Increasing the Productivity of the World's Micro-farmers

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Introduction

Three quarters of the farmers in developing countries cultivate less than five acres. The productivity of these small farmers is the key to practical sustainable solutions to the growing problem of food security in the world. In light of this, it is remarkable that the critical needs of microfarmers have for so long been ignored, both by both the development establishment influenced powerfully by western bigness biases, and policy makers in developing countries focussed on large multi-million dollar projects. The adoption of high yielding seeds and fertilizer combined with access to irrigation has tripled the global grain harvest in the past 30 years. But the harvest of the microfarmers of the world has failed to keep up. The main constraint to tripling the harvest of small farmers like their larger farmer neighbors is absent access to affordable and divisible irrigation.

This critical access to affordable irrigation is beginning to be provided by the recent design of affordable small plot devices like Treadle Pumps and low cost drip and sprinkler irrigation systems. But making positive sustainable impacts on a national scale through small farmers requires the initiation of practical large scale rural mass marketing initiatives. To meet the increase in demand that this stimulates, requires the activation of a reliable and sustainable rural product and spare parts supply chain, consisting of thousands of private sector production, distribution and marketing enterprises.

A Portrait of Microfarmers In Developing Countries

In Bangladesh, 92% of the farms are less than 5 acres, and 60% are under 2 acres.[1] . In Bihar, India, 75.% of landholdings are less than two and a half acres)[2], and in Egypt, 95% of landholdings were less than five acres in 1984[3]. In China, when land redistribution took place in 1952, 300 million landless peasants each received an average of 0.4 acres of land.[4] Since each farm is usually divided into four or five separate plots, the small farmer global majority is farming on microplots so tiny that modern western agricultural devices have no relevance. To make things worse, the typical small farm cash income of two or three hundred dollars a year or less makes the purchase of existing irrigation technology like five hundred dollar 5 horsepower diesel pumps totally out of the question.

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[1] Prosterman, L , Temple, M.N., and Hanstad, T.M. Agrarian Reform and Grassroots Development. Lynne Rienner Pbulishers, Boulder and London, 1990.

[2] Yougandhar, B N and Gopal Iyer, eds. Land Reforms in India- Bihar Constitutional Constraints. Vol.1, Sage Publications, New Delhi, 1993.

[3] Blaikie, MP, Cameron, J, and Seddon, JD. The Shruggle for Basic Needs in Nepal. Development Center of the Organization for Economic Co-operation and Development, Paris,1979, P230.

[4] Riad el-Chonemy, M. The Political Economy of Rural Poverty. The Case for Land Reform. Routledge, London and NY, 1990, p194.

Small Farmers and Global Food Security

Some 800 million people out of the current global population of 5.5 billion now go hungry[5]. The increased food requirements of a growing world population will escalate existing food security problems. The root causes of hunger are poverty, and poor food distribution Small farmers are disproportionately concentrated in food deficient rural areas. A single disastrous crop failure can turn them into landless laborers or send them into urban ghettos.

If subsistence farmers could double their harvest by gaining access to irrigation, they would eliminate their own hunger and produce an income generating marketable surplus. The increased harvest in food deficient areas would redress food distribution imbalances. The increase in labor requirements for growing, harvesting and processing the crop would create jobs for rural landless laborers and increase the income available to buy food. The key to increasing the agricultural productivity of small farmers is opening their access to affordable and efficient irrigation technology. But current irrigation technology is too expensive for small farmers, and does not fit small plots.

Bypassed by the Green Revolution

Between 1950 and 1990, world grain production tripled, from 631 million tons to 1780 million tons as a result of increased use of high yielding seeds, fertilizer and a rapid expansion in irrigation[6]. But rural poverty and hunger have not disappeared in spite of the optimistic early predictions of green revolution advocates. 66% of the children under five in Bangladesh, and 64% in India, are underweight, in spite of the fact that both of these countries are net grain exporters. This is in large part due to the fact that the increase in agricultural productivity stimulated by hybrid seeds and fertilizer has bypassed small farmers in developing countries[7]. While both seeds and fertilizer are available in tiny affordable units, and so are accessible to small farmers as well as large ones, existing modern irrigation devices do not fit small plots, and are far too expensive to be affordable to the microfarmer majority.

Irrigation and Agricultural Productivity

Over the past 30 years, global irrigated acreage has increased to 250 million hectares. Irrigated farmland now produces 40% of the world's food supply on 17% of its arable land, and this proportion is steadily increasing. Absent access to irrigation is a critical constraint to increased small farmer productivity. While some small farmers have access to canal irrigation, the average farm size served by large canal schemes is well over five acres. Private and public tubewells are increasingly popular, but the high cost and limited divisibility of mechanized

[5] Serageldin, Ismail and Landell-mills, Pierre, Eds. Overcoming Global Hunger. The World Bank, Washington, D.C., 1994.
[6] Lester Brown et al, State of the World, 1994. Earthscan Publications, 1994, p181.
[7] Polak, Paul. Dismantling the Barriers to the Green Revolution for Small Farmers. 1996. International Development Enterprises, Lakewood, Colo.

pumps limit access to groundwater by small farmers. The cheapest diesel pumpset on a tubewell costs $500 (US) and does not pay for itself on less than five acres. For the majority of the world's farmers who cultivate less than five acres and earn $300 or so a year, a purchase price of $500 is not affordable. Without affordable irrigation, the benefits from small farmer access to divisible high yielding seeds and fertilizer are minimal.

Affordability- The Sina Qua Non for Small Farmer Irrigation Devices

It makes as much sense to apply drip irrigation equipment that costs a thousand dollars an acre to a tenth of an acre of vegetables as it does to use a $100,000 combine to harvest a quarter acre plot of wheat. Affordability is the sina qua non of small farm irrigation devices. But the whole direction of the design process optimizes efficiency instead of affordability. To fit the needs of small farmers, this western design paradigm needs to be reversed. Design for small farmers must go through a process that puts first priority on affordability. Defining the key contributors to cost of existing useful but expensive technologies is the first step in identifying tradeoffs acceptable to small farmers as consumers.

Breaking Irrigation Technology into Microplot Sized Pieces

Seeds can be divided into tiny packets that both fit the needs of tiny plots, are affordable to poor farmers. The same is true for the most part, for fertilizer. But it is decidedly not true for existing irrigation equipment. No existing drip irrigation system is available in India for plots under one acre. Yet inexpensive backyard drip kits are available in every hardware store in North America that can provide drip irrigation for a small kitchen garden. The smallest diesel pumpset in Nepal starts with a five acre command area.

Conventional irrigation devices need to be miniaturized to conform to the size and agricultural requirements of micro-plots. But because of the extreme limitations small farmers have in access to cash, ideal micro-irrigation technologies are designed so they can be added to incrementally, like a lego set. In this way, a small farmer can make a tiny initial investment, and use the income the investment generates to expand the technology for the next harvest.

A Farmer Based Technology Adaptation Process

Early prototypes in the design of affordable micro-irrigation technology are put in the hands of small farmers, and redesigned using their critical feedback. The same adaptation process is followed when micro-irrigation devices that work in one country are transferred to a new country, or into different agro-climactic conditions. Detailed small farmer feedback is also used as a basis for the design of a rural mass marketing strategy.

A Generation of New Affordable Micro-irrigation Devices

Three high impact affordable Micro-irrigation devices have been designed and mass marketed to small farmers in several countries by IDE, a Denver based non-profit development organization. Their experience shows that completing the

design process addresses no more than 10% of the problem. The other 90 % of the time and energy is required is for implement the mass dissemination strategy to put the technology in the hands of micro-farmers. This requires a long range effort focussed on rural mass marketing, and the establishment of a sustainable private sector supply chain network of profitable small private sector enterprises that manufacture, distribute, and install the technology.

The Treadle Pump Story

Millions of farmers in Bangladesh grow only two crops a year, in spite of the fact that a copious supply of regularly replenished groundwater is available 15 feet below the surface. To get at this water, Gunnar Barnes, a Norwegian development worker, designed a pump that a micro- farmer could buy by selling a sack of rice. A simple looking device, it is powered by walking on two bamboo treadles. This activates two steel cylinders that are made in a village workshop. The Treadle Pump costs eight dollars, and a total of $35 installed on a tubewell, less than one tenth of the cost of a diesel pump. By irrigating half an acre of dry season vegetables, a small farmer increases net income by a hundred dollars a year, diversifies crops, gains access to clean drinking water, and shortens the three month period of hunger.

Working at first in Bangladesh, IDE implemented a national rural mass marketing program for Treadle Pumps. Billboards, callenders, and demonstrations at village and regional markets made the technology known. A 90 minute entertainment movie featuring top Bangladeshi movie stars embeds the treadle pump story in a popular plot, and the movie is shown in open air settings to an audience of a million people a year.

To meet the demand generated by grass roots marketing strategies like the movie, IDE has facilitated the establishment of a local supply chain of 70 manufacturers and several thousand village dealers and technicians trained by IDE. Each of these micro-enterprises operates for a profit, and Treadle pumps are installed without subsidy. This rural mass marketing strategy then was applied, after adaptation, to initiate similar programs in India, Nepal, Cambodia, and Zambia. At present, approximately 150,000 Treadle Pumps are being installed each year in these countries.

One of the common objections raised by development policymakers to micr-irrigation technologies is that even if they improve the lives of poor farmers, their national impact is only a drop in the bucket because they are likely to be adopted by only a few people, and each pump only irrigates a small plot. The ten year experience of the Treadle Pump in Bangladesh sheds interesting light on this issue. By implementing a national rural mass marketing program, 1.3 million Treadle Pumps have been installed through the local private sector.

Each of these pumps provides an average increase in net cash income of $100 a year for small farmers, at an investment cost of $35. This amounts to an increase

in net cash annual income of $135 million dollars a year for small farmers, and an increase in gross income of approximately $270 million a year. Using a 2.5 multiplier, the effect on the local and national economy can be estimated at $675 million a year. This does not include the economic impact of thousands of self supporting enterprises that manufacture and distribute Treadle Pumps.Total costs for IDE's services over ten years was $8 million (US), and total investment by small farmers themselves over ten years was just under $46 million.

Cutting the Cost of Drip Irrigation by Two Thirds

Five years ago, IDE set out to apply what it had learned from the Treadle Pump experience to other irrigation problems critical to the increased productivity of the world's micro-farmers. In semi-arid areas where water is precious, large farmers use drip irrigation to minimize evaporation losses by delivering water directly to the roots of plants. At a cost of a $1,000 an acre for crops like vegetables, conventional drip systems are not affordable for small farmers. A standard drip system uses a tank, a filter, and plastic drip lines to deliver water to each drip point in the field. Hundreds of emitters at each drip point control drip rate and prevent clogging. Plastic drip lines and emitters are key contributors to cost.

To make drip irrigation affordable for small farmers, my colleagues and I designed a variety of low cost drip systems that cut the cost of conventional drip systems by two thirds[8] The investment in plastic pipes was reduced by making it possible for each plastic pipe (lateral) to serve 4-10 rows of plants instead of one. The cost was further reduced by replacing emitters with microtubes or baffled holes, which also are easier to unplug. This in turn made it possible to use simpler lower cost filters, and to lower system pressure. Four low cost drip systems are now available.

1. **Bucket Kits**
   This consists of a simple household bucket attached to a pole at shoulder height, which supplies a drip line with 26 microtubes, each of which waters four plants. A starter bucket kit costs $5 in India, including the bucket, and irrigates a 25 sq. meter kitchen garden to feed a family of 6, using 2-4 buckets of water a day. If the family sells some of the crop, they can use the profit to expand their system

2. **The Drum Kit** uses a 200 liter drum instead of a bucket, and uses five lateral lines to irrigate a 125 sq meter plot for a cost of $26. It can be expanded to irrigate 250 sq meters for an additional $16.

3. **Shiftable Drip Systems.** The shiftable drip system substitutes low cost labor for capital by making lateral lines shiftable, so that each line is capable of

[8]Polak, Paul, Nanes, Bob, and Adhikari, Deepak. A Low Cost Drip System for Small Farmers in Developing Countries. Journal of the American Water Resources Association, Vol 33, #1, Feb/97.

irrigating ten rows of plants instead of one[9]. Water drips out of baffled holes or curled microtubes instead of more expensive emitters.

4. **Larger Low Cost Drip Systems** Larger systems from ¼ hectare to 4 hectares cost of $625 a hectare for crops like cotton, using microtubes to reduce the requirement for plastic delivery lines from one for every row to one for every four rows. This does not include the cost of a pressure pump.[10]

Side by side comparisons of low cost drip and furrow irrigation with cotton, sugarcane, and mulberry in India found that low cost drip irrigation cut water use in half and increased crop yield, paralleling numerous earlier studies comparing conventional drip and flood irrigation in India. Several thousand low cost drip systems have now been purchased by micro-farmers in Nepal and India, and their introduction has been initiated in Sri Lanka and Vietnam.

5. **Low Cost Sprinkler Systems for Microfarmers**

The primary constraint to productivity for many microfarmers in semi-arid and hill area is a severe shortage of irrigation water. For row crops, low cost drip irrigation provides an effective solution. But many non-row crops, like wheat and oilseeds, are not amenable to drip. Sprinkler irrigation, though not as efficient in water use as drip, is significantly more efficient than conventional flood irrigation. But conventional sprinkler systems are too expensive for microfarmers, and do not fit small plots. My colleagues and I at IDE have now made Low cost sprinkler systems for microfarmers in India and Nepal. This process has been much simpler than the process for designing low cost drip systems, because all the key components for low cost sprinkler systems are already available in the Indian marketplace.

The first type of low cost sprinkler system consists of microsprinklers being produced by the manufacturers of conventional drip irrigation equipment. These systems are particularly useful for small plots of vegetables or other horticultural plots. The second system consists of a low cost overhead sprinkler attached to a flexible pipe and placed on a low cost tripod. By shifting this sprinkler six times, a small farmer can irrigate a half an acre of wheat at a total equipment cost of $26 (US), exclusive of the pressure source. This low pressure system runs on 10 meters of head, which can be produced by gravity or a ½ hp electric pump.

Grass Roots Rural Mass Marketing

The design on new affordable micro-irrigation technology completes only the first ten percent of the process of stimulating increased micro-farm productivity through improved irrigation. The other 90 percent of the process is putting the technology into the hands of millions of small farmers. This requires a long term

[9] Polak, Paul, Nanes, Bob, and Adhikari, Deepak. A Low Cost Drip System for Small Farmers in Developing Countries. Journal of the American Water Resources Association, Vol 33, #1, Feb/97.
[10] Progress Report on IDE Low Cost Drip Irrigation System. International Development Enterprises, Lakewood Colo., 1995.

process of rural mass marketing, and the establishment of a sustainable private sector supply chain.
The installation of 1.3 million Treadle Pumps in Bangladesh depended on a 10 year grass roots promotional campaign. Open air village entertainments that popularized the technology were instituted for villages without electricity. An award winning ninety minute entertainment movie in the Bangladeshi tradition was produced by a popular local director using leading local actors and actresses. In the story line, a Treadle Pump provided the dowry that made the marriage possible. The movie was shown in open air settings using a generator powered projector and a large screen, and has been seen by a rural audience of a million people a year. Village dealers were organized to play a key role in publicizing each showing and used the interest stimulated by the film to generate sales. Three hundred demonstration sites were established by recruiting exemplary farmers growing high return cash crops irrigated by Treadle Pumps. Local dealers were encouraged to take advantage of farmer interest in demonstration plots to generate sales.

This type of grass roots marketing campaign is customized to fit each area where micro-irrigation technology is introduced. Promotional campaigns based on the success of the Treadle Pump model are being introduced now to popularize low cost drip and sprinkler systems in India and Nepal.

A Sustainable Private Sector Supply Chain

To make each micro-irrigation technology sustainably accessible to small farmers, the establishment of a private sector network of manufacturers, deaters, and technicians is critical. A pump-priming investment in marketing can be an important motivator for manufacturers to make an investment in producing the technology. At least four manufacturers are required to establish a competitive marketplace, and assurance of quality standards is a critical component for establishing long term market demand for the product.

A key to the recruitment of manufacturers, dealers, and technicians is the demonstration of sufficient volume demand for the product in the marketplace to ensure profitability. To increase market demand for Treadle pumps in Bangladesh, Bangladeshi project staff were recruited and trained to assist local dealers and well drillers to sell and install clusters of 20-30 pumps in key villages. This is the critical mass required for word of mouth to produce exponential sales. A variety of proactive strategies was used to recruit local and international development organizations to promote the technology and offer credit for its purchase to small farmers. A three day training course with a certificate increased the drilling and well completion skills of three thousand well drillers, and motivated them to promote the technology. A similar process was used for village based dealers. After product demand reaches a sufficient level, new manufacturers, dealers, and technicians enter the market on their own.

Summary and Conclusions