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Microirrigation for Income Generation in Asia

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Achieving the Millennium Development Goals—particularly, the goal of halving the number of people surviving on less than a dollar a day—will require a major reorientation of worldwide development efforts away from pursuing general "economic development" and toward "poverty reduction" as a distinct and more urgent goal. In contrast to current trends, the allocation of development resources must become biased toward rural areas, agriculture, and smallholder agriculture in particular. Microirrigation stands out as a simple, practical, and widely applicable tool for enhancing the agricultural potential of smallholders and creating opportunities for more active and effective participation of smallholders in markets. This case study summarizes and draws lessons from the 20-year experience of International Development Enterprises (IDE) with microirrigation for smallholder income generation in Asia. Microirrigation technologies (treadle pumps and low-cost drip irrigation in particular) have had a widespread impact on rural poverty, helping some 2 million smallholder families increase their net income by an average of $100 per year for an initial investment of about $30. The distribution of microirrigation technologies through the private sector at affordable, sustainable, and unsubsidized prices has proven to be an effective and efficient means of achieving widespread impact with minimal donor resources. The income-generating potential of microirrigation is directly related to the degree to which smallholders are integrated with input and output markets. By developing smallholders' comparative advantage in the production of high-value crops and facilitating market environments that respond to their specific needs, smallholders are empowered to become effective market participants and to take advantage of market opportunities. Microirrigation holds great potential as a means to effectively target development resources at the rural poor in an environmentally sound and gender-sensitive manner. IDE is among the organizations spearheading the smallholder irrigation market initiative (SIMI), which seeks to facilitate the large-scale expansion of micro-irrigation and market integration for the rural poor, potentially reaching up to 30 million smallholder households in the next 15 years.

Introduction

Out of the 1.2 billion poor people living on less than $1 a day, 75%, or 900 million, live and work in rural areas. Fully two thirds of these rural poor live in Asia, with a heavy concentration (43%) in South Asia alone. The majority of the rural poor are subsistence farmers with limited access to productive assets, credit sources, and markets. As a result, their agricultural productivity and income are

low, and they are highly vulnerable to climatic extremes, price variations, environmental degradation, natural calamities, family illnesses, and other economic shocks. The rural poor are often located in less-favorable regions with poor soils, poor infrastructure, and limited water resources.

This is the environment where IDE has worked for the last 20 years with the sole focus of poverty reduction through the application of market principles to benefit the poor. IDE is a nonprofit organization incorporated in Canada, India, Switzerland, United Kingdom, and United States. Together, the IDE family of organizations supports field programs in seven countries: Bangladesh, Cambodia, People's Republic of China, India, Nepal, Viet Nam, and Zambia.

This case study describes IDE's experience with microirrigation for smallholders in Asia and its potential for generating income for the rural poor. For the purpose of this discussion, microirrigation is defined as self-contained irrigation systems for use on small plots of land (typically less than 0.5 ha) by small groups of people (typically a single household) without the need for collective infrastructure. Smallholders are defined as households that engage in subsistence agriculture on small plots of land. They may own or rent their land or make use of common property and thus may include those who are normally classified as "tenant farmers" or even "landless."

Microirrigation Technology

IDE has taken a lead role in the development and dissemination of two micro-irrigation technologies that have proven successful in helping individual smallholder households to access and control water for irrigating small plots of land.

Treadle Pumps

The treadle pump is a foot-powered pump that can be used to lift water from shallow groundwater or surface water sources. The pump can be operated comfortably for long periods, delivering sufficient water for irrigation of rice and vegetable crops. The basic treadle pump costs less than $30 in Bangladesh (including the cost of the tube well), making it accessible to even very poor smallholders. In total, approximately 2 million treadle pumps have been purchased and installed by smallholders in Asia as a result of IDE's programs.

Table 1. Treadle Pump Dissemination in Asia Attributable to IDE Interventions

Country	Year Started	Total Treadle Pumps[a]
Bangladesh	1986	1,500,000
Nepal	1987	40,000
India	1990	440,000
Cambodia	1994	20,000
Total		2,000,000

[a] Approximate totals as of mid-2002.

A major key to the success of the treadle pump technology has been its dissemination through market channels. IDE stimulated demand for the pumps through creative information and marketing campaigns aimed directly at the rural poor. Simultaneously, IDE worked with the local private sector to establish a network of pump manufacturers, distributors, and installers. The private sector supply chain has now grown to include more than 100 manufacturers, 1,100 dealers, and 3,000 installers.

Drip irrigation

Drip irrigation delivers water from a storage vessel directly to plants through a system of plastic tubes with minimal water loss. Crops irrigated by drip show water savings of up to 50% and yield increases of 30–50%. Drip irrigation is often associated with the capital-intensive, commercial farms of more wealthy farmers. Systems used on large farms, however, are unaffordable for smallholders and are not available in sizes suitable for small plots.

Beginning in 1995, IDE developed various of low-cost drip irrigation kits that are appropriate for small landholdings and affordable for smallholders. The smallest kit consists of a 20-l bucket with enough tubing to irrigate a 25-square meter (m^2) plot and costs about $5. The next size consists of a 200-liter (l) drum with tubing to irrigate 125 m^2 and costs about $25. Larger kits can irrigate areas up to 1,000 m^2. The systems are expandable so that farmers can start small and scale up as their financial capacity and technical skills increase. The kits are typically used to maximize water efficiency in arid regions for the production of horticulture crops including vegetables and fruits.

To date, some 20,000 low-cost drip irrigation systems have been distributed through market channels in Bangladesh, India, Nepal, and Viet Nam.

Relating Microrrigation to Key Action Areas of the Water and Poverty Initiative

Economic and social benefits derived from microirrigation at the household level relate directly to key action areas identified in the thematic framework for the Water and Poverty Initiative.[1]

Pro-Poor Economic Growth and Livelihood Improvement

Treadle pumps and drip irrigation systems provide an affordable entry into irrigated agriculture, giving smallholders an opportunity to increase their production and generate income by selling their surplus. Farmers investing in treadle pumps or drip irrigation systems have seen income increases averaging over $100 per year. Approximately 2 million microirrigation systems have been installed in South and Southeast Asia, raising the productivity of more than .25 million ha of farmland and injecting more than $200 million per year into rural economies.

[1] The social and economic benefits of IDE microirrigation systems have been documented in regional and country-level impact evaluations by independent investigators. One such report is Shah, Tushaar, et al. 2000. Pedaling Out of Poverty: Social Impact of a Manual Irrigation Technology in South Asia. Available: *www.cgiar.org/iwmi/pubs/Pub045/Report45.pdf.*

Economic benefits resulting from microirrigation technologies are biased toward the poor because technologies themselves are self-targeting. Treadle pumps and low-cost drip have high labor requirements relative to more expensive irrigation options such as engine pumps and state-of-the-art drip irrigation equipment. For this reason, microirrigation systems are primarily attractive to the rural poor, who have small landholdings and relatively abundant family labor, but are of little interest to more wealthy farmers with larger landholdings.

As a spin-off benefit, microirrigation technologies stimulate the rural economy as financially empowered smallholders begin purchasing goods and services from rural markets. Local small and medium enterprises are also engaged in producing, distributing, and installing the microirrigation equipment, creating employment in the rural nonfarm sector.

Improved Access to Water

Microirrigation provides an affordable alternative for many smallholders who would not otherwise be able to access irrigation water. Large-scale irrigation systems are typically developed in more favorable agricultural areas populated by well-endowed farmers. Community-level irrigation schemes also require considerable capital and social investment, putting them out of reach for many. In all cases, the poorest farmers are prone to marginalization and receive proportionately less benefit from collectively operated irrigation systems, if they receive any benefit at all. Microirrigation fills an important technology gap for the rural poor by providing a low-cost entry into irrigated agriculture that requires very low capital investment and little or no social organization.

The use of market channels has been a key factor in achieving widespread distribution of microirrigation technologies. Subsidized or free distribution of technologies through NGO or government programs is unlikely to have had the same far-reaching and sustainable effects. The private marketplace is arguably the most efficient and effective mechanism for widespread distribution of a technology to maximize both access and impact.

The accessibility of microirrigation has been further enhanced by its income-generating characteristics. The cost of a microirrigation system can usually be repaid in a single growing season. This rapid return on investment makes it economically feasible to purchase a pump, even with money borrowed at very high interest rates (e.g., from a local moneylender). Financial barriers to micro-irrigation are reduced even further when microirrigation technologies are linked with microcredit schemes that charge reasonable interest rates.

Capacity Building and Empowerment

Access to affordable irrigation options through the private sector empowers the poor to participate in markets and progressively increase their level of self-reliance. As consumers (as opposed to charity recipients), smallholder households have the ability to choose technologies that are appropriate for their situation, and collectively, they can have an influence on the technology itself through feedback to the technology suppliers.

Increasing the food security and cash income of the rural poor also reduces their vulnerability and susceptibility to exploitation. Increased economic status is associated with improved education, greater exercise of human rights, and increased expectations for democratic participation in decision making at all levels.

Microirrigation also contributes to gender equity by reducing women's workloads, improving family nutrition, providing a source of independent income for women, creating opportunities for women to learn new skills, and reducing the necessity for family members to migrate from the home for seasonal wage labor.

Disaster Mitigation

Treadle pumps and drip irrigation systems have been used in rehabilitation projects to help restore rural food production following natural disasters. Irrigated vegetables can begin providing a source of food and income within 2 months.

Lessons Learned

The Critical Role of Water in Poverty Reduction

Scarce water resources and a lack of control over water resources are pervasive constraints facing a large majority of smallholders. Water, being essential for agriculture and human health, is a critical factor in livelihood strategies of the rural poor. For this reason, water is an effective and strategic entry point for addressing rural poverty.

Without access to and control over water, smallholders do not have a basis for commercial agricultural production. The risk of losing their crops due to erratic rainfall or insufficient irrigation water deters smallholders from investing in high-value production. IDE's 20-year experience with smallholders in Asia demonstrates that water control at critically important stages of crop production is usually the most important factor in enabling smallholders to become commercial producers of high-value crops.

The Need to Focus on Rural Poverty and Smallholders in Particular

The slow progress of international efforts to reduce poverty stems from rural poverty not being confronted head-on. The president of the International Fund for Agricultural Development (IFAD) has stated

> ...the failure [to meet Millennium Development Goals] stems in large part from a misconception that the main poverty problem has moved from the countryside to the burgeoning mega-cities of the developing world [however], 75% of the world's poor live in rural areas, most of which make their living in farming or farm labor. As this figure will drop only to 60% by 2020, a focus on rural poverty and agricultural development is crucial to the reduction of poverty overall.[2]

Resources that have found their way into agricultural development have too often focused on production technologies suited for more well-endowed farmers

[2] Fawzy H. Al-Sultan in Rural Poverty Report 2001: The Challenge of Ending Rural Poverty 2001. Rome: IFAD.

(e.g., large-scale irrigation and seed-based technologies), which, at best, have a secondary effect on poverty among smallholders. Dealing with the challenge of poverty requires dealing with the smallholder—directly and unequivocally. IDE has found that significant gains in rural livelihoods can be achieved with relatively modest resources by facilitating market forces to directly support the agricultural production requirements of smallholders.

Smallholders' Comparative Advantage in Agricultural Production

Smallholders have an important advantage over larger commercial farmers as their family members can usually satisfy farm labor requirements without the use of hired labor and with little or no supervision cost.[3] This provides the basis for a comparative advantage for smallholders in labor-intensive farming systems where factors of production must be closely managed.

Given an adequate supply of water, smallholders can exploit their labor advantage in the production of horticultural crops such as fruits, vegetables, nuts, spices, mushrooms, flowers, and other specialty crops. With these crops—using concentrated, labor-intensive production systems—it is possible for smallholders to achieve higher yields per unit area and better quality produce than farmers that cultivate larger areas with capital-intensive farming systems do. Larger farmers, on the other hand, are better suited to the production of staple crops, which require less intensive management and are more adaptable to mechanization. The smallholders' aptitude for horticultural crops and the large farmers' aptitude for staple crop result in a comparative advantage for smallholders in the production of horticultural crops.[4]

This comparative advantage of smallholders can be further enhanced by providing products and services that are suited to their unique characteristics and that will enhance their ability to grow and sell crops efficiently. Under intensive production systems, the smallholder has the capacity to create annual net returns of $0.70 per m^2, and—under favorable market conditions—may go significantly beyond this value.[5]

Meeting the Specialized Needs of the Poor

To meet the specific needs of the poor, technologies must be engineered from a poor person's point of view. In many cases, it is not sufficient to merely scale down a solution that is appropriate for a large commercial farm. In the case of

[3] Costly supervision is required to monitor the work of nonfamily agricultural labor (Stiglitz 1974). The costs of monitoring labor for nonmechanized, labor-intensive agricultural production are particularly high (Eswaran and Kotwal 1985).

[4] To have a comparative advantage in horticultural crops, smallholders do not necessarily have to produce them more efficiently, in absolute terms, than larger farmers. It merely requires that smallholders be less disadvantaged in producing horticultural crops than they are in staple crops. The economic law of comparative advantage asserts that the total production of all goods increases and all market participants benefit when each participant specializes in the product for which he/she has a comparative advantage.

[5] Mushroom production techniques promoted by IDE in Cambodia have enabled some farmers to earn net incomes as high as $400 per year on only 50 m^2 of land (an annual return of $8 per m^2).

drip irrigation, commonly available systems have sophisticated and expensive water filtering and emitter systems designed to prevent clogging and thereby reduce maintenance. IDE's low-cost systems have very basic filters and emitters, which significantly reduce the cost of the system, but require that the emitters be monitored and periodically unclogged—a procedure that can be easily accomplished by a smallholder with relatively abundant family labor on a small plot of land, but which would be impractical on a large farm with hired labor.

It is also important to recognize that priorities of the poor are often different from more wealthy consumers. In Bangladesh, IDE experimented with different price-quality variations of the treadle pump. When given a choice between a pump that would last 7 years and a less expensive pump that would last 2 years, the poorest smallholders preferred the lower cost, less durable pump. The poor value affordability more highly than durability. This makes economic sense, given that cash is always in short supply for the poor and the food and income generated by the lower-priced pump will provide for their needs today while enabling them to upgrade their pump at a later date.

Integrating Smallholders into Markets

From a smallholder's point of view, the market environment can be envisaged as a three-part system consisting of the input market, the small farm, and the output market.

- The *input market* includes the enterprises and organizations that provide the goods, services, information, and credit required for agricultural production.
- The *small farm* is the household production unit that consumes inputs to cultivate crops for self-consumption and for sale to output markets.
- The *output market* includes the enterprises and organizations that provide the goods, services, information, and credit required moving the small farm production from field to consumers at economically rewarding prices.

Microirrigation technology has no power to generate income for smallholders unless there are market opportunities to exploit. Market opportunities provide the driving force that draws goods and services through the market system with value being added at each stage: from input supply chains, through on-farm production, to postharvest processing and delivery to consumers. Thus, smallholders should see technology such as microirrigation as a factor that enables market participation, not as a driving force in itself.[6]

If smallholders are to benefit from the movement of commodities through market systems, it is important that they be integrated into those systems, as consumers of goods and services and as producers of saleable crops. In areas where IDE works, we have found that the most successful smallholders—those who have been able to lift themselves out of abject poverty—are those who participate more fully in markets by purchasing more inputs, making effective use of technical

[6] Similarly, other agricultural production factors such as credit, information, capacity building, policy, and infrastructure should be seen as enablers of market participation, not as driving forces in themselves.

knowledge and market information, and developing stable linkages to output markets.

Unfortunately, smallholder-friendly market environments rarely arise spontaneously. Rather, a situation of market failure usually exists, whereby the market does not provide the goods and services needed by the smallholder. The rural poor tend to be ill served or bypassed as a market segment for many reasons: they are located in sparsely populated remote areas, they have low purchasing power, they make purchases and sell produce in small volumes, and the quality quantity of their production are inconsistent.

To create smallholder-friendly market conditions, some form of external intervention, facilitation, and investment is required to align market forces and provide the activation energy that will eventually lead to self-sustaining and expanding market systems. IDE has demonstrated, for instance, that it is possible to facilitate networks of small and medium enterprises to profitably manufacture and distribute microirrigation technologies in rural areas. Treating the rural poor as customers, facilitating an efficient supply chain, and actively promoting products that meet a real need have accomplished this. In this way, IDE has helped create markets for affordable microirrigation equipment where no market existed before. The experience of IDE and other organizations has shown that other agricultural inputs (such as high-quality seeds and micro-credit) and output services (such as agro-processing and market linkages) can be made affordable for smallholders and still be profitable for suppliers. With the right products—appropriately sized, priced, and marketed—the private sector can deliver appropriate inputs and output services to smallholders in a sustainable "win-win" relationship.

The Way Forward

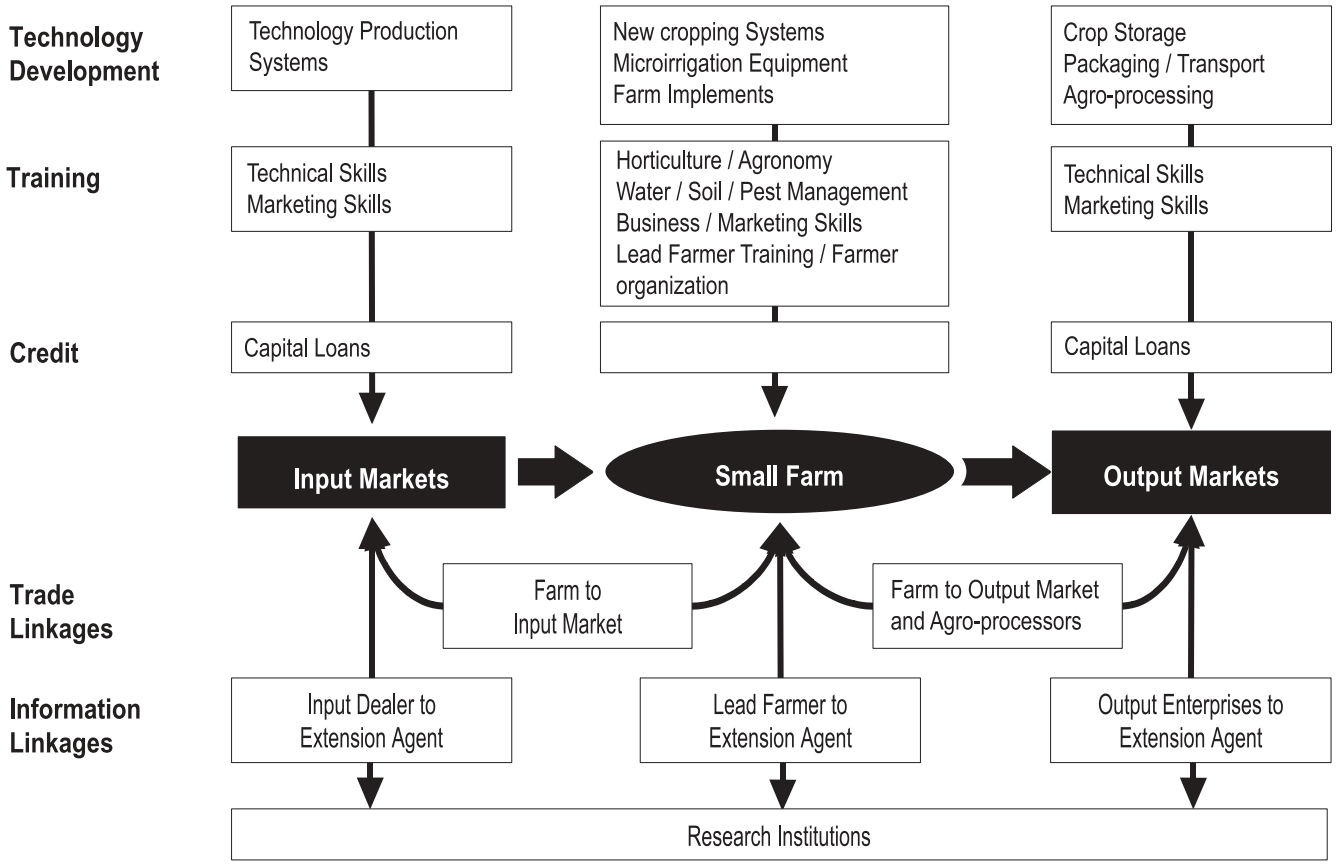
The worldwide scope for affordable microirrigation is very large, with widespread applicability to the creation of production systems that are extremely efficient—in water usage and in targeting economic benefits toward the rural poor. Two preliminary studies prepared by IDE and Winrock International have indicated that as many as 30 million rural households can potentially benefit over the next 15 years from microirrigation as a means to smallholder market integration.[7]

As an initial step toward this very ambitious goal, IDE (in collaboration with Winrock and other partners) has spearheaded the SIMI. The SIMI aims to coordinate efforts of the international development community to tap the productive potential of microirrigation and market integration for rural poverty reduction. Affordable microirrigation technologies are taken as a starting point for increasing smallholder production. Increased production then becomes the basis for profitable interactions with the market, which in turn lead to increased incomes and improved livelihood for smallholders. The SIMI follows a series of six logical steps.

[7] Smallholder Irrigation Initiative: Study on the Dissemination Potential of Affordable Drip and Other Irrigation Systems and the Concrete Strategies for their Promotion, funded by SDC and Japan Irrigation and Drainage Institute (March 2001), and Smallholder Irrigation Market Initiative (SIMI): A Plan to Achieve Large-Scale Poverty Reduction through Water Control and Market Participation, funded by the Dutch Ministry of Foreign Affairs (April 2002).

- *Market-shed definition.* A "market shed" is defined as the geographical area and associated population that has real or potential trade relationships with a particular market center. A single market shed may comprise anywhere from several thousand to several hundred thousand smallholder families that share a degree of uniformity in hydrology, agro-ecology, market access, and socio-cultural characteristics. Market sheds are selected in areas where smallholders have at least minimal access to water and markets since infrastructure projects for water resource development and transportation are not included in the SIMI model. Rather, the SIMI seeks to help smallholders and small enterprises take advantage of existing water and market opportunities, whether they exist naturally or through the intervention of other projects.
- *Water strategy*. Analyze the water situation within the marketshed to identify an overall approach that will allow smallholders to access and control water for irrigation. Emphasis is placed on low-cost, household-level, micro-irrigation systems for accessing, storing, and controlling irrigation water. Such systems are consistent with the ideal of maximizing water-use efficiency and minimizing social transaction costs for users. Environmental assessment is of primary importance at this stage to minimize adverse effects of the proposed water strategy and ensure sustainability in the long term. Other key considerations at this stage include water policy, customary water-use arrangements, power relations (including gender issues), and potential water-use conflicts.
- *Opportunity analysis*. Based on an analysis of high-value crop markets—and with extensive participation of farmers, research institutions, NGOs, and government agencies—identify a set of cash crops that smallholders can produce with comparative advantage and for which there are promising markets.
- *Constraints analysis*. For each of the crops identified above, identify constraints in the input-production-output chain. The basic tool used to identify constraints is sub-sector analysis, which seeks to identify the significant players in the market system, the relationships between those players, and the rules that govern those relationships. Emphasis is placed on four areas of potential constraint: technology, capital/credit, capacity building, and market information.
- *Intervention design*. Intervention strategies are designed to address the priority constraints identified above. Figure 1 indicates the types of interventions that may be required in a given market shed. Typically, production factors (such as technology, capital/credit, capacity building, and market information) are neither available to smallholders in a form that is useful to them nor at affordable prices. Market interventions seek to activate the private sector to address the particular needs of smallholders by delivering appropriate and affordable products and services. Networks of small agribusinesses provide the critical linkages between smallholders and the wider economy. External intervention in the form of public investment and grant funding is used to "get the ball rolling," allowing market forces to take over and become self-sustaining. After 5–6 years of market interventions, it is expected that smallholders will be sufficiently integrated with market systems, that they will achieve net incomes amounting to $500–1,000 per year from cash crop

Figure 1. Potential Areas for Intervention to Facilitate Smallholder Market Integration



production. At this point, external intervention is phased out, leaving the market to operate under its own power, and leaving farmers well informed, motivated, and organized to continue developing and taking advantage of market opportunities on their own.

- *Implementation and evaluation.* Details of this step are very much dependent on the results of the program formulation in preceding steps. It is clear, however, that market intervention of the kind proposed here requires concerted efforts of multiple players that are able to deal with technology development, the injection of capital and credit, training and capacity building, and market information development. A key strategy will be to create "platforms" upon which participating organizations—including government, NGOs, research, and private-sector organizations—can work together in a deliberate, determined, and targeted fashion toward the goal of sustainable market participation by the rural poor. The platform organizations act as facilitators, supporting the real "actors" in the market system, i.e., the smallholders and small enterprises in the input and output chains.

The SIMI is, by necessity, demand-driven. Market systems simply will not function sustainably unless they respond to real demands. Grassroots participation of smallholders and small enterprises in each of the six steps is necessary to ensure that resulting market systems conform to actual needs and field realities.

A flexible approach is therefore required so that the implementation of the SIMI and resulting market systems can be tailored to conditions in each market shed.

To facilitate the learning process, IDE has proposed that the SIMI be piloted in the context of several regions that are generally comparable in terms of hydrology, agro-ecology, market access, and sociocultural characteristics.[8] Pilot projects in these regions will be accompanied by intensive action research to document and draw lessons from the ongoing field experience. Once a solid knowledge base for market-shed development in a specific region is in place, it can serve as the basis for rapid expansion of market-shed development efforts within the same region. In each new market shed, the learning approach will continue, though research and documentation activities will be less intensive than in regional pilot projects.

Conclusion

Achieving the Millennium Development Goals—particularly the goal of halving the number of people surviving on less than a dollar a day—will require a major reorientation of worldwide development efforts from pursuing general "economic development" and toward "poverty reduction" as a distinct and more urgent goal. In contrast to current trends, the allocation of development resources must become biased *toward* rural areas, agriculture, and smallholder agriculture in particular.

Microirrigation stands out as a simple, practical, and widely applicable tool for liberating market forces to benefit the rural poor. The experience of IDE during the past 2 decades has demonstrated how this can be achieved on a relatively small scale (2 million smallholders). The concepts embodied in the SIMI approach provide a way forward, employing a demand-driven, action-oriented approach to reduce poverty on a very large scale through the integration of smallholders into expanding markets, with microirrigation as an entry point.

[8] Regions have been initially identified in Asia, including the Gangetic plain (Bangladesh, West Bengal in India, and the Terai of Nepal); the Deccan plateau (central India); Eastern India (Orissa), the hill regions of Asia (Lao People's Democratic Republic [Lao PDR], Myanmar, Nepal, North India, Thailand, and Viet Nam); south-central People's Republic of China (Guizhou, Sichuan, and Yunnan); and the Greater Mekong Subregion (Cambodia, Lao PDR, Thailand, and Viet Nam).