16 TRANSFORMING RURAL WATER ACCESS INTO PROFITABLE BUSINESS OPPORTUNITIES

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Summary

More than a billion people in the world's poor rural areas do not have access to clean drinking water, and a similar number lack access to affordable small-plot irrigation. Yet, the world's experts in water and sanitation on the one hand, and irrigation on the other hand, rarely talk to each other, much less collabourate. This is unconscionable, because integrating access to drinking water and irrigation water at the village level provides an unparalleled opportunity to provide clean drinking water for the rural poor and at the same time expand the access of smallholders to the irrigation water they need to increase and stabilize their income from agriculture. The good news is that such hybrid systems can be created and operated as profitable income-generating businesses by water user groups, repaying the loan required to build them in three to five years and providing a sustainable source of village income after that. The implementation of successful income-generating hybrid systems for drinking water and irrigation follows four basic principles:

- The design of village hybrid systems should provide for the delivery sufficient water to meet the participating villagers' needs both for clean drinking and small plot irrigation.
- An effective water user organization should have the ultimate authority over the design and building of the hybrid systems, as well as assuming responsibility for operating it and regularly collecting fees from irrigation and drinking water users. The structure for such water-users groups already exists in many rural villages.
- Hybrid systems require additional short-term capital investments to cover the transaction costs of forming effective water user groups, and opening smallholder access to affordable small-plot irrigation technologies, markets, information, credit, and agronomic training.
- Hybrid systems are most effectively financed through commercial credit rather than depending on government subsidies or donor grants.

The basic steps required to build a hybrid system are exactly the same as those widely practised already in the construction of piped drinking water systems that carry water from springs or streams to hill area villages. The exception is the marginal cost of increasing the diameter of the water pipe to carry additional water for smallholder irrigation, and providing separate irrigation water outlets in addition to domestic water outlets. But the financing of the hybrid system is radically different. In the conventional piped water system, the village may wait a very long time for a government or donor grant to cover the materials cost of the piped water system. If the money by an act of God or good political connections does become available, the villagers contribute their labour to build the system.

In the hybrid system, however, the villagers apply for a commercial loan (or micro-credit loan), build the system, and pay it off in three to five years from the proceeds generated by payments from smallholders with small drip-irrigated plots of cash crops. Small fees from households receiving clean drinking water also supplement this. The hybrid system model for handpumps on wells is even simpler- the group of families using the handpump carries the water to their homes or drip irrigated fields in buckets. The hybrid system can fit just as well for six households getting drinking and cash crop irrigation water from a $125 tubewell hand pump in Asia, or for fifteen families getting water from a $600 rope and washer pump on a well in Africa.

By providing a source of sustainable income from user fees, hybrid systems can make a significant contribution to the alleviation of rural poverty, as well as providing an economically sustainable source of clean drinking water for the rural poor. But, to achieve these goals, major policy changes will need to be made by donors, NGOs development agencies, and the governments of developing countries in how the provision of clean drinking water to the rural poor is conceptualized and implemented.

16.1 Access to water at the village level

16.1.1 Global clean water and poverty eradication initiatives

The people in the world without clean drinking water are targeted by the Millennium Development goal of cutting in half the more than one billion people in the world who do not have access to safe water and sanitation by 2015. The rural poor with no access to affordable small-plot irrigation water represent the majority of the people targeted by the Millennium goal of cutting in half the percentage of people in the world who earn less than a dollar a day by 2015. Both these groups of poor people with serious constraints in access to water share one more important characteristic. Without major changes in current approaches to alleviate poverty and open access to clean domestic water, the global initiatives launched in their name are destined to fail

The rural poor will not emerge from their poverty unless they can find a way to increase their incomes from agriculture, and to accomplish this they need access to affordable small plot irrigation water, a key constraint that has not been addressed by the poverty alleviation constituency. And village access to clean drinking water has been severely constrained because the water and sanitation constituency has relied too much on a supply driven approach funded by donations and subsidies, which usually simply does not work.

16.1.2 Access of the rural poor to clean drinking water

For most of the rural poor, access to clean drinking water is as far removed as it can be from the western context of simply turning on a tap. They can get it instead from a village handpump sitting on a drilled or hand-dug well, producing clean water from a water-bearing sand layer called an aquifer. In many poor hill areas, villagers can gain access to clean water by building a gravity flow pipe system that carries water from clean springs or streams. But the problem is that a handpump on a tubewell in most locations costs far too much for a village, much less a family, to afford. The main factor influencing the cost of a hand pump is how deep the tubewell needs to go to reach the nearest sand layer, called an aquifer, where clean water can be found.

In many parts of Africa, for example, a handpump on a tubewell costs more than $1,000, and most of the people who need clean drinking water earn less than a dollar a day. The most popular solution for this situation is for either the government or a donor agency to pay for installing a village hand pump, which might provide water for 30 or more families. But there is never enough donor or government money to reach all the villages, and often when a hand pump is installed as a gift, it falls into disrepair within a year either because nobody feels ownership of it, or it is too difficult to repair with the resources villagers have available. The same holds true for villages in hill areas, which aspire to piped water from a clean water spring above the village. Such a piped system starts at $1,000 for materials; so most hill villages are still waiting for the government or a donor to come up with the money.

An important exception to this is river delta areas like Bangladesh and eastern India, where bacteria-free water is available close enough to the surface to install a hand pump on a tubewell for $30 or less. In these areas, millions of small cast iron UNICEF number 6 hand pumps have been purchased and installed by poor families. Since it is often customary for a family with a hand pump to provide free access to water to the neighbors, there is a sufficient quantity of affordable hand pumps in these areas to provide access to clean drinking water for most of the population. And when the cost of an installed hand pump is in the $60 range, it is often possible to use a variety of strategies to bring the cost down to the $30 range, as was recently accomplished in Vietnam (Baumann, 2002).

While clean drinking water supplied through pipes to people in cities is relatively expensive, because of the costs of treating it to remove bacteria, water from properly installed wells and many springs and streams is clean at the source. So using it also for small-plot irrigation requires little added expense. But the water and sanitation constituency has not incorporated strategies to build village hybrid system strategies, capable of transforming access to drinking water into profitable businesses capable of paying off a loan to cover installation costs in three to five years, and providing a continuing income stream for the village after the loan is paid off.

16.1.3 Access of the rural poor to affordable small plot irrigation water

A low-cost irrigation system that suits a small farm can easily pay for itself in less than a year. To have a chance at increasing their incomes from agriculture, the 75%of farmers in countries like India and China who cultivate less than two hectares desperately need irrigation devices that fit small plots with a starting price in the range of $25. (Postel *et al*, 2000).

What the irrigation establishment provides instead is donor-funded, government-operated multimillion-dollar irrigation projects. The poor farmer, lucky enough to gain access to one of these systems, finds himself with water erratically delivered, a teaspoon at a time, to the tail end of a canal. The irrigation establishment has simply failed to pay attention to the design of affordable small-plot irrigation for individual small farms, and its mass dissemination through the private sector, which must be the backbone of practical strategies to eradicate rural poverty.

The development and mass dissemination of affordable small plot irrigation devices over the past 15 years has begun to redress this imbalance, (Polak, 2000). For example, more than two million poor rural families have responded enthusiastically to affordable small-plot irrigation devices like treadle pumps and low-cost drip irrigation system. The exponential increase in global demand for low-cost drip systems, on the other hand, is limited for many families by a critical constraint - access to an affordable expanded source of micro-irrigation water.

Families in the hill villages of Nepal around Pokhara, for example, are already taking the first step toward hybrid systems, by using excess water in piped village drinking water systems to irrigate off-season vegetables. They irrigate with a $25, 100 m^2 gravity drip systems, supplied through the private sector by International Development Enterprises (IDE), earning net income of $60 in the winter growing season. But when they take the logical next step to expand their drip system to 500 m^2, they quickly learn that there is not enough water in the existing village piped water system to allow them to expand their irrigated plots.

16.1.4 Water source constraints for affordable small plot irrigation

Quite often, however, the limitation to the spread of the systems is lack of access to a small but reliable source of water. For instance, in Nepal, 60 % of the users of drip irrigation are actually using the excess water available from drinking water systems as the primary source of irrigation water. But when the farmers meet with success on their small plots, and would like to expand, or when neighbours want to add their own systems, they are not allowed to because the community cannot put their drinking water supply at risk. This is the case despite the fact that there are thousands of undeveloped water sources throughout the region, which could be used by tens of thousands of smallholders to increase their incomes and food security.

So what is the problem? The technology needed for these systems is virtually the same as that used for drinking water systems, and bears little resemblance to what is traditionally thought of as an irrigation system. Developing a water source and conveyance to the village usually costs in the range of $2,000-$5,000 and this is too much money for a typical farmers' group or community to pay for up front. So what about public sources of money? Well, unfortunately, this type of development can neither be paid for by money earmarked for drinking water (it is used for irrigation), nor by money earmarked for irrigation (only irrigation systems of 10 ha or more are considered for funding). So the technology has changed, but the development community cannot meet the needs of the farmers because they haven't kept pace.

16.2 Integrating drinking water and smallholder irrigation

The recent development and mass marketing, of affordable small plot irrigation technologies like low-cost drip systems, opens up the possibility of turning both village hand pumps and gravity pipe systems into sustainable income generating businesses that can be financed, not by subsidies, but by repayable loans. Transforming the financing of water and sanitation projects to repayable loans instead of subsidies and gifts opens up a realistic possibility of reaching ambitious goals for supplying clean drinking water to the people who need it. On the irrigation side, it opens up practical possibilities of opening access of smallholders to expanded sources of irrigation for their high-value horticultural crops, irrigated by affordable small-plot irrigation systems.

The rapid development and dissemination of hybrid income, generating drinking water and smallholder irrigation systems, makes possible both a rapid increase in the access of the rural poor to both clean drinking water and improved incomes from agriculture (Moriarty, 2000).

16.2.1 Development of affordable small plot micro-irrigation technology

Recent breakthroughs in affordable small-plot irrigation devices, that are adapted to the particular needs of the smallholders in developing countries, provide them with new income-generating opportunities. These innovations share the following characteristics:

- relatively low cost

- simplicity of manufacture, installation and use
- highly efficient use of water
- low labour requirements compared to hand watering
- applicable to small plots ranging from 25 m² to 2,000 m²
- applicable to a wide range of horticultural crops
- capable of operating on extremely low heads of 1-2 m.

These smallholder irrigation devices include treadle pump tubewells starting at $25 (US), (Polak 2000), low-cost drip systems starting at $5 (Polak *et al.* 1997, Polak, 2000, Keller, 2002, Polak, 2000b), and low-cost micro sprinkler systems (Shah, 2000) Such low-cost smallholder irrigation technologies now make it possible for poor families to earn, what is for them significant incremental incomes, from newly acquired access to relatively small amounts of water that would not be sufficient as a source for conventional flood irrigation.

For example, in Nepal, International Development Enterprises (IDE) has developed a drip system, which ranges in cost from $13 to $35, covers from 125 m² to 500 m², and is used mainly for growing off-season vegetable crops on the water scarce hillsides. More than 5,000 of these systems have been produced by private sector manufacturers and sold through a private sector dealership network facilitated by IDE. Farmers are increasing their annual average income by $75 to $300 depending on the size of the system.

Similar systems with slightly different designs but equivalent use and results have also been developed and marketed in India by IDE (15,000 systems) and in Sub-Saharan Africa by Chapin Watermatics, IDE, and Netafim (10,000 systems). Farmers in these varying localities are increasingly finding these systems a good investment, given their limited means and limited water supply. When combined with breakthroughs in the affordability of hand pumps, achieved through a combination of design innovation integrated with decentralized private sector supply chain strategies, these new affordable smallholder irrigation technologies enable the mass dissemination of economically sustainable hybrid village water systems that transform access to drinking water to an income-generating opportunity.

16.2.2 Drinking water and affordable small plot irrigation combined

But what if the farmers could be given a loan to develop the system themselves? If a group of 40 farmers is earning an average of $150 per year, they should be able to pay $50 per year each for paying back the cost of the system. This would be a total of $2,000 per year, and would be enough to pay back a small system in one year, or a larger system in two or three years. Combining the distribution system for small plot irrigation with a drinking water distribution system would require little marginal cost, and provide a source of additional revenue. If the clean water source supplying the 40 farmers could also provide water distribution points for 60 village families, and each family would be willing to pay a ten dollar a year user fee for access to clean drinking water, the water users' association would gain $600 a year in income for a very small additional installation cost. And since access to clean drinking water is highly valued in poor rural areas, its integration in the village water system would stimulate stronger support and participation by the village.

The methodology for implementing such schemes is well developed throughout the world, and has been used regularly to implement piped drinking water schemes from springs and streams for hill villages. It involves developing water users groups (WUGs), and building their capacity to operate and maintain both the group and the water system. By taking a participative approach, and involving the community in both planning and implementation of the scheme, the chances of success of such schemes can be greatly increased.

The WUG can also decrease the overall cost of the system, by donating unskilled labour and locally available materials such as sand. And, of course, some external input is needed, in terms of group formation and mobilization, and in terms of teaching irrigation and horticultural expertise. In parallel, the chances of the scheme can be greatly increased by a market development scheme, that will strengthen the private sector's capability to supply appropriate inputs, and make market linkages for selling their produce.

All that's needed are policies and funding mechanisms that support such schemes, and the methodology to implement them.

16.2.3 Multi-purpose productive use rural water supply systems

The same steps used to integrate household water supply with income-generating irrigated smallholder cash crops are applicable as well to other productive small scale uses of water, such as fish ponds, watering of livestock, and water-related livelihood enhancing small enterprises. As is the case for effective livelihood enhancing irrigated gardens, the success of other productive uses of water is tied to access to markets, access to up to-date information and training on effective production methods - for example, in the case of fish ponds, ways to effectively prevent and treat fish diseases, ways to optimize fish feeds from locally produced sources, affordable technologies for adding oxygen to the water, and so on. When rural communities find a way to build and operate their own water supply systems, they invariably build multiple use systems which combine access to clean household water with a variety of productive water uses. Multi-purpose rural water supply systems follow the model for multiple productive uses of water already incorporated by rural communities in the systems they build for themselves, supplemented by the implementation of methods to optimize productivity and market access that fit the village context.

16.2.4 The Guatemalan experience

In Guatemala there are more than 100 small-scale community owned and operated sprinkle irrigation systems that also supply domestic water (Lebaron *et al.,* 1987 and Lebaron, 1993). These systems were installed by hillside farmers primarily for irrigation. The systems rely on gravity pressure that is obtained by the villagers installing a pipeline from higher elevation springs and conveying it to their farming area and later to their homes. The communities of farmers borrowed money from the government's Agricultural Bank and were provided engineering technical assistance from the Extension Service. In the initial stages the Extension Service Engineers received technical help from Mr. B. L. Embry, an experienced irrigation engineer, who was funded by a USAID Project.

The average system size is about 20 ha and the average farm plot is roughly 0.2 ha. Each farm plot is serviced by a pressure tap in its middle. The farmers then used a hose with a conventional brass sprinkler on a tripod stand that they moved around to irrigate their land. The payback of the government loans was typically achieved in less than three years. This was made possible by growing high value horticultural crops and marketing the vegetables and frits in Guatemala City or smaller urban areas, in addition to a mixture of grain crops for subsistence.

At last count there were well over 100 of these small-scale systems. According to Lebaron (1993), three main criteria are attributed to the success of this endeavor: a) available credit at reasonable rates of interest and technical assistance; b) tightly knit and relatively small groups of participants; and c) potential to grow and market relatively high value crops such as small fruits and vegetables.

16.3 Contexts where hybrid systems are not likely to apply

While some two thirds of the rural families needing access to clean drinking water are likely to be able to take advantage of hybrid systems, there are several contexts where their application is unlikely. These include:

- Situations where it is necessary to treat the water with expensive methods to make it drinkable. The cost of treatment is likely to make the water too expensive to use for irrigation purposes.
- Applications where the construction of the water system would be too expensive to make it possible to pay off a loan for construction costs from the proceeds of horticultural crops irrigated by water from the system
- Contexts in which the village is too far removed from a sustainable market for high value crops, or there are other unsolvable constraints to market access to generate sufficient volume sales required to make the hybrid system economically sustainable.
- In situations where clean drinking water is available to individual families at a modest cost, such as the $25 required to put a small handpump on a tubewell in shallow aquifer areas like much of the Gangetic plain, rural families are likely to prefer individual access to the more cumbersome and, in many cases more costly, group solution.

16.4 Policy implications

While the impact hybrid of village systems providing sustainable village access to water is likely to be promising, their further development and mass dissemination require significant policy changes:

- Mechanisms need to be formulated and implemented to convert the existing patterns of non-communication and negative competition between the water and sanitation and irrigation constituencies to one of productive collabouration. Funding mechanisms for the joint design and implementation of hybrid village systems would be an important step in this direction.

- Immediate steps should be taken for the further development, installation, field-testing and evaluation of hybrid village water systems under a systematic variation of rural contexts.
- Funding policies should shift from subsidizing the cost of village water systems to the short-term support of the formation of water users' associations for hybrid systems, the facilitation of their access to credit, and facilitating the access of smallholders in hybrid systems to markets, agronomic training, inputs, and relevant information.
- An evaluation of the feasibility of installing a sustainable income-generating hybrid system, providing both clean drinking water and smallholder irrigation water capable of providing a 3-5 year payout of a commercial loan covering construction costs, should be the first step in the construction of all future government and/or donor supported rural drinking water systems.
- A further shift in funding should take place from grants supporting village water system construction to loans, based on the presentation by water users' associations of sustainable business plans for building and operating hybrid systems

16.5 Case examples

16.5.1 Case 1: A $125 Jibon pump becomes an income generating opportunity for six rural families in Bangladesh

A group of six families living within a 300-metre radius of each other are interested in installing a Jibon pump, a low-cost handpump developed by IDE Bangladesh, so they can switch from using convenient, but bacteria infested surface water for their households to clean drinking water close to their homes. Because the water-bearing aquifer is 25 m deep, they estimate that it will cost $125 to install a Jibon pump which could produce much more water than the four to five buckets a day that they estimate each household will need. Their biggest constraint is that none of the families could afford the $125 initial investment, and while each family could afford to pay 50 cents a month for access to clean drinking water, this would not be enough to pay back a loan to cover the installation cost.

16.5.1.1 Hybrid system solution

The six families form a water users' group, and obtain a loan for $125 to install the Jibon pump. In addition, each household borrows $18 to purchase a low-cost 100 m^2 gravity drip irrigation system. The drip systems provide new net income of $50 a year for each family from growing off-season drip-irrigated vegetables.

From this income, each family pays $10 a year to pay off the drip system, and $10 a year to pay off the pump. This allows the loans for both the Jibon pump and the drip systems to be paid off in 30 months, and continues to produce new net income of $50 a year for each participating family indefinitely. To accomplish this, however, requires a one-time grant to a local grass roots development organization to facilitate the formation and operation of the water users group, and to train each participating family in the use of the drip system, agronomic training, and facilitating access to markets for off season vegetables.

16.5.2 Case 2: A rural village in Zimbabwe installs a $600 rope and washer pump

A village of 15 families, a three hours drive from Harare in Zimbabwe, decides to install a community hand pump to provide drinking water to replace a 2 km walk to a community well in a neighboring village. They learn that it will cost US$600 to install a rope and washer pump on the 30m borehole required to reach a sand layer capable of delivering an acceptable supply of clean water.

But consider what might happen if ten of the families were to install 100 m 2 drip kits in addition to a hand pump. IDE and DAI have already field-tested 560 micro tube drip kits in Zimbabwe. Each drip kit irrigates 100 m^2 of high-value vegetables, and is capable of generating net income of $75 a year and more because of current high prices for vegetables during the current food shortage in Zimbabwe.

A 100 m^2 micro tube drip system imported from India with two 85 l gravity tanks costs $30 to install, and requires a fence to keep goats and other animals out of the vegetable garden. A five-strand barbed wire fence combined with a thorn bush hedge costs an additional $10 for materials, for a total installation cost of $40 for an expandable $100 m^2 drip kit.

The villagers estimate that each of the fifteen families will use 125 liters of water for domestic use each day, making a total of just under 2,000 liters of water a day. Ten of these fifteen families elect to install drip irrigation systems growing cash crops. The 100 m^2 vegetable income garden requires an average of

400 lof water a day under typical weather conditions for the area, less when the vegetables are first planted and more as they reach maturity. The combination of drip irrigation and domestic water represents total water need of 6,000 lof water a day. At an estimated water delivery rate of 10 l a minute, the rope and washer pump will be operated for about 10 hours a day, with the families taking turns using it.

Villagers will carry water to their homes from the borehole in buckets and irrigation water to the gravity drip system in wheelbarrows carrying two, 20-l buckets at a time.

From the net annual income of $75 from each drip system, each family growing drip irrigated cash crops will pay 15 dollars a year in irrigation water user fees, and $15 a year to pay for the drip equipment. In addition, each of the families agrees to pay $10 a year as a fee for the domestic water they use, contributing a total of $150 a year. This provides a total of $300 a year to pay off $600 loan for the community-owned parts of the system, namely the pump and the tubewell, enough to pay off a $600 loan with interest at 20% within three years. After the initial loan is paid off, villagers can consider increasing the size of their drip irrigated plots, and installing more pumps and wells.

Projected capital cost for the hybrid system (US$):

Domestic water:		
Installation cost for rope and washer pump and well		$600
Domestic water user fee income per year	15x10=	$150
Irrigation water user fee income per year	10x15=	$150
Total available to pay off well and pump		$300/yr
Irrigation water:		
Installation cost for drip system and fence (100 m^2)		$40
Payment by each cash crop family to retire debt		$15/yr

Enough income can be generated, from the combination of cash producing drip irrigated plots and reasonable annual fees for domestic water use, to pay off both the individual loans for the drip irrigation systems and the community loan for the installation of the rope and washer pump in 3-5 years.

16.5.3 Case 3: A gravity piped water drip systems for a village near Pokhara in the Nepal Hill Area

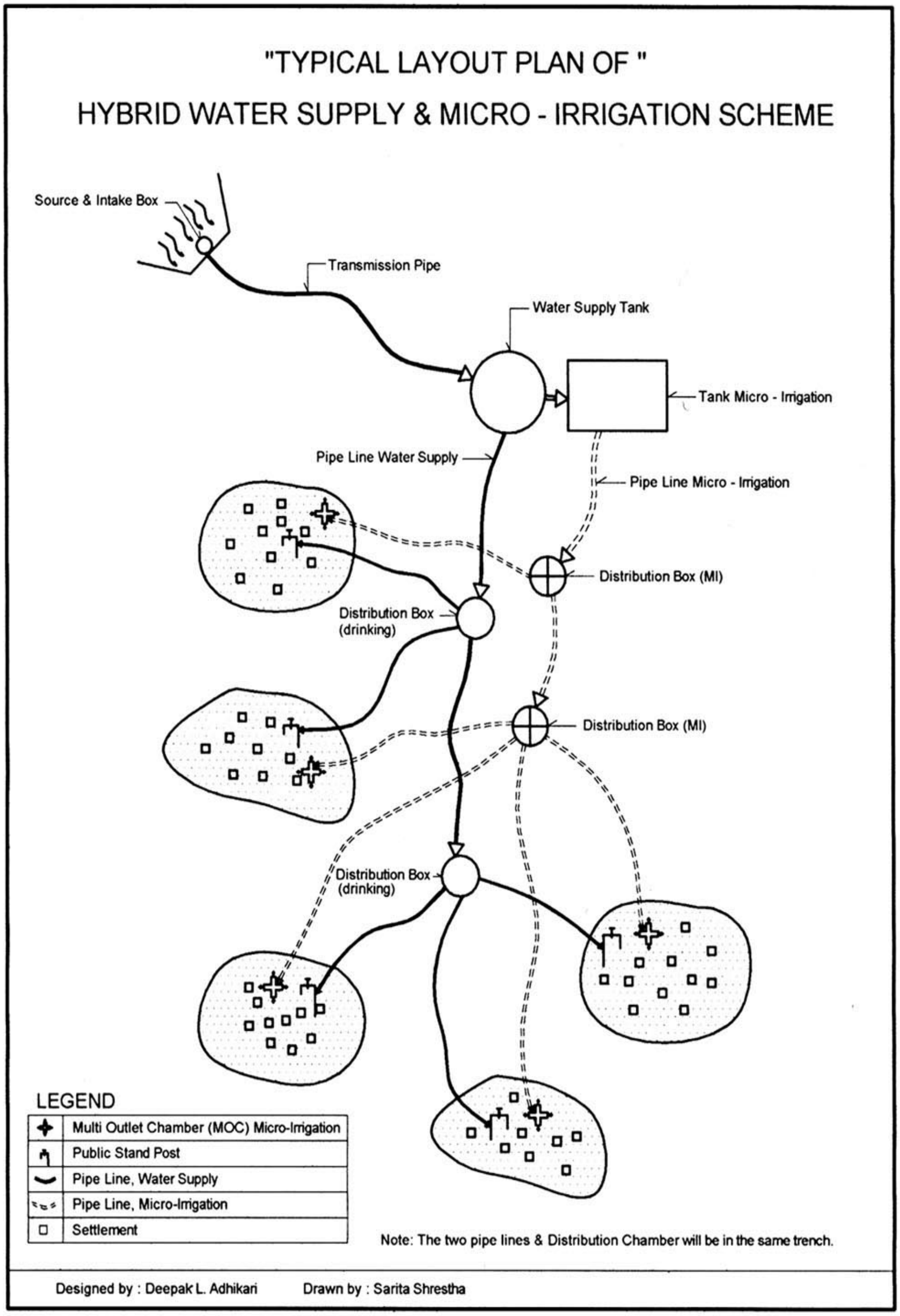
A village with 60 families near Pokhara is tired of waiting for the government of Nepal, using World Bank funding, to build a gravity pipeline to the village from a spring with clean water 1 km from the village.

The long range plan is for the government to give the village a grant to pay the materials cost to construct a 1 kilometer pipeline using HDPE pipe 32 mm in diameter, with a holding tank just above the village, and six water taps, each shared by five families. The village will supply the labour to build the system. But, since there are many more requests for government grants to build village piped water systems than there are for the supply of government funding, no construction date can be set, even though the village has been on the waiting list for six years.

Instead of continuing to wait for the government grant, the village decides to obtain a loan to install a hybrid system, incorporating the same drinking water plan as before, but adding the capacity to irrigate 30 drip irrigated plots of 500 m^2 each to grow off-season vegetables like cucumber and cauliflower for the Katmandu market, plus fruits like papaya and selected herbs. The village has already field tested 10 drip systems of 100 m^2 each, which have generated an average annual net income of $75, but they have not had sufficient water from the current source to expand.

16.5.3.1 Hybrid system solution (see diagram)

The best water source for the village is a spring, with a minimum low volume during the driest time of the year of only one half of a liter per second. But since the spring flows for 24 hours, the hybrid system plans incorporate a 32 mm pipe from the spring to a 6,000 ldrinking water gravity tank above the village. When that tank is filled, water flows through an overflow valve leading to a second 12,000 lirrigation water gravity tank. Following the standard drinking water system design, the separate domestic water delivery system delivers water through a pipeline to six water taps, each serving 10 families. A second pipeline from the micro-irrigation gravity tank supplies water under pressure to 30 smallholder plots of 500 m^2, through multiple outlet chambers. Because of the cool climate and 60 cm conventional spacing of cash crops, projected water needs for a 500 m^2 plot are relatively low- 800 l a day. Out of the projected $250 a year in net income from two off-season cash crops, each irrigator will pay a fee of $80 a year to repay loans for the hybrid system, drip equipment, and inputs. Each family using domestic water will pay a user fee of $100 a year. A village committee oversees the building and operation of the hybrid system, under which a separate drinking water and irrigation committee is responsible for fee collection and operation and maintenance of each system after it has been installed.



Projected Capital Cost for the Hybrid System (US$):

Number of water users (domestic)	60 families
Number of micro-irrigation users	30 families
Acreage of micro-irrigation user	500 m^2/family
Daily water required for domestic need	225 l/family
Daily water required for micro-irrigation need	800 l/500 m^2 plot per family
Discharge of the water source	0.5 l per second

Construction Cost of Water Source scheme:	
Intake Structure	$100
Transmission pipeline 32 mm dia, 1 km	$ 500
Storage tank	
Drinking = 6,000 and irrigation 12,000 l $ 600	
Distribution pipeline	
75 mm 500 m	$ 500
50 mm 500 m	$ 300
20 mm 2000 m	$ 500
Public stand posts 6 @ $100	$ 600
Distribution box 6 @ 50 $ 300	
Pipe fittings/accessories	$ 500
Skilled mason for pipe laying/fittings	$ 400
Installation labour provided by villagers	
Sub-total of construction of W/S scheme $4,300	
Materials for 30 fenced drip systems	$1,500
Initial input costs	$1,000
Total cost	$ 7,000

Projected annual income and expenses for hybrid system:	
Household water fee = 600 families x $10/yr	$600
Mircro-irrgation water users fee = 30x$80	$2,400
Estimated annual operating expense	$300
Net annual income	$2,700

Estimated loan payback period: 4yrs with 20% annual interest

After the loan is paid, the village is free to use the annual income from the hybrid system as a source of further needed village investment, micro credit loans for villagers, or other uses determined through the existing village governance structure. Since the funds available for the provision of clean drinking water are converted from grants to loans, they can be recycled many times.

16.5.4 Case 4. A hybrid system for sixty families of Ta Leng Hamlet in Quang Tri Province in the Central Hills of Vietnam

As is not unusual in the tribal villages of Vietnam's central hill area not far from the border with Laos, the 68 residents of the hamlet have no written language. They are able to grow only half of the rice that they need to survive on, and what they do grow is on their small low yielding rain fed upland rice fields, and even smaller irrigated rice paddies. To generate the cash required to buy the rest of the rice they need, they gather rattan, firewood, and grass used to make hats from the forest, and sell it to traders along the highway often at very unfavorable prices. Many of them raise one buffalo a year and sell it for meat or as a work animal for the plains areas of Vietnam.

Their current household water source is a stream 2 m wide and 20 cm deep, which never runs dry. During the dry season, they carry water by bucket from a deep spot on the stream about 500 m away and seven vertical metres below their homes. During the rainy season, they carry their water from a closer spot in the stream.

There is a natural basin in the stream some 15 m in vertical height above the hamlet. It is a natural flat spot where a small dam could easily be built to form a takeoff point for a pipeline. There is no major obstruction to bringing piped water from this point to the village, although there is a gently sloping hill that the pipe would have to go over between the water source and the hamlet.

The villagers have applied to the government for a grant to build the pipeline, but have no indication at present if money might be available. The government does pay for and install piped drinking water systems for villages, but if and when it does, it forbids the use of the piped water for anything but domestic use. But that is not the biggest problem. The biggest problem is that only a tiny percentage of hill villages have piped water systems, because the government simply lacks sufficient funds to meet the demand.

A third of the way from Ta Leng to the flat spot in the stream is a prosperous farmer with 4,000 coffee trees. He paid for and installed his own 38 mm PVC pipeline from the stream, and is using it to fill a newly built 700 m^2 fishpond. He uses his pipeline to irrigate his coffee and other crops, to fill his fishpond, and to supply water for his house.

Instead of waiting for a government donated domestic water pipeline, the hamlet could build their own income-generating hybrid system pipeline if they could locate a source of credit to build the system.

16.5.4.1 Hybrid system solution

The village could build a 5-inch pipeline for an estimated $4,300 in materials cost, including a tank for the distribution of drinking water and two tanks for fishponds and irrigation plots. Micro-irrigation would be provided to 30,500 m^2 drip-irrigated plots growing coffee, pepper vines, mandarins, vegetables and spices for sale along the highway. The operation and maintenance of the hybrid system and the collection of fees from owners of fish ponds and irrigated horticultural crops would be the responsibility of a committee appointed by the hamlet governance structure.

16.5.4.2 A significant investment in villager training and support

The Nepal Hill village near Pokhara already has farmers experienced in irrigation, agronomics, and finding markets for their cash crops. But the families of Ta Leng hamlet who have fishponds now produce only one tenth of the fish yields of comparable ponds in the plains area of Vietnam. They have little or no knowledge of irrigation or of sustainable ways to increase agricultural yields. Finally, because of their lack of a written language, and their poor trading skills, they regularly receive below market prices for the crops they do sell along the highway. Before they can be expected to earn enough income to pay off the loan to build their hybrid system, a significant investment needs to be made in training and knowledge acquisition in irrigation, agronomics, and sustainable ways to increase agricultural productivity, as well as improved access to markets for their crops and training and support for improved trading practices. In addition, they will not likely be able to earn enough money from their fish ponds and drip irrigated plots to pay back the loan with interest - they will need, at least in the beginning, a subsidized loan at zero interest rate.

Projected capital cost for the hybrid system (US$):

Materials for 2 km 12 mm pipeline	$4,423
Installation labour provided by villagers	---
Thirty 500 m^2 drip systems	$1,500
Initial inputs for crops	$1,600
Twenty-five small fishponds (Labour provided by owners)	$319
Total capital cost	$7,843

Projected annual income and expenses for hybrid system:

Household water fee - 60 families x $5/yr	$300
Micro-irrigation water users fee - 30 x $40	$1,200
Fish Pond Users Fee - 25 x $10	$250
Total Income	$1,750
Annual Operating Expenses	$300
Net annual income	$1,450

Estimated loan payback period: 5 yrs at no interest

16.5.5 Case 5: A private sector investment in a open dug well and six-kilometre pipeline to Belgoan Dhaga Village, Maharastra

Belgaon Dhaga is a small village in Nasik District of Maharashtra state in India. It has a population of approximately 1,500 people. Eighty%of the people in the village who work are employed in agriculture, and the remaining 20 % have jobs in neighboring towns. Two hundred farmers in Belgaon Dhaga village, representing 90 % of all the farmers in the village, cultivate less than 2 ha. This village has immense potential for supplying vegetables to the nearby town of Nasik. But the village is situated on the upstream side of a dam around 6 km away, which results in an acute shortage of water for irrigation as well as drinking water. There are two large farmers in the village who lift water from the area near the dam and deliver it to their large 25 ha farms through a lift irrigation system using a 15 mm diameter PVC main pipe.

There are several outlets on this pipeline and each outlet irrigates around 1 ha area through field channels.

There are some enterprising young small holders who would like to get together and invest in a water supply scheme that would deliver drinking water to their homes and irrigation water to their farms, and earn income from the sale of drinking and irrigation water to other smallholders in the village. The major constraint they face is technology and capital for this scheme, but they have located a possible source of credit from The Sustainable Village, a development organization in Colorado, USA, who asked IDE to help with the design of such a system. These young farmers are organized in a Self Help Group by a local NGO – The Human Resource Development Group.

16.5.5.1 Hybrid system solution

IDE has conducted several meetings with the farmers and identified six enterprising smallholders who are willing to invest in the scheme. They will be the private-sector owners of the hybrid system, and plan to sell irrigation water to 100 smallholders. Each smallholder will purchase and install a one acre (0.4 ha) low-cost drip system at an approximate cost of US$150, and will grow vegetables, fruit trees, herbs, and other cash crops for the Nasik market.

The hybrid system will consist of an open dug well around 10 to 15 m deep. The 6 km pipeline will be designed as a telescopic line starting with larger diameter (around 15 mm) and then gradually reducing the diameter as the water gets distributed on the way. Each smallholder will have access to the mainline, and will install an elevated low cost water storage tank with a capacity of 10,000 l costing around US$200. Farmers will irrigate their crops from the tank by gravity. Farmers whose homes are close to their farms can use their access to the pipeline to provide clean water for their households as well as their livestock. Farmers whose homes are in the village or at a distance from their farms will transport water for household use through bullock carts.

Projected capital cost for the hybrid system (in US$):	
Estimated land acquisition cost for well location	$4,000
Estimated dug well	$1,000
Estimated cost for electric motor and pump	$3,000
Estimated cost of pipeline	$25,000
Cost of fittings, valves, connectors, etc	$2,000
Cost of trenching, pipe laying, head works etc.	$5,000
Total estimated capital cost	$40,000

Investment cost and returns for smallholders:	
One acre (0.4 ha) drip irrigation delivery system	$150
Ten thousand l tank	$200
Initial input cost (seeds, fertilizer, pest management)	$100
Total investment for each farmer	$ 400
Estimated net annual return for each 1 acre farmer	$800 *

Projected annual income and expenses for hybrid system:	
Estimated total installation cost for hybrid system	$40,000
Total estimated annual income at user fee of $150	$15,000
Estimated annual operating expenses	$1000
Estimated term for hybrid system loan	4 –5 years
Each farmer gets a loan to cover cost of	
Drip system and initial inputs	$400
Estimated annual payments by each farmer on loan	$100
Estimated farmer loan payback period:	4-5 years

Since in IDE's experience it is not unusual for experienced cash crop smallholders to earn net income of 50 cents (US) per square meter ($2,000 per acre) these loan repayment schedules can be considered to be conservative.

16.5.5.2 Smallholder access to inputs and output markets

Sustainable access on the part of participating smallholders to markets for their crops, good quality inputs, credit at a fair market price, information, and pest management will be critical to the successful operation of the hybrid system.

16.5.5.3 Smallholder access to training and information

The provision of training and support for participating smallholders in effective cash crop selection and diversification, agronomics, pest management, marketing strategy, and timely information will be critical to the operation of the hybrid system in Belgoan Dhaga Village.

16.6 Conclusion

These five case examples illustrate the practical steps that need to be taken, and the issues that need to be overcome, to successfully implement hybrid drinking water and smallholder irrigation systems at the village level. But to make the implementation of village level hybrid systems possible, major changes in the policy of donors, development agencies, and the government of developing countries will be required.

16.7 References

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