Micro-Scale Water Harvesting

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Introduction

The following is a report on a technology that we (COSECHA) consider very promising, but that is still in its early phases. We feel it is now ready only for introduction among farmer leaders who can stand a certain amount of risk, and who will experiment with it to find better, more efficient ways of using it. In the not too distant future, we would hope (and feel confident) that this technology will become less expensive, more efficient and more varied, and will thus be capable of benefiting hundreds of thousands of the poorer farmers on the hillsides of the semi-arid and subhumid areas of the developing world.

The Definition Of The Problem

More and more, the small-scale farmers of the semi-arid and subhumid areas of the world are losing their harvests because of the irregularity of rains. During some part of what has traditionally been the rainy season, the rains cease, and as a result, the crops that depend on that rain are either totally lost or produce but a small fraction of what they would have produced had the rainfall pattern been normal. At other times, the lack of rainfall comes at the very beginning or end of the traditional rainy season, drastically cutting productivity because the growing season is shortened, thereby not allowing for proper growth of traditional crops, or perhaps any locally used crops at all.

We cannot be sure exactly why this phenomenon is becoming so common in so many parts of the world, but it is likely related to heavy deforestation (forests tend to buffer both humidity and temperatures, both of which, in turn, when buffered, would tend to make rainfall less irregular). Another possible cause of the increasing irregularity of rains is the greenhouse effect, one of whose predicted long-term effects is precisely an increased irregularity in many different climatic variables, of which rainfall is just one. If these are the major factors causing the increased irregularity of rains, we should expect that the problem will continue to worsen for many decades to come, because neither large-scale net deforestation nor global warming are anywhere near coming under control or being slowed down.

Thus, it is very likely that the crop losses, famines, decreased productivity and ecological damage that are directly and indirectly caused by irregular rains will worsen during at least the next three decades.

For all these reasons, three programs in Honduras have been looking for ways that poor hillside farmers can capture rainwater in their own fields and hold it there for two or three months. This water could then be used for supplemental irrigation during droughts or for extending the cropping season into the dry season.

We have limited our research to systems that cost less than US$500.00/hectare, and can be adopted and provide benefits in increments of $10.00 at a time. That is, a farmer can invest $10.00 and then increase his/her income enough to expand the system, thereby self-financing the gradual adoption of the technology on larger and larger parts of a farm. We have also limited ourselves to technologies that an individual farmer can adopt without requiring the permission or cooperation of any other farmers or the entire community. And we have furthermore limited our research to systems for use on hillsides, because hillsides provide tremendous economic advantages for such systems, making them less expensive than similar systems on flat land. In this way, we would also hope to contribute to the competitiveness of hillsides, where large portions of the rural poor in the developing world now live.

WHAT WE HAVE LEARNED TO DATE

We have been experimenting mostly with very small “micro-catchments” which can be distributed throughout much of a farmer’s field, in part to simplify the distribution of the water, in part to lower the “entry costs” of the technology to the previously mentioned $10.00, and in part to allow the collection of any water in the field that starts to flow downhill, causing erosion. The size and shape of such micro-catchments can vary depending on the nature of the soil profile, the presence of toddlers (for whom there might be a risk of drowning), the slope of the field and other factors. The most common size would be approximately 2 m in length along the contour, 60 cm deep and 80 cm wide, allowing for approximately 1 cubic meter of capacity. This quantity of water is sufficient to irrigate about 200 square meters of land once or twice, depending on the intensity of application.

We normally construct the catchments every 20 m along the hedgerow or contour live barrier, assuming the barriers are about 10 m apart (allowing 200 sq. m of land for each catchment). In this manner, a few stalks of grass or other material in the barrier can be used to provide shade for preventing evaporation of the water, and a ditch or terrace along the lower edge of the bund can serve both to catch water eroding from above and to carry the overflow from each micro-catchment that is already full on to the next one.

In many, if not most cases, farmers will have major sources of water other than just the surface of their fields. These sources will include roofs, patios, roads, paths, or natural drainage courses where rivulets of water run during a rain. These sources will probably provide most of the water for the micro-catchments, although some water would also drain from the farmers' own fields. A small ditch from any such source(s) of water would run to the first of the catchments, and then continue along the contour (or preferably at a half percent slope) to the others. At the end of the field or line of micro-catchments, a small vertical ditch would run down to the second line of micro-catchments.

Of course, another common source of water will be "gray water" from potable water sources that farmers are prohibited from using for irrigation. Small, ground-level home-made filters of rock, sand, and charcoal can filter out most of the soap, so that this gray water could also run by ditch into the micro-catchment system.

In the vast majority of cases, these micro-catchments must be made watertight. We are presently using either cement linings, a thin lining of cement over a layer of lime, or plastic. These solutions, however, represent much of the expense of the micro-catchments, and we hope, in time, to find ways of using dispersed clay, clay plus animal manure, clay plus different kinds of resins or tree sap, etc. Thus, in time, we hope to reduce costs, but for now, in order to get the technology into farmers' hands so they can participate in the search for better solutions, we are using these simpler but more expensive means.

The distribution of the water would most easily be done with just one section of hose, about 20 m long, employed as a siphon, which would serve for any number of microcatchments the farmer has. Since the water could thus only be used for crops planted below the level of the water in the micro-catchment, each micro-catchment would be used to irrigate a patch of land that would start some 5-15 m away from the micro-catchment, rather than an area of land contiguous to it. Experiments with micro-catchments have demonstrated that the value of just one harvest of vegetables saved by one micro-catchment will often more than pay for the total cost (including labor) of its construction, especially in areas where there are no nearby irrigated fields whose produce will compete with that of the fields watered by the microcatchments.

Many farmers would initially prefer to have just one large tank made with cement walls near the water source, and with a several-hundred-meter hose to distribute the water. This may well be the best solution for farmers who possess the necessary economic means or access to large loans, and have only one major water source, with very little flow of water down their fields. But for poorer farmers, who have multiple sources (a situation that occurs more than we originally thought), or a fair amount of infield run-off, a series of micro-catchments will be much better. In any case, micro-catchments that poorer farmers begin with should always be placed so that eventually, if and when their incomes increase, they can later incorporate larger tanks at strategic places in the system.

Of course, micro-catchments will not compete with gravity fed irrigation systems where these are available.

What We Have Yet To Learn

1. What are the cheapest, simplest, and most widely applicable ways of lining the catchments in order to make them impermeable?
2. How can we best naturally control mosquitoes, so the catchments do not become a source of disease? Using preparations of tobacco leaves, gliricidia leaves, neem leaves, or even a little oil on the water surface, are possibilities, but we need to test these possibilities on a fairly large scale and over time. Some of these possibilities would also serve to fertilize the crops being irrigated.
3. What sizes and shapes of catchments and combinations thereof will be most useful in each situation?
4. What alternative uses will compete with irrigation for this water? We assume that families without available drinking water will be sorely tempted to use it for that purpose, and animals will likely be watered from the micro-catchments, as well. Farmers also use the water to fill their backpack sprayers. How will these uses change depending on the distance of the fields from the house, the inclusion of filtered gray water, the presence and adequacy of potable water systems, and/or the size or number of catchments? In light of the fact that these alternative uses are (and well should be) higher priorities than those of irrigation, how much water will be left for irrigation? Another issue in the case of fields distant from the household would be that of the theft of water, especially for these alternative uses, although treatment of the water for mosquitoes will probably also reduce this problem.

Uses and Advantages

Of course, once a farmer has water in his or her microcatchments, he/she will have a series of options as to its use for irrigation purposes. One use is to irrigate crops during a drought. A second use would be to use it to extend the growing season a couple of weeks or a month beyond the end of the rains. Another possibility would be to plant perhaps one quarter of the field, perhaps in patches below the catchments, in crops that would require as much as a month or two more rain, allowing for three or four irrigations. In still other cases, a farmer with water in the catchments could decide to plant very small patches of crops at the beginning of the dry season, calculating the quantity of crops planted such that they could be irrigated all the times needed with the water available. And, of course, farmers could plant perhaps half their crops after the very first rains (if the catchments filled up during the rain), figuring that even if the rainy season has not started yet, they can water the crops two or three times during the month or so before it does start, thereby getting a head start on other farmers, and getting their produce to market before anyone else.

The introduction of this technology could also have a major impact on the adoption of soil conservation technologies in many areas of the world. If farmers have a 30 to 60% chance of losing their crops to drought in any given year, most soil conservation techniques will not be economically feasible. Very few such techniques are economically viable if the benefits are reduced by 30 to 60%. With microcatchments, a farmer could easily reduce that percentage to 5 or 10%, making soil conservation and recuperation (green manure/cover crops) considerably more attractive.

Water harvesting will also have many positive environmental and economic impacts, including less cutting of forests as existing farm land becomes more productive, less erosion, less destruction of roads, less need for bridges over temporary streams, fewer floods downstream, and increased food security and incomes for the poorest farmers.

But the technology won't be adopted because of these factors. It will be adopted because farmers want the benefits that will accrue to them personally. And although we have only begun working with farmers on this technology, we have found it far more popular than any soil conservation or soil recuperation or even productivity-enhancing technology we have worked with to date. There have actually been cases where farmers who were not chosen berated our extensionists for not having taught them to make microcatchments also. In thirty years of work, this had never previously happened to our extensionists here in Central America. Ironically, thousands of development organizations, virtually all of whom say they work on the basis of the people's felt needs, have worked for decades with soil conservation, soil recuperation, the use of fertilizers and insecticides, IPM, etc., when the people were complaining most vociferously about the droughts that were killing their crops. Now that we have, at last, quit turning a deaf ear to their pleas, the farmers are demonstrating to us once again that we will be a good deal more successful if we do respond to their strongly felt, and frequently expressed, needs.

