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Treadle pumps *for* irrigation in Africa

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TREADLE PUMPS FOR IRRIGATION IN AFRICA

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Are treadle pumps a viable option for Africa?

Treadle pumps – what are they?

Over the past decade, a small but significant revolution has been taking place in small-scale irrigation in the developing world with the introduction of the treadle pump. This simple, human-powered device can be manufactured and maintained at low cost in rural workshops in developing countries. Its acceptance in Bangladesh, where it was first developed in the early 1980s, has been described as extraordinary. Over 500 000 pumps are now in daily use in that country.

How treadle pumps work is described in detail in the relevant chapter. The principle is based on suction lift using a cylinder and piston to draw water from a source below ground level, for example a river or shallow groundwater. Originally developed for hand pumps for domestic water pumping, it has been skilfully adapted for use in irrigation, where much greater volumes of water are needed, by changing the driving power from arms and hands to feet and legs. These have much more powerful muscles and so are capable of lifting much more water. Two pistons are used, each connected to a treadle. The operator stands on the treadles, pressing the pistons up and down in a rhythmic motion.

Two pumps have developed from this idea. The first was a *suction pump* to lift water from a shallow source and discharge it over a spout into a canal for gravity irrigation. This was developed in Bangladesh where farmers needed to lift large quantities of water through shallow lifts of 1-2 m. The second development was the *pressure pump*. This works on exactly the same principle as the suction pump but the delivery end was modified so that water could be fed into a pipe under pressure for sprinklers or hoses. It is also better at lifting water from deeper sources than the suction pump. This development came from the needs of African farmers who often have to lift water from deeper sources, in excess of 4 m, and irrigate undulating land with sprinklers or hosepipes.

What pumps are available in Africa?

Both suction and pressure pumps are available and are in use in many countries throughout Africa. In this report are details of the pumps used in Zambia, Zimbabwe, the Niger and Kenya.

Which pump gives the best performance?

Two pump types are available and many modifications have been made to them to suit local operating conditions. Which is the best pump? This may seem a reasonable question to ask but in reality it is a most difficult one to answer. First, the two main pump types are designed to do different tasks and so they are not directly comparable. Second, there is not enough information available on all the design modifications to enable effective comparisons to be made between pumps of the same type. There are differences in design, e.g. the materials used, dimensions of components and the standards of workmanship and in the methods of testing. A more appropriate question, and one that can be answered, is: Which is the best pump for particular site conditions?

In Africa, treadle pump development has been largely based on the Bangladesh pump, with modifications to suit African conditions. This is essentially a suction pump, redesigned so that it can also be used as a pressure pump. ApproTEC (Appropriate Technologies for Enterprise Creation), a non-governmental organization (NGO) based in Kenya, developed new designs for both suction and pressure pumps, which it believes is better suited to Africa. Its designs are based on the need to lift water from deeper sources, irrigate more hilly lands and be portable for security. Essentially, they exploit the principle of mechanical advantage (the lever principle) very effectively to get higher pressures. A recent design by a Swiss organization has introduced a suction pump that exploits the same principle.

The first choice is thus between suction and pressure pumps. The second choice is between the Bangladesh design and the Kenya design.

Suction pumps

These are designed for lifting large volumes of water from relatively shallow water sources (1-2 m). Pressure is not usually an issue. The Bangladesh suction pump model is the most appropriate in this situation, because this is the job it was designed to do. When water sources are deeper, however, the ApproTEC and the Swiss suction pump designs, with additional leverage, start to come into their own.

Average discharges based on sustainable pumping over the day for one operator would be in the range of 1-2 litres/second for shallow sources. This would increase if there were two operators working together. For the deeper sources, lower sustainable discharges can be expected: 1 litre/second or less would be more realistic.

Pressure pumps

These are designed to create pressure, so the volume of water lifted is less important. They are used when water sources are deep (more than 4 m) and there is a need to deliver water under pressure to sprinklers, drippers or to a header tank. This requirement may also be the result of irrigating undulating or steeply sloping land. The ApproTEC pressure pump model, which exploits a high mechanical advantage, is more appropriate in this situation. Total pumping pressures up to 14 m can be obtained but the discharge will be low at this level of pressure, about 0.3-1 litre/second. The Bangladesh model will still do a good job but it is less appropriate and it will be difficult to operate at the higher pressures. This is not the job it was designed to do.

When quoting pressures, it is the total pumping pressure head that matters. This is the sum of the suction head and the delivery head. They cannot be separated. If a pump produces a total pumping pressure of 14 m, then with a suction lift of 3 m, the delivery pressure will be 11 m. If the suction lift increases to 5 m, the delivery pressure will fall to 9 m.

It should be noted that treadle pump design is not an exact science, because of the difficulty of standardizing the power input, which depends both on the physical strength of the operator and the ability to sustain this power over a period of time.

Beware of comparing pump performance data from different manufacturers. Some are tested in laboratories, some in the field. There are also unanswered questions about the operators used in testing. Were they heavy or light? Was there one or were there two? How fast did they treadle and for how long? Unless there is a common basis for testing, a detailed comparison between pumps on a performance basis will need careful interpretation.

Finally, deciding which pump is best is not just a question of technical performance. Judgement must be based on a wide range of factors, including costs and benefits, reliability, maintenance, availability of spares and a complex range of local social issues. The experience of others in dealing with these issues forms an important part of this report.

How much do they cost?

Pump prices in Africa vary from country to country but are in the range US$50-120 (see Table 1). The differences are due to the different costs of labour and materials in each country.

Table 1. Pump prices

Country	Suction pump	Pressure pump
Zambia	60–77	100–120
Zimbabwe	Not available	Not available
The Niger	100	100
Kenya	53	75

Prices in US$

Prices also vary along the supply chain from the manufacturer to the farmer, as each group that handles the pumps is paid for the service they provide. Table 2 gives some indication of the levels of mark-up for pumps sold in Kenya.

The mark-up by ApproTEC pays for the services they put into the marketing effort, which is a key to pump sales.

In Zambia, prices vary at present, depending on the way pumps are supplied. Most retailers are unable to get credit to buy pumps directly from manufacturers and so the majority of pumps are bought by an NGO, International Development Enterprises (IDE), who pass them on to retailers on a commission basis. IDE carries the financial burden and the retailer receives a commission when pumps are sold. This route is more expensive than the more traditional direct route from manufacturer to retailer, so IDE has introduced a temporary subsidy to bring prices into line (see How are they sold to farmers?).

How many have been sold?

The data in Table 3 show that significant numbers have been sold on a commercial basis and give some idea of the likely uptake of treadle pumps based on the substantial levels of marketing that have been used to promote them. The majority of these pumps are reported to be still in use.

The numbers give some indication of the manufacturing capacity that must be built up to meet the demand for pumps once promotional work begins.

Note that not all the pumps made in Kenya are actually sold in Kenya. They are distributed throughout Uganda and the United Republic of Tanzania as well.

Table 2. Mark-up on pumps sold in Kenya

Activity	Suction pump	Pressure pump
ApproTEC buys pumps from manufacturers	29	43
Dealers buy pumps from ApproTEC	46	63
Farmers buy pumps from dealers	53	75

Prices in US$

Table 3. Number of pumps sold in each country

Country	Date introduced	Suction pump	Pressure pump
Zambia	1997	1 113	208
Zimbabwe	1988	-	>400
The Niger	1997	265	162
Kenya	1996	3 925	-
Kenya	1998	-	2 705

Who manufactures them?

One of the prerequisites for successful uptake is local manufacturing capacity. In most of the country reviews, pumps were initially imported into the country to take advantage of well-established designs. This was, however, quickly replaced with local manufacture. All the pumps described in this report need specialist skills and tools to produce them to a good standard. In most cases, NGOs have taken on the responsibility for approaching potential manufacturers, providing them with designs, materials lists and specialist tools and then training them to construct the pumps.

In many countries, manufacturers produce only the metalwork components known as the pump head. The NGO then takes on the task of bringing together the other components, before a pump is ready for delivery to farmers. These components include the wooden treadles, ropes and the pump seals, which may be imported injection products, locally produced leather or rubber from tyres. This final pump assembly process is potentially a weak link in the local supply chain at the moment, although strengthened by the NGOs. To be sustainable, assembly will need to be carried out locally by the manufacturer or the distributor.

Most workshops can manufacture treadle pumps, once staff are trained and have the right tools. Manufacturing precision is important if the pumps are to be durable and perform reliably and well in the field. Consequently, important aspects of local production are quality and quality control over all aspects of the manufacturing process. Because manufacturers are often not familiar with this, it became necessary for the NGOs to introduce systems of quality control and to train staff in the procedures. The process rejects all faulty pumps, while the good ones are certified for use in the field and carry a mark to confirm this. This has led to the introduction of a guarantee of repair or replacement for faulty workmanship in the first 12 months of use.

Local capacity in the countries reviewed was more than able to meet the requirements of producing good-quality pumps, although some experienced early difficulties. Manufacturers generally were not very customer-oriented; it will be some time before they realize that a good-quality product creates satisfied customers and can bring in more business. This is the beginning of a sustainable supply chain.

How are they sold to farmers?

The emphasis here is on selling pumps to farmers on a commercial basis, rather than supplying them as gifts. The connection between the farmer as a customer and the manufacturer as supplier is generally not a good one. A distribution network or supply chain is essential to link the farmer with the manufacturer. It consists of manufacturers, wholesalers, retailers, NGOs/partners and customers (farmers). In Zambia there are eight manufacturers, 28 retailers and 30 active collaborating partners, who are all involved in the distribution and sale of treadle pumps.

IDE has been the catalyst for setting up supply chains in Zambia. This involves IDE acting as a distributor linking manufacturers to retailers, because many retailers do not have the capital or the access to credit to work directly with manufacturers. IDE established agreements with manufacturers to allow pumps to be supplied on a consignment basis for sale at their offices and through registered retailers. Retailers only pay IDE

for pumps when they are sold, for which they receive a commission incentive. The money is then paid to the manufacturers to produce more pumps. In spite of a few teething problems, the arrangement is reported to be working well.

This input from IDE is only temporary; retailers are slowly being encouraged to go direct to manufacturers and establish a more conventional chain. Some already do this and are able to negotiate more competitive prices. Once it has become more established, IDE intends to concentrate on promotions and marketing.

Retailers were selected because of their strategic position in major provincial towns, for their level of commitment to the programme, the strength and reputation of their business and their accountability and willingness to accept the low price mark-ups that were being recommended. Agreements were made with them to adhere to the pricing structure. In return, retailers received pumps on a consignment basis, together with promotional literature and operation and maintenance manuals. They were also trained to use the pumps and in methods of promotion.

A group of sales agents was recruited to promote and sell pumps directly to farmers and receive payment on a commission basis.

In Kenya, ApproTEC takes responsibility for ordering and buying pumps from manufacturers and for sale and delivery to retailers or dealers. Dealers must purchase a minimum of ten pumps but ApproTEC allows the first batch of ten to be sold on consignment. This arrangement is common for new products in Kenya and came about from the unwillingness of many dealers to take the financial risk of investment without proven local sales. Later batches are purchased with 50 percent paid up front, although some dealers are paying in full at delivery. NGOs who purchase pumps from ApproTEC are treated as dealers: they pay the wholesale price for the pumps.

Sales through dealerships have proved to be by far the best mode of distribution. Commissioned sales people found it difficult to make a living solely from pump sales. ApproTEC originally targeted hardware stores in urban or peri-urban centres as pump dealerships. However, focus was later shifted to agricultural and veterinary (agri-vet) input stores in small to medium-sized towns, because these proved to have better access to customers. There are at present over 80 dealerships in Kenya, The United Republic of Tanzania and Uganda.

At the time of purchase, buyers fill out a guarantee form giving details of their location and planned use, which allows them to be tracked for extension services and monitoring. Comprehensive, regular surveys of randomly selected pump owners are made to determine the use and impact of the pumps.

In the Niger, there are cash flow problems similar to those in Zambia. In such cases, manufacturers provide credit to gardeners, especially at sites where the pumps are not well known. A contract is arranged with a gardener, who agrees to make a down payment (negotiable, but usually 50 percent) and agrees to pay the balance by a mutually acceptable date. If the gardener defaults on payment, the manufacturer can repossess the pump and keep the down payment as a hire fee. The village chief or another responsible member of the community witnesses the contract.

The supply chain must also function as a conduit for spares, maintenance services and feedback to manufacturers. In the Niger, as part of the after-sales care, all the gardeners are visited at least three times – after one week, one month and six months – by a field agent and a representative of the manufacturer. During the first visit, a quality control check is made to ensure that manufacturers are continuing to follow the recommended norms for materials and procedures. The pump installation is checked and site-specific suggestions may be made to improve pump performance. The first visit is especially important for the first few pumps at a new site. Once several gardeners in an area have some experience, they are able to help their neighbours with installation problems. If a major manufacturing defect is identified, the manufacturer is contacted and obliged to correct the problem.

The lack of an effective supply chain in Zimbabwe is undoubtedly linked to the poor uptake of pumps there. They are well known in the country but no single agency has taken it upon itself to market them on a wide scale and production is not continuous.

What about marketing?

Local manufacturers are capable of producing good pumps but they are not so good at selling them. Indeed, they do not normally see this as their role. “If farmers want pumps, let them come and buy them” was a common attitude. This is not such a problem with well-known products but a more

aggressive marketing strategy is needed for new products, if farmers are going to benefit.

In Zambia, treadle pumps have been promoted principally through practical demonstrations on farmers' field days, at agricultural shows, at markets, in farmers' fields and at IDE offices. Demonstration gardens have been established in strategic areas where rapid adoption could be expected. These have provided farmers with the opportunity try out the pump in their own time. In these cases, pamphlets, leaflets and brochures were distributed to provide information about the pumps and where they can be purchased.

Other marketing activities have included advertising retail outlets and the pumps through radio programmes, television and newspapers. It is planned to start printing calendars and T-shirts that show treadle pumps in use and provide details of the benefits. Village theatre performances, too, have had a very favourable impact on sales.

Many partner organizations have also been recruited to participate in promotion. NGOs such as CARE International, Africare, the US Peace Corps and many others have not only promoted the use of treadle pumps but have also purchased pumps for use in their own programmes.

In the Niger, publicity has been an important part of marketing. The first step in a multifaceted publicity campaign was to choose a name for the pump. Staff chose Niyya da Kokari, a phrase meaning willingness and courage that is understood in the three main languages. A local acting troupe was commissioned to write a song extolling the virtues of the pump and publicizing its new name. It has been included in radio and television commercials and the brand name Niyya da Kokari is now well known throughout the country.

Television has been a major factor in creating brand name recognition. The same local troupe was commissioned to perform in a commercial for television, produced in Hausa and Djerma, that clearly conveys the advantages of the pump in comparison to traditional rope-and-bucket irrigation systems. Although this kind of publicity is expensive, the visual impact of seeing the pumps in action creates a very positive impression. The large number of people in rural areas who have reported seeing the television commercial has surprised project staff.

Audiocassette tape manuals using the local languages of Hausa and Djerma are used in preference to written manuals and have found a wider acceptance. A copy is supplied with each pump sold.

The lack of marketing effort in Zimbabwe is undoubtedly a major factor in the poor uptake of pumps there.

Are there preconditions for uptake?

Enterprise Works in the Niger investigated preconditions for uptake as part of their initial studies on the use of treadle pumps. They suggest that in order for a technology to be commercialized and adopted, it should be produced as close to the end-user as possible. It must be affordable for the buyer and profitable for the producer. The technology must also function reliably and the purchaser must be satisfied. It only takes a few dissatisfied customers to ruin the market for a new product. But no technology can be considered appropriate for all conditions. This is where the identification of appropriate sites becomes important. Appropriate criteria include:

- a market for vegetable products;
- a water source within 6 m of the ground surface;
- an adequate water supply (>1 litre/second per pump);
- a concentration of market gardeners using traditional water-lifting methods;
- adequate land available for garden expansion.

The best way to determine where there are concentrations of market gardeners is to start at the markets. By asking the vendors where the produce was grown, the more important gardening sites can be identified. Visits to markets also provide an opportunity for practical pump demonstrations.

What area can be irrigated?

This depends on the crops, the climate and the effectiveness of the way the farmer uses water. In broad terms, assuming an irrigation time of 20 hours per week, a crop water requirement of 25 mm per week, typical of a dry season in southern Africa, and a power input of 50 watts (only one person pumping water), the area that can be irrigated using a treadle pump is approximately 0.24 ha. Using watering cans under similar conditions would reduce the area to 0.03 ha. Surveys of small-scale irrigation in Kenya indicate an average area of 0.4 ha for suction pumps and 0.27 ha for pressure pumps. If

more than one operator is working the pump, the irrigated area can be much greater.

What are the impacts on farming practices?

The reported impacts on farming practices have been substantial and include:

- increased land area under irrigation;
- reduced work time compared with bucket irrigation;
- full irrigation of fields, resulting in improved crop quality;
- reduced frequency of irrigation to two or three times per week;
- less strenuous irrigation work compared with bucket irrigation;
- additional and new crops grown each season;
- increased number of growing cycles, as crops are able to grow faster with full irrigation.

What are the economic benefits?

The economic benefits of introducing treadle pumps can be significant. In Zambia, incomes have risen more than sixfold from US$125 achieved with bucket irrigation on 0.25 ha of land to US$850-1 700 using treadle pumps. This was attributed to increased crop yields and to being able to increase the area of land irrigated. Cropping intensity also rose in some cases up to 300 percent (three crops a year), with noticeable increases in the variety of crops grown. With more water available, farmers were more willing to take risks with new crops. Similar benefits have been reported in other countries where treadle pumps have been introduced.

In addition to the direct benefits for farming families, there is the positive effect on the whole supply chain of manufacturers, retailers and selling agents. Employment has increased in rural areas where artisans are manufacturing pumps, carpenters are producing treadles and an increased workforce is needed on the farm to cope with the additional produce.

But a word of warning. The increase in crop yields can bring with it the problem of a market glut when supply exceeds demand. This is a particular problem with common household crops and it is exacerbated by the tendency of farmers to grow the same crops at the same time of year. The search for new, more distant markets may solve this difficulty but it can create different problems. Transport is costly and difficult to find in remote rural areas with poorly developed feeder roads. It is also unreliable. A farmer may have to wait days for transport, which may result in deterioration of perishable produce, which in turn reduces profits.

Strategies to avoid the glut problem include:

- adoption of alternative cropping patterns;
- uptake of contract farming;
- linking with bulk buying companies;
- introducing solar drying and food processing technologies;
- adopting alternative low-cost transport such as bicycle-powered carts to get to distant markets.

Water resources can also limit economic growth in small-scale irrigation. A few farmers pumping from a small stream or shallow groundwater may not cause much of a problem but large numbers of farmers operating in the same area could result in overexploitation of the resource to the detriment of everyone. If the local watertable dropped by one or two metres, for example, this could put the water beyond the reach of treadle pumps.

What are the social and cultural impacts?

Social and cultural issues vary from country to country but they can play an important role in the adoption of any new technology. In Zambia, irrigating crops, weeding, fertilizing and harvesting of vegetables are generally considered to be women's activities. Women operate treadle pumps without any traditional or religious constraints and see this as an opportunity for empowerment. Women are targeted by organizations promoting treadle pumps and used in publicity material. It has been reported that women find the pumps harder to operate than men do. They do, however, find suction pumps easier to use than pressure pumps. Of all the pumps sold in 1999 in Zambia, only four were purchased by women, though women are the main users of treadle pumps.

In Zimbabwe, although treadle pumps are not so widely used, the improvement of family nutrition as a result of the increase in garden produce has been noted in many areas. There is little economic benefit, however, as most communities produce just enough for their own consumption. Very few farmers use treadle pumps to produce vegetables for marketing.

The cost of pumps is still beyond the reach of many ordinary communal farmers. More than half of the pumps in use were donated, and are thus community property. It has been observed that

individually owned pumps are much better maintained than those owned by the whole community.

Pumps are mostly operated by women and children, as they tend to do all work in the garden. Because an operator is elevated above the ground, women do not feel comfortable standing on the pumps for long periods. They feel exposed and consider it undignified. A sensitive issue has been men trying to discourage their wives from using the pumps, because they become overtired in the evenings. This issue is difficult to verify, although some people believe it is more speculation than reality

In Kenya, although men buy most of the pumps, women mainly manage them and then control and benefit from the additional income. However, most of the pumps are actually operated by young men hired by women managers. In contrast to this, men buy and operate most of the pumps used in the Niger.

Is training necessary?

Training for all those involved in the supply chain is essential if treadle pumps are to succeed. Suggested training needs for various groups are given below:

Government extension staff who work directly with irrigation farmers

- Training to build up capacity in irrigation in extension services, including horticultural methods
- Irrigation techniques
- Water management, including crop water requirements and scheduling
- Treadle pump operation and maintenance
- Stripping and assembling a pump to highlight technical aspects and the importance of proper installation procedures and maintenance of each component
- Field demonstrations with farmers

Retailers involved in purchasing pumps and selling them on to farmers

- Marketing and promoting treadle pumps
- Customer relations
- After-sales services
- Quality control and identification of a quality pump
- Record keeping
- Business development and accounting

Farmers using the pumps for irrigation

- Operation and maintenance of treadle pumps
- Water management
- Agronomic practices
- Basic market economics of supply, demand and the effects on prices

So are treadle pumps really appropriate for Africa?

Small-scale irrigation is seen as one of the success stories in many countries in Africa, at a time when large-scale developments have failed to come up to expectations. It is usually developed privately by farmers in response to family and local market requirements, without the need for government intervention. This has been at the heart of its success (Kay *et al.*, 1985). Treadle pumps introduced on a commercial basis seem to be ideal for the small farmer in this situation. The evidence available to date indicates that there is much to be gained by taking up this type of technology.

Attempts to use treadle pumps in Africa in the early 1990s were less successful than in Bangladesh. Conditions in Africa are very different from those in Bangladesh, however. The groundwater is much deeper and the irrigated land much more hilly, so the water must be pushed much further from its source to the point of use. Development of pressure pumps has helped to overcome this constraint and has transformed the situation, resulting in significant sales of pumps in many countries in the past few years.

It is important to bear in mind the social and cultural implications of introducing pumps of this kind, if the economic benefits are to be realized. There will also be a great deal of work to be done in setting up the supply chains and ensuring that there is sufficient manufacturing capacity of a high enough quality to meet the demand. As demand usually needs to be stimulated when new technologies are introduced, there is the opportunity to combine marketing activities with the development of supply chains. In this way, it may be possible to balance the level of expectation created among farmers with the means of satisfying it.

All the pumps described in this report require specialist machine tools and parts to ensure production of efficient, reliable units. There are those who argue that the specialist tools and components bring with them an unacceptable level of dependence on others. If spare parts are not available or if local

skills are insufficient to cope with routine maintenance and repair, the system is unlikely to be sustainable in the long term.

To be profitable, a technology must have a low overall cost – low enough not to overexpose the owner to debt. It must then make money. Fear of failure has often driven people towards high tech solutions to avoid the problems of breakdown. All machinery fails eventually. In developing countries, however, failure tends to occur sooner because maintenance is poorer and the conditions are more hostile. The result is the machinery graveyards that can be seen surrounding many towns and villages. For this reason, the need for strong supply chains to support the supply of spare parts and maintenance must not be underestimated.

A final comment from experience in East Africa indicates that four preconditions are vital for the sustained success of treadle pumps:

- a market-driven demand and suitable environmental and economic conditions and a significant population able to afford the pump and sustain local demand for horticulture;
- a well-designed pump that is appropriate for the local farming, economic and manufacturing systems;
- a local private sector capability for mass production and quality control;
- effective private-sector distribution networks for agricultural inputs and equipment, including transport, infrastructure and retailers.

Is there a role for Donors and NGOs?

Donors and NGOs can take action to facilitate and enhance treadle pump use. Donors can fund viable projects where the four preconditions for sustained success are met. NGOs can play an important role in demonstration and promotion. Donors and NGOs, however, should not donate or sell pumps below retail cost. They should support the private sector and avoid actions which can skew the market and result in detrimental impacts on consumer-driven demand.

Background

As previously stated (see Treadle pumps – what are they?) introduction of the treadle pump, which can be manufactured and maintained at low cost in rural workshops, represents a significant revolution in small-scale irrigation in the developing world. Its acceptance in Bangladesh, where it was first developed in the early 1980s, has been described as extraordinary, with over 500 000 pumps now in daily use in that country.

The costs of buying, running and maintaining engine-driven pumps for irrigation are prohibitive for most small farmers in the developing world. The majority rely on traditional human-powered water lifting devices but these too have their drawbacks. They are essentially bucket-lifting technologies operated by hand, such as shadoofs and scoops, which are slow and cumbersome and require high labour inputs to irrigate very small plots of land. Water lifting rates are at best 0.5-1.0 m^3/h. Treadle pumps have been changing all this. They use the legs, which have much stronger muscles than the arms. They work in a comfortable, rhythmic walking motion, lifting up to 2.5-5 m^3/hr by suction from rivers or shallow groundwater – enough to irrigate between 0.2-0.4 ha in most tropical and arid countries.

The first treadle pump was designed and developed by Gunnar Barnes, a Norwegian agricultural engineer working for the Rangpur-Dinajpur Rehabilitation Service in Bangladesh in 1981. The early designs where called tapak-tapak pumps by the farmers, because of the sound they made.

Treadle pumps of various designs are now available in many African countries. Various NGOs introduced a lot of these from Asia. Manufacturing has tended to be small-scale, by blacksmith or small enterprises, with an emphasis on low cost. Prices vary from country to country, but most pumps are sold to farmers at between US$50-100. The Food and Agriculture Organization of the United Nations (FAO) has promoted them through its various Special Programme for Food Security (SPFS) initiatives. A notable success has been their uptake in Zambia. Development still continues, with tests looking at long-term performance and maintenance needs and improvements to pressure delivery pumps. There is probably still scope for improvements in ergonomics and opportunities for mass production.

The International Programme for Technology and Research in Irrigation and Drainage (IPTRID) commissioned this report on the status and prospects for treadle pumps in Africa, particularly concerning how smallholders can take up such devices to support irrigation. In view of the fact that treadle pumps are now being used in many African countries, this document is a state-of-the-art report. It identifies what needs to be done by agencies, donors, NGOs and manufacturers to make such pumps acceptable and accessible for smallholders. It is aimed at irrigation professionals, donors, decision makers and NGOs promoting small-scale irrigation in Africa.

Information has been provided from many sources. Particular reference is made to the national experts who were commissioned by IPTRID to collect up-to-date information from a number of African countries.

The report begins with a review of the different treadle pumps currently in use in Africa and the information available on their technical performance, with a view to trying to answer the question – Which is the best treadle pump? Or perhaps more appropriately – Which is the best for a given situation? This is followed by reports prepared by national experts on the experience of using treadle pumps in different countries across Africa. These principally address the important issues of economic and social impact of this technology change, its acceptability and sustainability. This experience should help those who are just beginning to think about treadle pumps, wondering if they are right for them and, if so, how best to introduce them into their situation.