Sprinkler Kit (MS4) | 250 with five shift | 10 |
| Micro- Sprinkler Kit (MS8) | 500 with five shifts | 15 |
| Micro- Sprinkler Kit (MS16) | 1000 with five shifts | 25 |

5. Treadle Pump -- Pedaling Out of Poverty

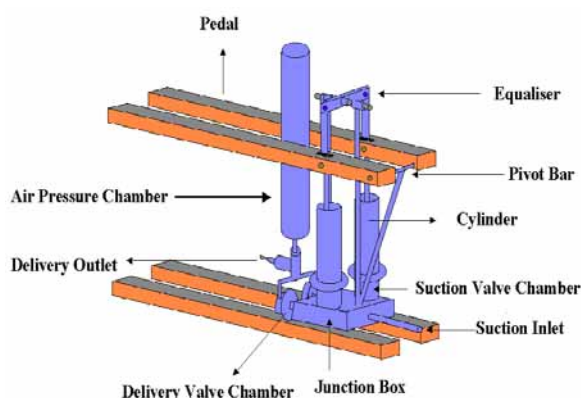
The Treadle pump (also known as Pedal pump) is a water-lifting device similar in principle to the hand pump. The difference lies in the fact that a hand pump consists of a single barrel or cylinder and requires arm and upper body motion to operate, whereas the treadle pump comprises two cylinders and is foot operated. One person, whether a man, woman or even a child, can operate the pump by manipulating his/her body weight on two foot pedals or treadles while holding a frame for support.

IDE developed several treadle pump models to match soil, water, and income conditions in the different regions of operation. Two major types are described below:

1. **Suction Treadle Pump:** The suction treadle pump lifts water from an underground or lower level source and delivers it at the elevation of pump. It does not pressurize water to lift it above the pump. The suction treadle pump can be installed at higher elevations—a platform or earth mound—to enable gravity flow through field channels or a pipe.



2. **Pressure Treadle Pump:** The pressure treadle pump lifts water from any water source and brings it to the surface. Water is discharged from the pump under pressure so it can pump water to an elevation above the pump. It can be connected to sprinkler or drip system for system irrigation. It can also be connected to a long delivery pipe to move water to whatever point required for irrigation.



Applications

The pedal pump is ideal for areas where the water table is high, ranging from 10 feet to 25 feet below the ground. The pump is promoted by IDE in the eastern part of India, tarai region of Nepal, Vietnam, Cambodia and Zambia. It can be installed on tube wells (made of GI, PVC or bamboo), ponds, canals, streams and dug wells.

One pedal pump is appropriate for irrigating up to one hectare of cultivable land. It is ideal for vegetable cultivation. The treadle pump is well suited for small and marginal farmers.

Why Treadle Pump for Small Farmers?

In the past small farmers used locally built water lifting devices, such as *tenda*, *dhekuli*, *sena*, *tar* and *don*, to irrigate their small land holdings. Drawing water manually from rivers canals and wells with these devices has been in practice for ages, and is prevalent even today. These traditional irrigation methods have many disadvantages, the main being that they are very laborious and time consuming; and restricted to surface water or open wells.

For small farmers diesel and electric pumps are too expensive to purchase, operate, and maintain for irrigating a small plot. Compared to the traditional water lifting devices and the costly diesel and electric pumps, treadle pumps have the following advantages:

1. **Low-Cost and Affordable.** It is cheaper than diesel and electric pumps. Besides, there is no need for diesel, electricity or battery to operate the treadle pump. The operating cost is household labor. A marginal farmer in the Gangetic basin can easily get full return of his/her investment within three to four months of purchase and usage.
2. **Easy to Operate.** One just has to pedal to lift water from a tube well. It is so easy that even a child, a woman or even an old person can operate the pump. Adults can operate for hours at a time. It is possible to pedal while in a sitting position. In addition to being easier to operate the treadle pump delivers much more water for an equal lift and pumping period than a hand pump.
3. **Easy to Install on any Well.** The treadle pump can not only be installed on a 1.5” tube wells but also on 3” and 4” tube wells that are meant for installing electric and diesel pumps.
4. **Light and Portable.** A farmer can easily carry the treadle pump (except the concrete model) on his/her head or shoulder or can transport it in a cycle carrier. This is important for farmers who have a number of small plots in different locations. They can buy one pump, drill a bore on each plot and shift the pump from one plot to another for irrigation..
5. **Sturdy and Durable.** The barrels of both the metal and bamboo treadle pump models are made of sheet metal and hence are sturdy. The concrete pump is sturdy because of its weight.

The following table shows different IDE treadle pump models and their respective cost. The costs given are ex-factory and they do not include taxes, duties and transportation or markups for dealers and the cost of installation and any after sales service.



Pressure Pump India # 2 (Pressure Pump developed in India)

Different Treadle Pump Models and Their Respective Cost

| | Model | Cylinders & Diameters (mm) | Discharge (liters/hour) | Ideal Water Depth (m) | Price (US \$) |
|-----------|---------------------------|---------------------------------------|--------------------------------|------------------------------|----------------------|
| 1 | Bamboo Pedal Pump-3.5 | 2 x 89 | 4500 | 2.5 to 5.0 | 15.00 |
| 2 | Metal Pedal Pump-3.5 | 2 x 89 | 4500 | 5.0 to 7.5 | 25.00 |
| 3 | Metal Pedal Pump-5 | 2 x 127 | 5400 | 4.0 to 6.0 | 35.00 |
| 4 | River Pump (Zambia) | 2 x 90 | 5400 | 4.0 to 6.0 | 40.00 |
| 5 | Concrete Pump | 2 x 127 | 5400 | 4.0 to 6.0 | 40.00 |
| 6 | Surface Treadle Pump | 2 x 90 | 5000 | 4.0 to 6.0 | 32.00 |
| 7 | Pressure Pump (India # 1) | 2 x 109 | 5000 | 4.0 to 6.0 | 45.00 |
| 8 | Pressure Pump (India # 2) | 2 x 106 | 5000 | 4.0 to 6.0 | 40.00 |
| 9 | Pressure Pump (India # 3) | 2 x 106 | 5000 | 4.0 to 6.0 | 50.00 |
| 10 | Pressure Pump (Zambia) | 2 x 90 | 4500 | 4.0 to 6.0 | 60.00 |
| 11 | Pressure Pump (Zimbabwe) | 2 x 90 | 4800 | 4.0 to 6.0 | 65.00 |
| 12 | Pressure Pump (Cambodia) | 2 x 106 | 4500 | 4.0 to 6.0 | 50.00 |

6. Rope and Washer Pumps

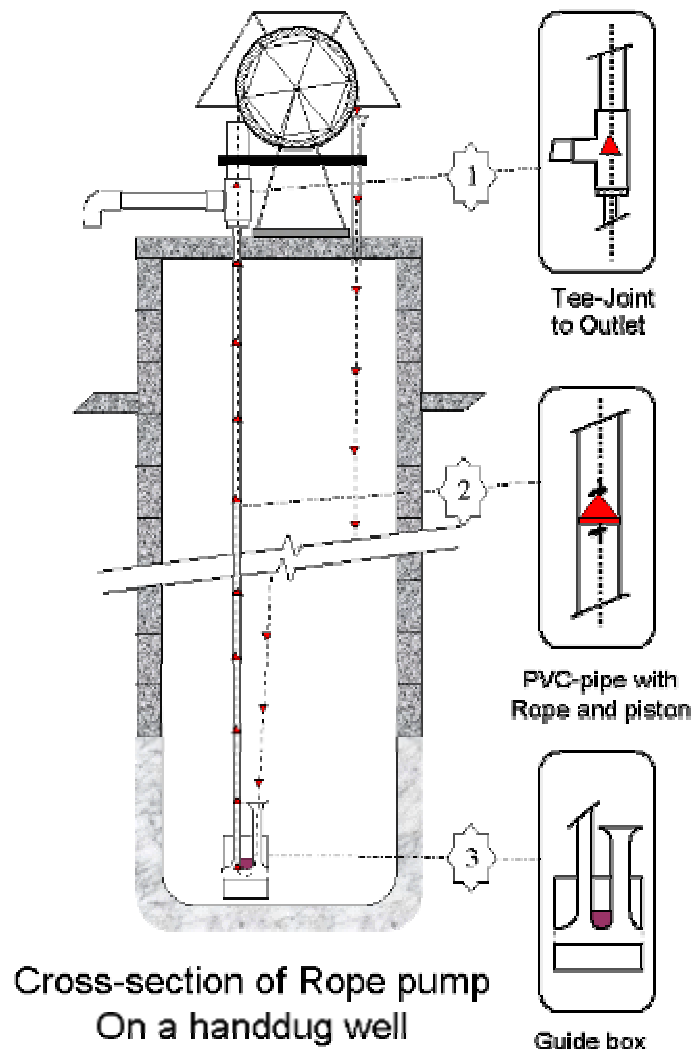
The pumping elements of the rope pump are pistons fixed on endless rope, which pull the water to the surface through the pumping pipe made of PVC or plastic. The rotation of the wheel, moved by a handle, pulls the rope and the pistons. The pistons, made of polypropylene or polyethylene injected into molds, are of high precision to prevent hydraulic losses. The structure is basically made out of angle iron, piping, concrete and steel. The pulley wheel is made out of the two internal rings cut out of truck tires and joined by staples and spokes. This must be strong for intensive use. A guide box at the bottom of the well leads the rope into the pumping pipe. The guide box is made out of concrete with an internal glazed ceramic piece to prevent any wear. The rope pump can be operated by any member of a family or used at the community level, for small agriculture production or cattle watering. It is also a high

efficiency and low-cost technology, but includes some pieces of high precision and high quality.

Application

Rope pumps are installed on hand dug wells, drilled wells or boreholes. The intake pipe does not need to be installed vertically. Thus rope pumps can be installed at the side of rivers. The guide box is positioned on the bottom of the well since sand does not affect the functioning of rope pumps, as can happen with other brand pumps.

Under dry season conditions when the water table drops traditional pumps often stop delivering water even though villagers can still fetch water with a rope and bucket and users tend to blame the pump. In reality the pumps are fine but the need to space at the bottom of the well for the foot-valve to prevent sand from entering the pump. The rope and washer pump can draw water from closer to the bottom of the well as effectively as the manual rope and bucket.



The depth of the water table in drilled wells depends very much on the local geologic situation. A 4-inch well casing is the minimum diameter for the drilled wells for installing a standard rope pumps. The rope pump will work in casings as small as two inches but a smaller diameter pipe and guide box must be used reducing the capacity. The maximum

practical lifts (depths) for rope pumps are: 40-meters standard; and 60-meters with special adjustments and a double crank or mechanical power. However, rope pumps suitable for lifting water by up to 80 meters are in experimental phase

The diameter of the pipe that should be used varies with the depth from surface to the water level in the well as indicated in the table below

| Depth (meters) | Intake Pipe (inch) | Discharge Pipe (inch) |
|----------------|--------------------|-----------------------|
| 0 -- 11 | 1 | 2 |
| 11 – 19 | ¾ | 1½ |
| 19 – 50 | ½ | 1 |

The standards used in PVC pipe production differ from one country to the other and will thus influence in the indicated ranges.

Pumping capacity of the rope pump for adults and children with different pumping lifts (depths to the water surface).

| Lift or Depth (meter) | Adult (Liters/minute) | Child (Liters/minute) | Time needed for an adult pump 200 liters (minutes) |
|-----------------------|-----------------------|-----------------------|--|
| 5 | 70 | 39 | 3 |
| 10 | 41 | 19 | 5 |
| 15 | 27 | 13 | 8 |
| 20 | 20 | 10 | 10 |
| 25 | 16 | 8 | 13 |
| 30 | 14 | 6,5 | 15 |
| 35 | 12 | 5.5 | 18 |
| 40 | 10 | 4.8 | 20 |

Rope Pump Models and Prices

The rope pump is a simple technology that has been widely applied in the Nicaraguan rural area, especially in various water and sanitation projects and smallholder irrigation. The following models are available in Nicaragua.

- Pumps for drilled wells
- Double-crank pumps
- Arial pumps (to fill tanks)
- Bici-bombas (bicycle type pumps)
- Air pumps (activated by the wind)
- Animal traction pumps (activated by a horse or ox)
- Motor pumps (activated by a gasoline motor)
- Tractor-adapted pumps (Activated by the power of a tractor)

Typical prices in Nicaragua range between US\$ 30 and US\$ 90 depending on the type of rope pump and model.

Recently a new model rope pump was developed by IDE-India that has improved bearings and rope-washers. It is very efficient from the human energy standpoint and particularly suitable for local Indian conditions.

7. The EMAS Pump

A German engineer developed the EMAS pump in Bolivia. It consists of two PVC pipes, one pipe moving inside the other one with valve arrangements at the bottom of the pipes. The valve consists of simple ceramic marble, which opens and closes the valve opening as the inner pipe moves in and out to pull the water to the surface through it. It has a tee connected at the top with one end closed and the other end connected to a flexible pipe. The EMAS pump is operated with arm motion like a “rower pump” and water flows through the inner pipe and through the tee joint to the conveyance pipe. It can lift water from 0 to 50 meters of depth and also provide delivery head up to 30 meters.

Important Features

Some of the important features of EMAS pumps are:

- Manually operated with arm motion.
- Made of local PVC Pipes.
- Two pipes (Inner & Outer).
- Valves made of Marbles.
- Inner pipe with horizontal pipe at the top for handle and outlet.
- Discharge 25 liters/minute at 10 m depth.
- Range of Suction depths – up to 7 meters.
- Range of Delivery head – up to 50 meters.

Applications and Cost

Some of the important features of EMAS pumps are:

- Mainly for domestic water supply and home gardening.
- To lift ground water and fill a tank.
- To transport shallow ground water long distances on the farm.
- To lift water from underground and put it in overhead tank for drip systems.
- To lift water and operate micro-sprinkler system.
- Cost – US\$ 1 to US\$ 1.50 per meter ex-factory.



8. LAY-FLAT TUBING FOR WATER CONVEYANCE

Conveyance of water from the source to planted area, by gravity or at low pressure is done using plastic pipes. These plastic pipes are made from different plastic polymers including: Polyvinyl Chloride (PVC), High Density Polyethylene (HDPE), Low Density Polyethylene (LDPE), Linear Low Density Polyethylene (LLDPE) or recycled material of the above polymers. The virgin material is durable whereas the recycled material has a shorter life. PVC has less resistance to the ultraviolet rays as compared to polyethylene and therefore pipe made from PVC has to be buried underground for a longer life. Polyethylene pipes have larger wall thickness and are costly as compared to PVC pipe. IDE developed thin walled pipes from LLDPE, which are produced, like the lay-flat tubing used as *KB Drip* tape, can be used as a flexible tubing to convey water from one place to another using low pressures or gravity.

Important Features

Some of the important features of lay-flat tubing are:

- Since it flattens like a tape it can be coiled in a compact roll and requires less volume and cost for transport
- Made of virgin LLDPE material.
- Develops into complete round tube shape on pressurizing.
- Available in 32 mm and 50 mm sizes.
- Wall thickness 0.7 to 1 mm.
- By careful selection of manufacturing sizes, standard adaptors, fittings and take-offs can be used for drip and sprinkler system

Applications and Prices

The principal features and typical prices for lay-flat tubing are:

- For conveying water from source to the field by gravity.
- To transport water at low pressure up to 2 Kg/cm².
- As mainline and sub-main pipe for drip irrigation system.
- As mainline and sub-main pipe for micro-sprinkler system.
- With treadle pumps to transport water from the pump to the field.
- 32 mm pipe - 0.20 US\$ per meter ex-factory.
- 50 mm pipe – 0.29 US\$ per meter ex-factory.
-

9. Water Storage for Multiple Uses

For many small farmers, access to water for drinking and irrigation follows a feast or famine pattern. Either there is too much water during the rainy season requiring measures to mitigate or prevent flooding, or there is an acute water shortage during dry season when there not only is no water available for irrigation, but drinking water wells run dry requiring emergency drinking water supplies.

One solution to this problem is to store water that is available during the rainy season in low-cost, non-evaporative storage systems that make it available for drinking and/or for irrigation and other uses during the dry season. Enclosed storage is expensive, starting at a purchase price of 2.5 cents (US) per liter for a ferro-cement tank (about one Rupee/liter in India). IDE

has developed a prototype low-cost design water storage unit that will sell at an unsubsidized price for roughly \$40 to 50 (US) 10,000 liters, or 0.4 cents (US) per liter.



A newly installed 10,000-liter storage unit installed in a 1-meter wide by 1-meter deep by 10-meter long trench.

Over a 4-month period in 2003-4, IDE India tested five different low-cost water storage systems in India. Each system stored approximately 8,000 liters of water at a cost of approximately \$30 (US). Each consisted of a plastic totally enclosed water bag installed in a hand-dug trench. The cost of these initial units was in the range of Indian Rs 0.10 per liter. Several problems that required design modification were identified during these tests but the tests also provided proof of concept.

A further series of tests is currently under way. The second stage, field-testing will use standardized 10,000-liter storage units that are designed to fit in a 1-m wide x 1-m deep x 10-m long trench. The storage units are like casings for large sausages. They will be made with a three layer laminated walls, with a 50 to 100 micron outside layer and a 150 to 200 micron black LDPE inside layer that form a “sandwich” over a 100-micron high-density PE (HDPE) woven sack-cloth inner layer for strength.

Tests are planned to identify stored water requirements for 100-m² *KB Drip* Kit plots growing a 3-month horticulture crop in Maharashtra, India. The estimated stored water requirement for crops planted in the October through January period is 30 m³. Planting in the months from March through April is estimated to require 50 m³ of stored water. Water conservation through surface and in-soil mulching will also be tested. This phase of testing will be complete by September 2005, but the initial results are expected by the end of June 2004.

Storing for Multiple Uses

Tests are being carried out using the water storage bags for the following uses:

- Storage for domestic use;
- Storage for multiple use—domestic use and small plot micro-irrigation;
- Storage to enable daily microirrigation when the water source is intermittent, i.e., available only once a week;
- Supplemental storage for farmers with wells that provide ample water supplies during and for a few months after the rainy season, but “run dry” before the next rainy season.