Investing In Smallholder Irrigation

BY: THE WATER FOR FOOD TEAM

In many developing countries, irrigation is counted on to increase production, reduce reliance on unpredictable rainfall, and provide food security, income, and employment to poor farmers. Large schemes, which the World Bank financed for decades, have often lacked sustainability; frequently used to produce uncompetitive cereals for import substitution, such large schemes typically suffer from the inability of government or parastatals to maintain the infrastructure. Smaller, communal schemes work well in many countries but can be plagued by collective action problems, although the basic rules for success are well documented (Ostrom 1992). Elsewhere, there is considerable scope for the expansion of small, privately owned pumping technologies that benefit small farmers, particularly for the production of high-value crops such as horticulture.

Smallholder irrigated horticulture has proven to be a viable and attractive option for poor farmers in developing countries. Returns from intensive irrigated horticulture, even on tiny plots, can greatly exceed returns from rainfed cereals production. Private ownership of simple pumping technologies has avoided collective action problems related to larger public or communal schemes. To promote expansion of smallholder irrigation, poor farmers must have access to cost-effective technologies that provide a rapid return on investment, a reliable and quality supply of water and other inputs, land for expansion, and markets to absorb increased production.

Potential Areas of Investment

Throughout the developing world, many smallholders produce vegetables on irrigated plots during the dry season as a hedge against a rainy season crop failure and as a source of cash income and food. These plots may be very small: surveys have shown that garden size rarely exceeds 0.1 hectares and is often less than 0.05 hectares (500 square meters). With nonmechanized systems using ropes, buckets, and watering cans, irrigation of even such small areas can be extremely labor intensive. The labor constraint often limits increased production simply because the farm family lacks the time and energy to provide sufficient water for the crops. Moreover, the distance to water points has been shown to decrease the likelihood of girls attending school because they are often responsible for collecting water (WHO 2003).

The first hurdle to expanded smallholder irrigation, therefore, is to demonstrate and provide access to labor-saving technologies for lifting and distributing water. Mechanized technologies such as small gasoline or diesel pumpsets often exceed the means of poor farmers—both in terms of investment cost ($300 to $500) and of operating costs of fuel, oil, and spare parts. Moreover, the small size of many gardens may preclude economical use of a motorized pump. The treadle pump, on the other hand, has been shown to provide an economically viable solution for water lifting that is within the financial means of smallholders in Africa and Asia, and may allow a farmer to irrigate 0.5 hectares using only family labor and investing US$50–$100. Scaling up from traditional systems to treadle pumps and, further, to motorized irrigation systems requires careful thought and an incremental approach (Box 1).
BENEFITS

Smallholder irrigated horticulture can provide significant returns to farmers and increase local manufacturing capacity while creating employment. Surveys have shown that many farmers increase their land under cultivation by three times within two years after the purchase of a treadle pump, more than doubling their annual incomes. In West Africa, projects implemented by EnterpriseWorks Worldwide in Senegal, Mali, Niger, Benin, Burkina Faso, Côte d’Ivoire, and Ghana have promoted private sector sales of more than 8,000 treadle pumps and more than 1,000 low-cost tubewells. More important, these technologies have resulted in higher incomes for more than 80 small fabrication workshops and thousands of small-scale gardeners. The annual increase in income for gardeners varies widely between countries and within countries, but it ranges from $290 in Niger to $584 in Senegal.

Benefits do not stop at the farm gate. When locally made treadle pumps are used, the artisan sector may be stimulated. Small metal shops learn new skills and develop their ability to solve local problems. Local products may be preferred to externally produced pumps, as the artisans are closer and more accountable for quality and repair. The quality and quantity of food for local and household consumption is also important, and irrigated horticulture addresses household food security concerns. Many of these benefits are perceived by women farmers, who are able to augment garden production. Household drip irrigation systems, supplied from periodically filled buckets or drums, often with a treadle pump, to water household gardens or small plots of vegetables or fruit trees are particularly important for women as well as men.

POLICY AND IMPLEMENTATION

Several policy and resources conditions must be met for successful implementation of smallholder irrigated horticulture.

Access to adequate irrigable land

Improved water-lifting technologies have a higher discharge than traditional methods, and time saved in irrigating may be used to expand surface area if suitable land is available. Land tenure systems are a potential impediment to the expansion of irrigated horticulture;

Box 1: Scaling Up with Improved Technology Takes Time

Economic analysis in Niger has found that for plot sizes less than 0.69 hectares, treadle pumps are more profitable than small motorized pumps, but for larger plot sizes the motorized option becomes economically superior (World Bank 2001). To make best use of a motorized pump, an average farmer would need immediately to increase the size of his or her garden by 14 times (for example, from 0.05 hectares to 0.7 hectares) to ensure viability. This transition may easily surpass the technical and management capacity of the farmer, who will require more labor, inputs, and markets for the produce, which helps explain why many credit-based motorized pump-promotion projects for smallholders fail. Instead, by starting small and increasing incrementally, some treadle pump adopters have managed to graduate to mechanized technologies. The following scenario for scaling up has proven successful, minimizing risk for smallholders:

- Year 0: A farmer has a hand-dug well with a rudimentary rope-and-bucket gravity irrigation distribution system. This may be marginally profitable but is highly labor intensive.
- Year 1: The farmer buys a treadle pump but keeps the hand-dug well. The gardener realizes productivity gains but may observe that the water-lifting capacity now exceeds the well capacity and decides to improve the well.
- Year 2: The drilled tubewell, treadle pump, and rudimentary gravity irrigation distribution system permit a large expansion in the size of the garden, because neither the amount of water nor the time to lift it is a constraint.
- Year 3: As garden size expands and the length of the distribution canals increase, the gardener improves the distribution system with buried PVC pipes.
- Years 4–6: Extension of the PVC system again allows an increase in garden size. With a second well and pump, the distribution system is again expanded.
- Year 7: A motorized pump is added to the system, and manual pumps provide reliable back-up during fuel shortages or breakdowns.

Source: Jon Naugel, Enterprise Works, and Daniel Sellen, World Bank.
because, if farmers do not own the land, they will be reluctant to invest in permanent improvements such as tubewells. Conflicting land use can also be a problem, especially when dry season irrigation encroaches on land traditionally used by herders.

**Existence of sufficient water of suitable quality**

Expanded irrigated horticulture requires adequate supplies of ground or surface water to meet the requirements of the crops being grown because the most productive smallholder irrigation is performed during the dry season (when insects and plant diseases are scarce and when rainfed cereals production does not compete for labor). Irrigation water is most economical if subsurface water supplies are within 7 meters of the surface or if surface water supplies are within 50 meters of the plants. Water quality is also important because salinity can become a major problem, especially in arid climates, even when concentrations of salts in irrigation water are relatively low. Technical advisory services would then be needed to advise on selecting salt-tolerant crop varieties and saline irrigation practices.

**Availability of ample labor supply**

Although rural household labor is frequently in short supply during the rainy season, when farmers focus on staple crops, it is usually relatively abundant during the dry season when irrigated horticultural activities are performed. Labor productivity can be increased significantly through higher yields and expanded irrigated surface areas through the use of mechanized water lifting, piped distribution systems, and improved surface irrigation or drip irrigation systems.

**Availability of nonirrigation inputs**

Fertilizer, seed, and pesticides need to be adequately supplied by the commercial sector on the basis of market prices. If not, farmers produce their own seed, leading to reduction in yields as seed quality deteriorates. Vegetable seeds adapted to the prevailing environmental conditions are an important input that is frequently lacking. Subsidized inputs, typically fertilizer, have been shown to make these items less accessible to smallholders, because these benefits tend to be captured by larger farmers, creating scarcity.

**Market conditions**

Market outlets for irrigated production are imperative for a successful smallholder irrigation subsector. Proximity to markets or reliable transportation linkages must be present, particularly since horticultural products are perishable. Price cycles often accompany horticultural production, which may require additional investment in value-added production (such as drying or better storage) to smooth out supply. Of course, access to market information is also important.

**LESSONS LEARNED**

Two important lessons are reviewed here: development of supply chains for sustainable impact and the importance of a market-led approach for financing technology acquisition.

**Supply chain development**

Low-cost productive technologies must be available to smallholders in terms of both location and price and must correspond to their needs. A variety of ways of providing smallholders with access to these technologies have been used, ranging from importing treadle pumps to manufacturing items locally (Box 2). For market-driven sustainable development to occur, all parties in the supply chain must make a profit. In the case of treadle pumps, tubewells,
and improved piped water distribution systems, the manufacturers, installers, and the gardeners all benefit. Treadle pump manufacturers earn $15 to $25 profit per pump; tubewell installers earn $12 to $18 per well; and the plumbers installing buried PVC pipe distribution systems earn roughly $0.20 per meter of pipe installed.

Financing technology for a market-led approach

In many countries, the uptake of technologies by subsistence gardeners is hindered by the lack of institutions that provide rural finance. Although the development of low-cost technologies has reduced up-front costs, farmers typically require financial assistance, ideally through a pump supplier credit or other commercially viable credit mechanisms. Subsidized programs are risky because of market distortions, and should be investigated only if there are no rural finance institutions or it is felt that cost reduction is required for a “demonstration effect” where pumps are unknown. Therefore, coordination among donors in the irrigation sector is essential for mutual understanding of the long-term benefits of encouraging farmers to invest in a technology that will pay for itself in its first season of use. Poorly managed credit programs hurt the very people they are designed to help in the long term. Instead of developing sustainable local capacity, these programs leave smallholders dependent on foreign aid and waiting for a gift rather than investing in their own future. However, the smallholder market approach only works well when the technology being promoted has a short payback period (one or two seasons), and the initial cash payment is within the smallholder’s reach.

RECOMMENDATIONS FOR PRACTITIONERS

- Use privately owned technologies to avoid collective action problems and reliance on government assistance. This increases the likelihood that irrigation assets will be maintained.
- Consider simple technologies such as treadle pumps and drip irrigation kits. These self-select for poor households.
- Ensure that a minimum set of resource and market conditions are satisfied before promoting irrigation.
- Develop supply chains that are dominated by private entrepreneurs such as pump manufacturers and repair shops.
- Rethink the definition of smallholder-irrigated agriculture in view of market gardening. Many farmers, particularly the poorest, irrigate plots smaller than one-tenth of a hectare.
- Recognize that rapid introduction of mechanized technologies can easily overwhelm a poor smallholder in terms of capacity. Scaling up to mechanized pumps has been demonstrated successfully but may take time.
- Make sure there are markets for the outputs, or help create them, to ensure that increased production is profitable.

REFERENCES CITED


This Note was prepared by Jon Naugle of EnterpriseWorks and Daniel Sellen, Senior Agriculture Economist at the World Bank. It was revised by Salah Darghouth, Water Adviser for the Agriculture and Rural Development Department (ARD) of the World Bank, and Ariel Dinar, Lead Economist in ARD at the World Bank—both part of the Water For Food Team. The note is based on Investment Note 3.3 in the larger volume Shaping the Future of Water for Agriculture: A Sourcebook for Investment in Agricultural Water Management. The book documents a range of solutions and good practices from World Bank and worldwide experience, concentrating on investments in policy and institutional reforms in technology and management to improve water productivity and farming profitability. You can download a copy of the full report at www.worldbank.org/rural or email ard@worldbank.org.