

# Serving the smallholder farmer through rural product innovation

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## The rural farmer; the entrepreneur

In India, when the sun rises, more than 140 million farmers<sup>i</sup> head out to their fields. These farmers are focused on one thing: cultivating enough crops to feed their families. They haul water to pour into furrows in fields that dry up quickly in the heat. It's an ongoing battle - a continuous race - to keep their crops watered and food coming in.

But a new farmer is emerging. A business-savvy entrepreneur that is moving beyond the cycle of putting a meal on a single table. This professional smallholder farmer is feeding her community, not just her family. When she wakes up in the morning, she is confident in her ability to irrigate her crops - one of the most critical elements to creating a secure and sustainable agricultural business.

How did she arrive here? Aside from hard work, she invested in an [advanced treadle pump<sup>ii</sup>](#), which has the design and technology to elevate her farm's yield. She is able to exert minimal effort to maximize her irrigation capabilities, which has enabled her to expand her arable land and increase crop production.

She aspired to create a better life for her family and community, and with the help of the treadle pump, she has

established a sustainable water management system that will continue to carry her toward a successful future.

## Customization for the rural market

Farmers comprise one-third of the global population. 1.5 billion of this third are smallholder, or subsistence farmers. In many countries, the average smallholder farmer owns 5 acres of land or less<sup>iii</sup>. These meager plots of land produce only marginal amounts of food annually which, when used for revenue generation, place this group of rural farmers at the base of the economic pyramid.

There are dozens of philanthropic organizations around the world that are working to help subsistence farmers. These organizations are providing seeds and fertilizers, doling out rudimentary equipment, or donating instructors and volunteers. These activities are driving substantial increases in livelihood; and, opportunities exist to ensure an even greater percentage of the right things reach the smallholder farmer and are more targeted to their needs.

**There's a better way to support  
the smallholder farmer.  
It starts from the ground up.**

## It's about respect

Smallholder farmers are customers of agriculture; customers that are seeking products, services and training to help them improve their business, which is to produce the highest crop yields possible each year.

It's essential to recognize the small, rural farming community as customers that are willing to pay a premium for quality products targeted to their specific needs. When it comes to irrigation systems and water pumps, there is opportunity to best serve this customer group with original products developed to meet those needs, versus providing modified products that may not connect as strongly with them. Organizations that provide modified versions of existing

# Essence of Life

Living on only a couple dollars per day, the smallholder farmer typically falls at the base of the economic pyramid, raising crops to feed his/her family. These individuals are caught in an ongoing cycle that can be broken if the following facts are considered.

**Poverty alleviation is impossible without food security.** Three-quarters of the world's poor live in rural areas and depend on agriculture, forestry and fisheries for their livelihoods. Agriculture plays an outsized role in poverty reduction.

**Food security is impossible without agriculture.** In many developing countries, agriculture generates one-third of the national income and employs more than half of the total workforce – the majority of whom are women.

**Agriculture is impossible without water.** Without a rational, sustainable water management system, farmers must depend on inefficient and unreliable methods, leaving their families and ability to progress at the mercy of outside factors, such as weather.

These linked statements point to the need for a sound, productive irrigation system as an important consideration in ensuring successful farming operations. How can small, rural farmers get access to affordable irrigation systems?

Xylem, Inc., one of the world's largest pure play water companies, is tackling this question with a compelling business model that provides a differentiated value proposition for not only the rural farmer, but also the various public and private partners involved. The company's world-class manufacturing capabilities and broad portfolio of products and technologies for the transport, treatment and testing of water, enable the repurposing of core innovations to create defensible markets.



water pump products are supporting positive change for smallholder farmers, but Xylem, one of the world's leading pure play water companies, is taking that approach to the next level by offering highly customized products and education on how to effectively use and maintain them.

This approach demonstrates the company's respect for the smallholder farmer as a customer in the market for irrigation tools and capabilities that unlock their potential to expand their agricultural business. Further, Xylem understands the importance of enterprise in raising the livelihoods of the rural farming community and generating sustainable progress.

Irrigation is the core of any successful farming operation. Smallholder farmers need proper irrigation equipment, including water pumps, to maximize their yield-to-land ratios.

## The Saajhi solution

*Saajhi*, derived from the Hindi word *saajhedaari*, or *partnership*, is commonly used in India to address an ally, shareholder or partner in business. Based on the company's

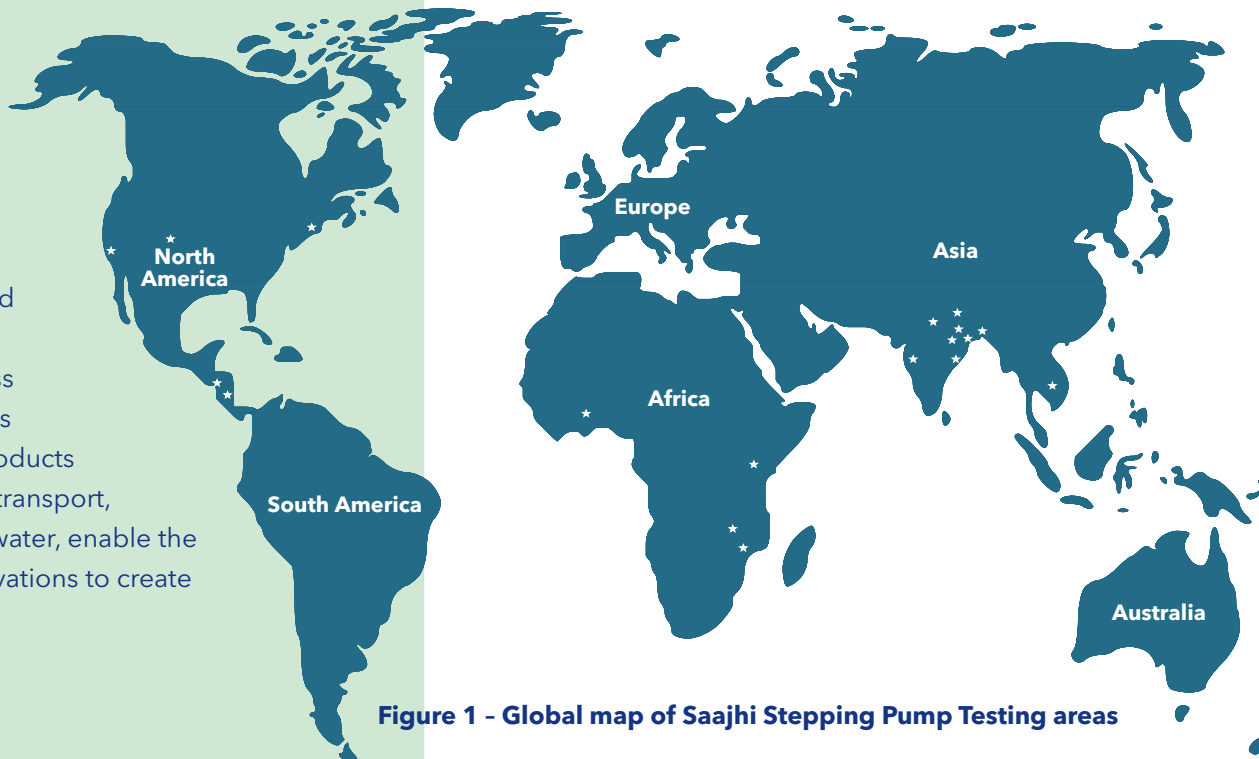


Figure 1 - Global map of Saajhi Stepping Pump Testing areas

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EOL business model, Xylem developed the [Saajhi Stepping Pump](#), a manual stepping pump that was engineered, designed and vetted within rural agricultural markets as an essential water pumping solution.

How large of an impact can a manual stepping pump make? Though the product is simple in its design, the research behind it and the fact that it embodies what the rural farmer is looking for in a water management system, enables it to be a significant technology for the smallholder farmer.

Xylem conducted extensive in-field customer profiling and research to identify not just the irrigation needs of the rural farmer, but also their wants and delights - key elements to product longevity in any market.

### Getting to the essence of rural farming

Underscoring the credibility of the Essence of Life (EOL) hybrid value chain (see EOL side bar), Xylem partnered with rural marketing experts and major Non Government Organizations (NGOs) to work with smallholder farmers in India, Africa, Pan-Asia and South America (see Fig. 1) on their irrigation priorities to begin this comprehensive research. The bulk of this voice of customer research consisted of more than 750 interviews in rural farming communities in India, across multiple states and with varying water tables, crop types and logistics capabilities. The interviews in India were supplemented by dozens more in Pan-Asia, Africa, and South America.

Understanding the needs of this customer group was absolutely critical, and Xylem knows the importance of gaining irrigation insights directly from the farmers. To support Xylem's voice of customer research efforts, the company also executed socio-economic mapping of water use and tracked poverty levels relative to access to water management technologies, applications and storage methods. The more advanced the methods, the more prosperous the farming operation becomes. [See page 4.](#)

Other vital elements to its research, Xylem also conducted prototyping<sup>iv</sup>, prototyping and rapid field sampling of water pump units. Prototyping was essential to begin water pump testing, and Xylem deployed more than 60 prototype pumps across the areas previously listed (see Fig. 1), supported by multiple technology demonstrations.

Prototyping also set the stage for appropriate prototyping. Multiple product design iterations were fielded to check the veracity of improvements and modifications with farmers directly, in-field and during cropping cycles.

### What smallholder farmers want

What did all this research, profiling, interviewing, listening and observing teach us about what small, rural farmers want in an irrigation system? Surprisingly, it uncovered core features and attributes that any typical farmer values in a water pump - the ability to increase revenue as a result

Xylem is comprised of individuals that value creativity and innovation among other qualities. At the heart of Xylem's work, creativity sparks critical problem solving, thinking beyond boundaries and anticipating tomorrow's challenges to unlock growth potential. Paired with the company's sustainability efforts, as evidenced by its 2012 and 2013 acceptance to the Dow Jones Sustainability Index, creativity has been the force behind the development of Essence of Life.

Essence of Life (EOL) is a planned portfolio that is unprecedented in the industry. A natural extension of Xylem's expertise and capabilities, EOL leverages an exclusive hybrid value chain that brings together the citizen sector (private and non-governmental organizations), business and government partnerships. This distinctive collaboration provides a sustainable engagement strategy, driving rural customer shared value that is supported by two key factors:

#### 1. Technological excellence

Xylem's small form factor, direct current (DC) and human-powered pumping solutions create inventive and differentiated water management systems that contribute to sustainable, secure smallholder irrigation prosperity.

#### 2. Synergistic rural community market and channel leadership

The company is creating an extended market offering by engaging specific agri-business market leaders, leveraging its advanced water management technology, and engaging its hybrid value chain partners' strong channel presence.

*Continued on page 5*



# Solving water at the base of the economic pyramid

Rigorous and thorough macro-level socio-economic mapping of rural water interactions

Leveraging dozens of field visits spread over a year of extensive international research, Xylem's rural business credibly addresses a pointed understanding of local purchasing characteristics of smallholder farming activities. We have correlated these purchasing dynamics to local economic conditions to define specific application and product requirements.

*Aggregating cross-geographical models to define an achievable and addressable customer base, we have repositioned and repurposed proven technologies to define the proper mix of capability, affordability, and serviceability.*

ABJECT POVERTY	SUBSISTENCE FARMER	SMALLHOLDER FARMER	PROFESSIONAL SMALL FARMER	PROSPERITY
	20-100 m <sup>2</sup> plot - Focus on feeding family Estimated \$100 per harvest. <i>Assume one or two harvests / year</i>	100-1,000 m <sup>2</sup> plot - Focus on feeding family, income Estimated \$800 per harvest. <i>Assumes three harvests / year</i>	500-5,000 m <sup>2</sup> plot - Focus on income Over \$1,000 per harvest. <i>Assumes three or more harvests / year</i>	

## WATER MANAGEMENT *Advanced methods*



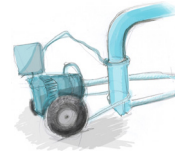
Rope & pulley



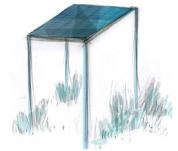
Bamboo treadle



Pressure treadle

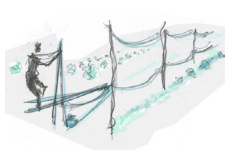


Diesel systems



Solar systems

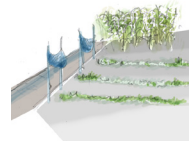
## WATER APPLICATION & STORAGE *Impact sprinklers and large scale systems*



Furrow irrigation



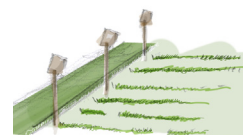
Manual spray



Small drip kit



Micro sprinkler



Large drip kit

## PORTFOLIO CORRELATED AGAINST FIELD VOICE OF CUSTOMER & SOCIO-ECONOMIC PURCHASING CAPABILITY

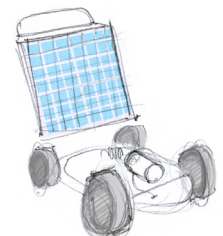
Traditional methods  
{installed}  
**< \$70**

Essence of Life  
treadle system  
**< \$200\***



Essence of Life  
portable solar cart  
**< \$1,000\***

\*Estimates based upon noted configurations



of using the product, labor and time reduction, output maximization, a focus on design and quality, and the ability to integrate directly with more efficient crop irrigation methodologies. The research also showed that subsistence farmers, in many cases, value similar attributes as large-scale commercial farmers.

Specifically, Xylem's research correlated farmer discussions across four key areas:

- Quality and product design
- Irrigation preference
- Brand selection
- Source of funds.

### Quality and Product Design

Quality is crucial to product success. Rural farmers want reliable, serviceable and well-built water pumps. Similar to customers in many developed regions, the rural farmer enjoys an aesthetically pleasing package and un-boxing experience. Upon initial product introduction, several Xylem partners commented on how impactful the presentation and the quality of our products were. Aligning with the EOL business model, customers also associate pride of ownership with the investment they're making in the purchase of the product. This pride in ownership fosters individual accountability and responsibility in overall enterprise success.

### Irrigation Preference

Human factors, including convenience, were greatly favored by smallholder farmers. In fact, **80 percent of those surveyed recognized ease of operation as the primary motivator** for product selection. These individuals are also interested in moving from manual to motorized solutions as quickly as possible.



### Continued from page 3

In addition to the sustainable engagement strategy, compelling business proposition, and differentiated product portfolio, EOL addresses the aspirational nature inherent in many rural communities. Aspiration is universal, and Xylem is helping people tap into their aspirations through the EOL initiative. The goal is to teach, guide, connect and delight the smallholder farmer as a valuable customer base. It's to develop unique products for their specific needs and offer service and information that support continuous growth toward well being. And, it's about defining innovative market channels and service practices that extend beyond product supply and engage ongoing product servicing and training.

## Customer profiling

Customer profiling was completed in India, Africa, Pan-Asia, and South America to complement voice of customer research. Profiling addressed the following items:

- Geographic locations and topography
- Market locations and characteristics
- Community and individual demographic profiles
- Education profiles and aspirational qualities
- Agriculture and cropping profiles
- Irrigation sources and characteristics
- Irrigation methodologies and preferences
- Branding recognition and preference drivers
- Conjoint analysis on proposed value propositions.

Additionally, smallholder farmers tend to select pumping technologies that achieve the highest efficiency in conversion of human motion to flow output, or the most water for the least effort.

The survey showed that **67 percent of respondents identified flow rate performance as a key part of their consideration set** for product purchase.

### Brand Selection

Interestingly, price is not the primary motivator for the purchase of water pumping systems by smallholder farmers, recognizing that sizeable price elasticity does exist in rural markets. Rather,

# Xylem's Saajhi pump: Defining rural innovation

"Saajhi" originated from the word "Saajhedaari" or "Partnership" which is commonly used in India to address an ally, shareholder, or partner in business.

## SMALL OVERALL DIMENSIONS

With its light weight (43 lbs / 19.5 kgs) and compact size (19.5 x 18.5 x 42 inches, 49.5 x 47 x 106.7 centimeters, handle removed), the Saajhi enables both ease of movement in rugged terrain and easy storage back home

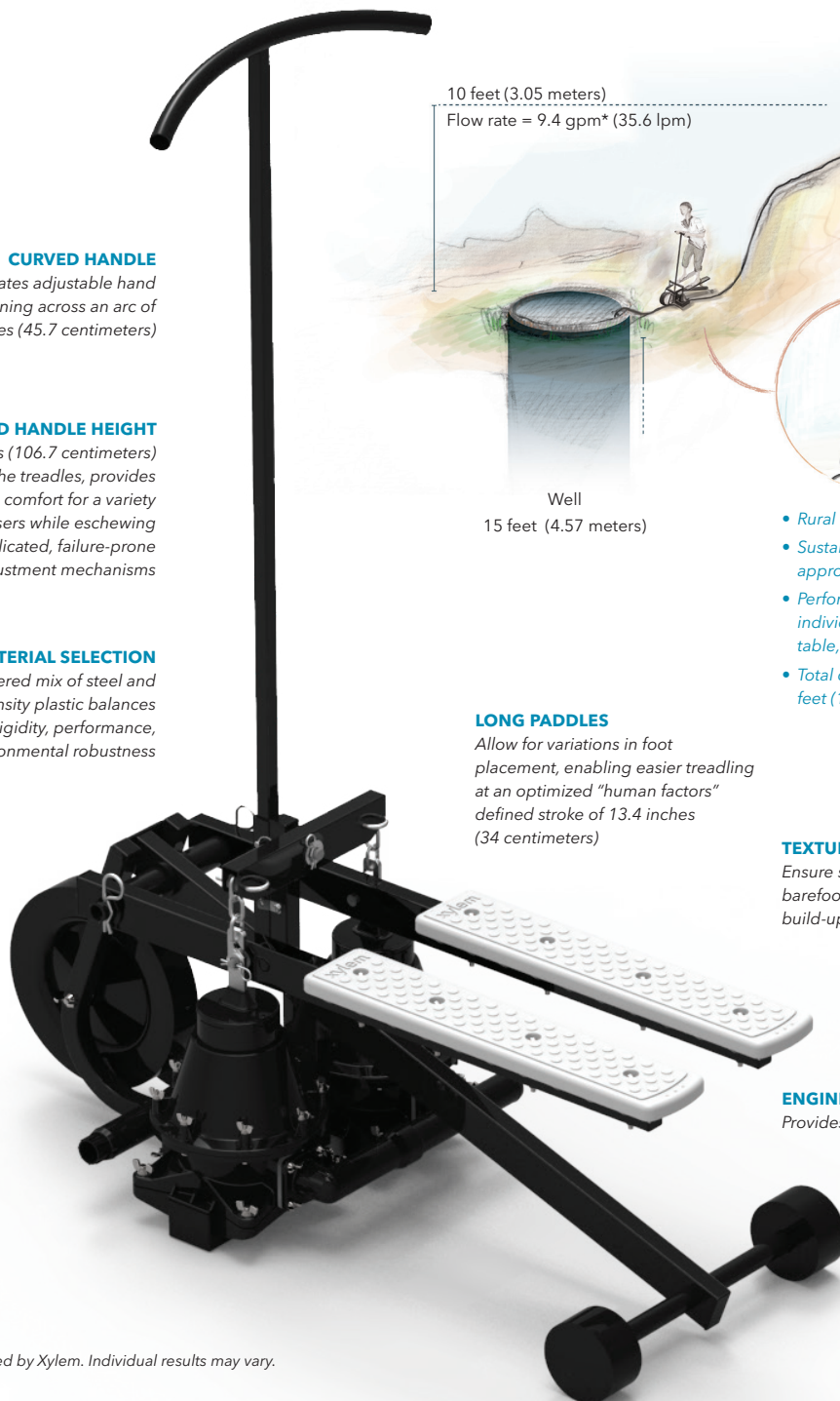


## TILT AND TRANSPORT DESIGN

Ergonomic angle-and-wheel combination is optimized for center of gravity, aiding even smaller users in transporting to and from the field

## SIMPLIFIED MAINTENANCE

Assembled with minimal parts, all of which are easily replaceable in the field with no special tools



## CURVED HANDLE

Facilitates adjustable hand positioning across an arc of 18 inches (45.7 centimeters)

## OPTIMIZED HANDLE HEIGHT

At 42 inches (106.7 centimeters) above the treadles, provides maximum comfort for a variety of users while eschewing complicated, failure-prone adjustment mechanisms

## DISCRETE MATERIAL SELECTION

Engineered mix of steel and high-density plastic balances weight, rigidity, performance, and environmental robustness

## SELF-PRIMING DIAPHRAGM-BASED SYSTEM

Efficient and easily serviceable, this high-performance pumping technology has been proven by Xylem in hostile marine markets for more than 20 years

## INTEGRATED, REMOVABLE AND REPLACEABLE FILTER

Removes large debris that could damage the pump's diaphragms; muddy water or small debris will not harm the Saajhi pump

Hose > 75 feet (22.86 meters)

10 feet (3.05 meters)  
Flow rate = 9.4 gpm\* (35.6 lpm)

Well  
15 feet (4.57 meters)



- Rural farmer of approximately 157 lbs.
- Sustainable treading rate of approximately 46 steps per minute.
- Performance will vary based upon individual, weather conditions, water table, and desired pressure head.
- Total dynamic head will exceed 46 feet (14 meters).

## LONG PADDLES

Allow for variations in foot placement, enabling easier treading at an optimized "human factors" defined stroke of 13.4 inches (34 centimeters)

## TEXTURED, WHITE TREADLES

Ensure safety when treading barefoot while reducing heat build-up in warm climates

## ENGINEERED FOOTPRINT

Provides stability on uneven surfaces

\*Results based on field trials conducted by Xylem. Individual results may vary.



## The Saajhi difference

The Saajhi Stepping Pump design includes the following key elements that differentiate it from competitive products available to the smallholder farmer today.

- Maximum suction depth capability at 27 feet
- Performance rated at an average weight of 157 pounds
- Optimized for a typical input power exertion of 70 watts
- Great efficiency from self-priming diaphragm technology
- Ergonomically correct 10-inch steps
- Handle height, carry weight, paddle length, etc.

To dig deeper into how the product will truly move the smallholder farmer towards professional farming operations status, recall the points of value that constitute what smallholder farmers want out of their irrigation systems.

*Continued from page 5*

**89 percent expressed quality reputation as the key purchasing factor.** When this customer group is considering a brand, they are focused on three aspects of the product, including design, quality manufacturing and serviceability.

### Source of Funds

The long-term sustainability of a business supplying water pumps in rural communities is reliant upon two financial factors: the ability to get a return on investment in relation to appropriate product pricing; and the customer's ability to source funds efficiently – often by engaging with micro-finance institutions (MFIs).

The support of MFIs to this school of thought is significant. **Not considering those who purchase from savings, surveys indicate that 31 percent of people pursuing loans referenced local moneylenders or micro-financing organizations for agricultural funding.** The feasibility for many farmers to afford and/or obtain financing through the traditional banking system is often limited and those located in remote areas are reliant on supplemental MFIs or informal lenders.

India, in particular, has embraced the advantages of MFIs in agriculture. In a 2007 Forbes study of top MFIs<sup>v</sup>, India took the lead with seven<sup>vi</sup> different institutions in this category. Access to microfinance loans for equipment, is shifting the traditional mentality of the smallholder farmer in rural India toward a more globalized perspective, challenging unsustainable irrigation methods – such as flood and furrow irrigation.

**Revenue increases** – The Saajhi pump will produce **three times or greater yield in revenue<sup>vii</sup>** through output and crop cycle increases, compared to rain-fed fields.

**Labor time reduction** – Pressurized water delivery provides more than a **25 percent reduction in labor time**, compared with traditional furrow irrigation methods.

**Output maximization (based on human input)** – The Saajhi pump ensures a **greater than 15 percent increase in water output per step**, which equates to an additional 10 liters per minute over similar pumping methods.

**Product Design** – Saajhi is manufactured by a company whose entire business focuses on the transport, treatment and testing of water. The product was also designed especially for the smallholder farmer using the core diaphragm technology derived from Xylem's industry leading marine pumping technology that keeps more than 10 million commercial boats afloat globally.

Beyond addressing these common customer issues the Saajhi Stepping Pump enables the farmer to use 40 percent less water than traditional furrow irrigation due to the dynamic pressure head of the water delivery system (spray or drip). In fact, the entire hybrid value chain of the EOL business model experiences benefits from the Saajhi pump. Government organizations, international financial organizations, NGOs and rural agri-business partners, also see the value in a pump that provides more water output based on human input, while also helping conserve water.

Additionally, because the pump is human powered, it requires no fossil fuels, electrical connections or standing

## Saajhi Comparison Against Competition [% Better for Xylem]

Comparison represents Flow Output per Step normalized over a fixed period of time				
Depth	Product 1	Product 2	Product 3	Average
Feet	Xylem Advantage	Xylem Advantage	Xylem Advantage	Xylem Advantage
8 Feet	42%	58%	> 100%	> 70%
25 Feet	50%	> 70%	> 70%	> 70%
> 26 Feet	13%	> 70%	Competitor broke in test	> 50%

**Table 1 - Saajhi Competitive Performance**

power supply, making it a net-zero product. This further saves the customer both the logistical complexity and high cost of acquiring fuels.

### Why the Saajhi Stepping Pump is extraordinary

The Saajhi Stepping Pump is **distinctive from anything else available to smallholder farmers in rural communities**. What makes the pump truly different is the performance technology, targeted design, advanced engineering (including durability, serviceability and manufacturing), and the EOL business model, as well as the hybrid value chain that supports it.

The partnerships cultivated through the hybrid value chain enable Xylem to capture insights from people in the field, engage community influencers and establish a socio-economic environment for product purchasing. The hybrid value chain is the key component that delivers definitive shared value to rural communities.

The pump itself is remarkable compared to standard piston irrigation pumps typically found in rural areas.

**Performance** - The Saajhi Stepping Pump uses diaphragm pump technology - an area that Xylem leads the industry in as part of its Rule and Jabsco marine product lines. In particular, the specific diaphragm used within the Saajhi pump has seen extended marine use for more than 20 years. The technology enables optimal human movement to water output, with various dynamic head options for the most efficient water delivery available.

The benefits of diaphragm pumps compared to piston pumps are clear:

- **Self-priming** - There is no need to pour water into a diaphragm pump for initial use, and no foot valve is required to prime the product.
- **Perfect sealing** - Diaphragm pumps utilize a sealed chamber to pull and move a quantity of water; consequently, losses due to moving sealing elements near pistons, are eliminated.
- **Higher efficiency** - Diaphragm pumps experience no friction caused from the piston seal moving against the pump wall.

- **Debris-resistant** - Mud and debris can damage a piston pump but have little effect on a diaphragm pump.

If these benefits were not enough, the Saajhi Stepping Pump's design improves on diaphragm technology. The composite steel and plastic material, combined with the pump's structural integrity, minimizes concerns related to the high force generated from the diaphragm. Further, the use of plastics in the diaphragm assembly and piping, guard against saline water conditions - prevalent in many rural communities and damaging to all metal products.

Table 1 (page 8) reflects the Saajhi performance against three commonly obtained treadle pump alternatives. The competitive products were purchased through traditional rural channels in India and Africa, forwarded to our India Technology Center in Baroda, and tested back-to-back using the same operator, day of the week, and local conditions.

To account for individual product treading operational differences (i.e., steps-per-minute and exertion to treadle), Xylem normalized the individual output flow performance values in output-per-step and noted these values against the Saajhi pump as a baseline. This methodology ensured Xylem represented individual treadle performance measurements in a manner indicative of actual operation in-field with smallholder farmers. The normalization addressed several real-life aspects of physical treadle operation. Namely, treadle chambers will not necessarily be completely filled as water depth varies and actual steps-per-minute will also vary based upon the ease-of-use of different products.

**Design** - Pump design to address human factors, including the desire for convenience and labor reduction, was a primary focus in developing the Saajhi product. The pump leverages human weight and gravity to move water - a design element that was found to put the least amount of strain and stress on the operator. A full flow curve is noted for the Saajhi Stepping Pump in Figure 2 (page 9). This curve identifies the Saajhi flow output for various dynamic heads, which can be determined by selecting an appropriate suction head (depth) and discharge head (height), and adding the two together.

In typical operation, a user will most likely not exceed 20 to 25 feet of suction depth (water table depth). Additional travel



through 65 feet of horizontal hose length resulted in minimal flow loss (very small frictional loss impact).

Each design element was built on specific human factors that are grounded in the research Xylem conducted, highlighting the difference in the way we define a water pump versus other organizations.

- The Saajhi pump has a maximum self-priming suction water depth of approximately 27 feet. For practical applications, max water depth should not normally exceed 20 to 25 feet, even under cool sea level conditions with a short suction pipe<sup>viii</sup>. This is significant because competitive products may make claims to reach water depths well beyond 27 feet - a physically impossible task.
- The average power input for the Saajhi Stepping Pump was measured at 70 watts. The input power was determined using a dual air piston test fixture that articulated the pedals while water was pumped through the Saajhi at incremental pressure loads. The stepping rate and flow rate were measured at each pressure load with a constant 157-pound force applied at the same position on the pedals. This 157-pound force represents the average Indian individual weight. At 70 watts the Saajhi Stepping Pump can be operated continuously for more than three hours, as supported by "Water Lifting Devices" by P.L. Fraenkel. The book calls out that the majority of humans can operate for 180 minutes at 90 and 75 watts for individuals 20 and 35 years of age respectively. It also states that 160-watt human power output can be generated for 30 and 60 minutes by a person of 20 and 35 years of age respectively<sup>ix</sup>. Additionally, the "Journal of Chemical Education" by Henry A. Bent, states that a full, 10-hour day of manual labor is done at 150 watts of

exertion<sup>x</sup>. Figure 2, the Saajhi Flow Performance Curve, illustrates the flow rate curve at 70 and 150 watts for a 157-pound person.

- The step rate and efficiency test results can be seen in Table 2 (page 10) for a constant 70-watt input power. One step on the Saajhi pump equates to one paddle in the most upright position pressed to the lowest position. The efficiency is for the overall pump using the output power divided by the input power. The output power ( $W_{out}$ , watt) was calculated using the standard equation:  $W_{out} = \text{specific weight } (\gamma, \text{ N/m}^3) * \text{flow rate } (Q, \text{ m}^3/\text{s}) * \text{pressure head } (H, \text{ m})$ . The efficiency results are good and not surprising, noting that a typical motor-operated diaphragm pump has a maximum overall efficiency of approximately 20 percent with motor efficiency at about 50 percent. Without the motor, pump efficiency would be roughly 40 percent. Saajhi pump test results show a maximum overall efficiency of 56 percent at 70 watt input power, which is larger than the estimated 40 percent.
- The Saajhi Stepping Pump was designed with a range of step lengths of 4 to 13.8 inches, which is achieved by giving the operator a choice of where to place his/her foot on the long pedal. The range of 4- to 13.8-inch step lengths was determined as the most comfortable by the Development Technology Unit at the Department of Engineering University of Warwick<sup>xi</sup>.
- Ergonomic, efficient and comfort-driven design aspects of the Saajhi Stepping Pump, including the handle height, carry weight and paddle length, were developed based on country-specific demographic data from the regions of India, Africa, South America and Pan-Asia.
- Another benefit attributable to the Saajhi diaphragm is the soft stop at the lowest point in a user's step. Interviews of traditional treadle product users uncovered a strong

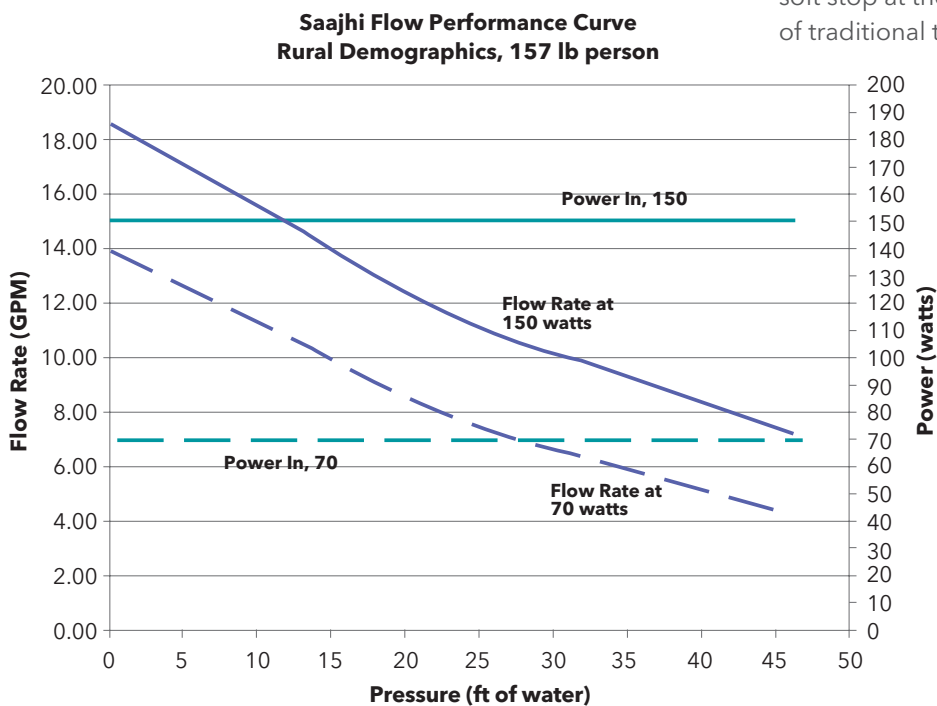


Figure 2 - Saajhi Flow Performance Curve

dislike for the jarring motion commonly associated with these products. This jarring motion occurs when the bottoming of the metal treadle comes into contact with the frame during stepping operations. This impacting force may be felt throughout a user's body. In comparison, the Saajhi soft stop is within the pump itself, using a cushion of water and reinforced plastic components to create a smooth end to a user's step.

Though hand and pedal powered water pumps are common, according to "Water Lifting Devices" by P.L. Fraenkel, **"converting a hand pump to a foot operated (i.e., treadle pump) pump improves the output by a factor of three (300 percent)."** The same text specifies that by "using one's leg muscles instead of arm muscles, the weight of the entire

## Saajhi Stepping Pump Performance Results

<b>Operator's Weight</b>	pounds	157	157	157	157
<b>Input Power</b>	watts	70	70	70	70
<b>Total Pressure Head</b>	feet of water	11.5	23.1	34.6	46.1
<b>Step Rate</b>	steps/minute	47	38	32	25
<b>Flow Rate</b>	gallons per minute	10.90	7.75	5.97	4.27
<b>Overall Pump Efficiency</b>	power-out/power-in	34%	48%	56%	53%

**Table 2 - Saajhi performance results**

body can be leveraged to increase the force of the pump.” Further, hand pumps are good for water supply activities versus irrigation because they are most effective for short periods of time (one to two minutes).<sup>xiii</sup>

Xylem’s product exploration extended beyond treadle systems. In-field prototyping also benefited from the early circulation of bike-mounted pumps into select rural communities. Ultimately, the Saajhi Stepping Pump was chosen to be a foot operated pump over a bike pump because of Xylem’s favorable test results. When operating under similar exertions (i.e., human power), treadle pumps were noted to provide higher sustainable flow outputs as compared to bicycle-mounted pumps.

Please note that the foot paddles are a design element of the Saajhi specifically engineered into the product to address operation of multiple users across various water depths. To accommodate varied physiologies of operators and local operating conditions, testing was conducted in the Americas, India, Africa and Pan-Asia.

**Durability** – Because smallholder farmers are typically located in rural areas with rugged terrain, the Saajhi pump needed to also be designed to withstand drops, kicks, weather, high salinity water and several other extreme factors. Every aspect of the Saajhi Stepping Pump went through multiple iterations until the most cost effective and superior solution could be implemented. Balance between cost and durability was achieved by using low carbon steel where structural integrity was needed and glass reinforced polypropylene at locations that experience a high rate of corrosion.

Extensive life testing of the Saajhi pump was conducted with more than 3 million steps implemented on a single unit, representing more than five years of continuous usage. For our testing, Xylem assumed an established and profitable smallholder farmer who tends 0.25 acres of vegetables, turns three crop rotations per year, and utilizes furrow formation flooding. The farmer uses approximately 16,000 liters per irrigation, irrigating two times per week during the appropriate cropping cycles.

Consequently, these testing protocols established a high usage situation, not necessarily representative of initial stepping pump adopters. Life testing was completed using typical parameters (11 feet of water suction and 14 feet of water pressure) with only the diaphragm needing replacement. The diaphragm was replaced after approximately one year of operation and is a simple in-field service item that requires no tools for replacement. Individual user results may vary.

**Serviceability** – The Saajhi pump was designed for rural serviceability, requiring no tools. All components are modular, replaceable and enhanced for extended wear and harsh conditions. The product is completely portable, with a wheel attached to its front so it can be easily transported between the area of storage or service and point of usage.

**Manufacturing** – Unlike many competing products, the Saajhi Stepping Pump does not utilize a distributed manufacturing model, as Xylem’s NGO partners have indicated that distributed models often suffer from quality issues. Instead, Xylem uses a centralized manufacturing model, producing the Saajhi pump within its ISO 9001 approved facility in Baroda, India – the largest pump test



facility in the world at 231,200 square feet in size. The facility tests 7.5MW at 80,000 cubic meters per hour, and implements several sustainability initiatives, including:

- Zero biological waste discharge from toilet to tap
- A solar power installation of up to 265kW to produce renewable energy
- Certification applied for IGBC-LEED Gold India
- A dedicated sub-station for 66/11KV HT supply
- Variable frequency drive for pump testing facility and IE1 motors for utilities

The lean manufacturing process, with 100 percent in-line testing, ensures the highest quality products, while also supporting the local economy.

**Irrigation and water movement** - The Saajhi pump is designed for abstracting water from bore holes, wells, ponds, streams and canals, then moving it to elevated storage at the point of use. The pump can also be connected directly to sprayers, micro-sprinklers and drip kits to effectively disseminate the water pumped, bridging the gap between purely manual solutions and motorized solutions (i.e., diesel or kerosene).

## The Big Four

Xylem's development of the Saajhi Stepping Pump uncovered four key takeaways. From inception through the research process and culminating in the development of the product, the journey has yielded a wealth of knowledge to help smallholder farmers support their communities and improve their local economies.

### 1. **The hybrid value chain is at the heart of it all** -

Unconventional, collaborative partnerships are critical to gain a deep understanding of everything from sales and service capabilities, to product extension opportunities and communications best practices. The hybrid value chain enables Xylem to build the EOL program within the rural community of smallholder farmers - not outside of it with the attempt to make it fit.

### 2. **Customer intimacy is critical** - In-field engagement drives product execution. The Saajhi pump delivers on its promise to the small, rural farming segment. This is no accident. The Saajhi introduction is the result of relentless research and customer engagement that addresses every pain point and primary motivator of the smallholder farmer.

### 3. **Innovative product execution** - The Saajhi Stepping Pump is the first product in Xylem's rural irrigation product portfolio. Expanding both our rural innovation process and our alternative energy strategy, we will be broadening this portfolio to include portable, solar powered rural pumping systems in the near future. Xylem's Saajhi pump provides the first opportunity to effectively vet our in-field logistics and service capability.

### 4. **Respecting the rural customer** - Xylem gives smallholder farmers the credit they deserve. It's about more than designing a product for the base of the economic pyramid. It's a holistic approach. It's manufacturing, servicing, delighting and understanding the irrigation needs of those in rural communities. In the end, it's about creating sustainable enterprise.

## Turning the bucket of water into economic livelihood

At the most basic level, smallholder farmers are striving toward the same goal - to better their livelihoods and the opportunities available for their families. Furthering one's socio-economic position through the conversion of subsistence agriculture into surplus revenue is a critical step in this journey to rural prosperity. Sustainable water management through advanced irrigation systems is imperative to realizing this goal. Xylem's Saajhi Stepping Pump is merely a tool - albeit a vital one - that entrepreneurial and aspirational communities may rely on to build their irrigation systems, and ultimately create a prosperous way of life.

The rural farmer, who may live on as little as \$2.50 a day, has built up an immense amount of sweat equity in their land. Both the EOL business model and the Saajhi Stepping Pump recognize this investment and support its progression.

What if this is the jumping point for Xylem to pioneer a sustainable engagement model to meet the fundamental needs of water management in rural communities across the globe? What if this is just Xylem's first step in aiding these communities in their strides toward growth from villages to towns, towns to peri-urban communities, urban communities to cities? What if EOL is only the beginning to making Xylem's mission of providing clean, safe water to everyone worldwide, a reality?

Essence of life is not just doing good business; it's doing good.

Good for the smallholder farmer, good for the evolution of agriculture in rural communities, and good for people as citizens of the planet. For more information about Xylem's Essence of Life, visit the [Xylem website](#), the [Ripple Effect](#), a dedicated blog, or follow us on [Twitter](#), [Facebook](#) and [Pinterest](#).





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