Decentralized Rainwater Harvesting in Madhya Pradesh

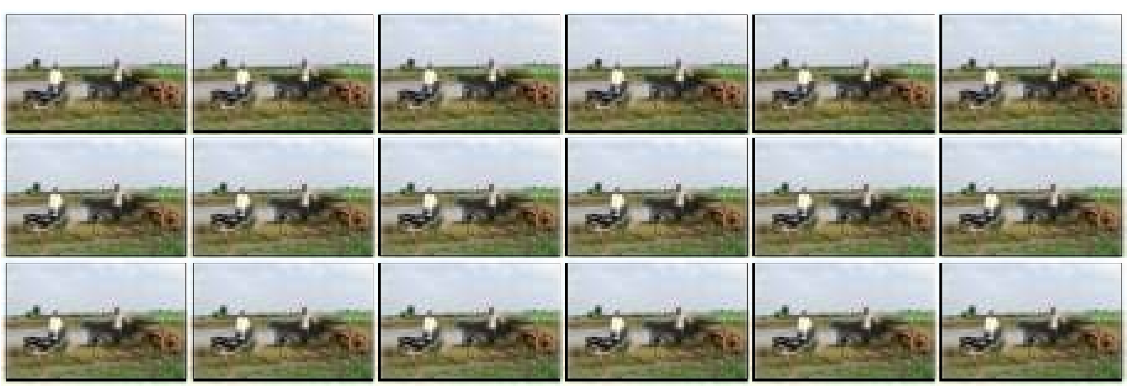
A profitable investment option to improve agricultural production and incomes

June 2012

Imagine this…

To overcome an acute water shortage in the dry season, Brijendra Singh and his son Pratep took a loan from the local bank to build a rainwater harvesting tank on their farm. With water stored in the structure during the following monsoon season, Brijendra and his family have been able to cultivate their otherwise fallow land in the dry season substantially increasing their wheat and gram production and improving the quality of their dairy cattle. The benefits from this investment have far exceeded costs, with a benefit-cost ratio close to 1:70. Brijendra has used part of the additional returns to buy a motorcycle and farm equipment and to improve the well-being of his family. The extra income earned is large enough for him to completely pay back his bank loan within a period of three years. Seeing the profitability of investment, Pratep now plans to continue working on the farm with his father rather than go to Delhi in search of work.

Now imagine this…



Hundreds of new water harvesting structures, like that of Brijendra's, producing thousands of quintals of dry season crops – wheat and gram – generating additional income for numerous farming households after only one year. Within three years, the initial investment cost is fully recovered, farmers own the assets, and, together with the broader community, continue to reap the ensuing economic and social benefits year after year.

Why this business plan?

There have been substantial economic and livelihood benefits from a recent movement in India's Madhya Pradesh province to promote privately funded rainwater harvesting structures on farmers' land. In contrast to the many poorly functioning, community managed rainwater harvesting programs, decentralized rainwater harvesting structures have led to significant improvements in availability of irrigation water, a revival of the agricultural economy of the region, substantial increases in farmer incomes and livelihoods, groundwater recharge and improvements to the local ecology. The model, which has been adopted by more than 5,000 farmers to date in Madhya Pradesh, involves the construction of rainwater harvesting structures on up to 10 percent of an individual farmer's land. The investments are cost effective and farmers are able to recover their initial investment in approximately three years. The key constraint to further scaling up this solution is the lack of a suitable financing mechanism for farmers to pay for the upfront costs to build rainwater harvesting structures.

Proposed solution

To address farmers' lack of access to investible financial resources, this business plan describes a proposed lending scheme. Three alternative lending models are presented with different underlying assumptions in terms of the size and contribution of different lenders to this portfolio. Variations in the different financial models include government subsidies or lending through local financial institutions at the agricultural concessionary rate.

To demonstrate the efficacy of the proposed lending scheme, we suggest an initial pilot project, focusing on 10 percent of the estimated 58,000 smallholder farmers[1] in Dewas District who are currently not irrigating their land (or 5,800 structures).

This business plan

This business plan examines the financial feasibility for scaling up the construction of small private rainwater harvesting structures. The case is based on research carried out under the AgWater Solutions project[2] in Madhya Pradesh. This business plan is written for the government of Madhya Pradesh to pursue with the public sector financial institutions, the private sector and/or national and international donors in support of this initiative.

The business plan shows:

- the applicability of this solution to other districts of Madhya Pradesh (see Scaling Up section) and outside of Madhya Pradesh in other regions with similar agro-livelihood contexts;
- that with an investment of INR 736 million (USD 15 million[3]), an additional 5,800 structures could be constructed in the state in a first pilot phase; and
- the estimated direct benefits in terms of increase in irrigated area, agricultural production and farmer income, and possible indirect benefits (groundwater recharge, improved ecology, and reduced electricity use).

[1] Defined as landholding size of 1-3 hectares.

[2] For more information about the AgWater Solutions Project, please visit: http://awm-solutions.iwmi.org/

[3] An exchange rate of USD 1 = INR 52 has been applied throughout the document.

Benefits

Based on the AgWater Solutions research findings, a host of benefits accrue to the farmer and larger community from investing in decentralized rainwater harvesting structures, including:

For smallholder farmers:

- Reduced cost of irrigation
- Increase in irrigated area
- Increase in agricultural production
- Increased farm income
- Options to extend into livestock and fisheries

For local environment and ecology

- Groundwater recharge
- Return of wildlife
- Reduction in diesel and electricity consumption

For society/economy

- Increase in agricultural production
- Greater food security

Contents

A proven solution

Agriculture in Madhya Pradesh

Agriculture accounts for about 21 percent of state gross domestic product in Madhya Pradesh. Wheat, soybean, paddy, oilseeds, maize and pulses are the most important crops. Farmers in Madhya Pradesh produce 10 percent of India's wheat, 23 percent of its pulses, 25 percent of its oilseeds, and 55 percent of soybeans.

There are 7.36 million operational holdings covering 16.37 million hectares of land. Of the 15 million hectares of net sown area, about 38 percent is irrigated. Surface water sources account for less than 20 percent of the net irrigated area. The remaining area is irrigated with groundwater.

A severe shortage of water for irrigation

Farmers in Madhya Pradesh have traditionally relied on groundwater for their irrigation water requirements. In the absence of any significant efforts to recharge groundwater aquifers, groundwater tables have steadily fallen. The water table in some parts of Dewas District, one of 12 districts in the Malwa region of Madhya Pradesh (see Figure 1) and the location for this AgWater Solutions case study, has declined to 200-300 feet below ground level. As a result, the failure rate of existing tubewells has risen significantly and new investments in tubewells either do not yield any water, or yield water for a short time and then stop working. Quite often the water is of poor quality and unfit for irrigation. Coupled with problems relating to water quantity and quality, even those farmers with working tubewells face severe constraints in pumping and using water due to frequent electric power cuts. Agricultural productivity has suffered, along with incomes and livelihoods.

Figure 1. District Map of Madhya Pradesh

Box 1.
A typical rainwater harvesting structure

- Retains water for 6-7 months of the year.
- Enables farmers to access water during the dry season.
- Reduces potential conflicts that arise from sharing and maintaining communal water sources.

Evolution

The 'decentralized' approach to constructing rainwater harvesting structures evolved in response to the problems associated with building, maintaining and managing community water harvesting structures and the frequent conflicts over distribution of available water in those structures. 'Decentralized' means the structures are built on a farmer's own land. This gives farmers complete control over the water and leads to more efficient use.

In the beginning, the district administration approached only those farmers with more than four hectares of agricultural land and persuaded them to allocate $1/10^{th}$ to $1/15^{th}$ of their land for construction of a pond or 'tank' which could store rainwater runoff during the monsoons and thereby assure a supply of water for irrigation during the dry season. Farmers could also use part of the stored water for crop-saving irrigation during the occasional long gaps in between wet season rainfalls.

Public agencies provided the technical and logistical support, and individual farmers contributed their land, labor and financial resources for construction. The district administration intervened to negotiate construction charges to ensure farmers were fairly treated. The District Collector personally attended all the groundbreaking ceremonies and contributed token labor at the start of each construction project. He personally attended to all the problems and complaints of the investing farmers and took immediate decisions to resolve them.

As part of the scaling up effort, district officials convinced the District Cooperative Bank to provide loans to at least a few farmers for tank construction. The District Collector gave a personal guarantee for some of the initial loans advanced by the Bank to farmers. Farmers with small and medium size landholdings soon came forward to construct tanks in their fields. As of January 2012, more than 5,000 tanks of varying sizes had been constructed by the farmers of Dewas District alone.

The subsidy

Early in the evolution of the program in Dewas District, the local administration initiated a subsidy of INR 50,000, which was later raised to INR 80,000 per structure. The subsidy had the paradoxical effect of both accelerating and slowing down the program. The total amount of subsidy allocated by the government to a district in a year is fixed, hence, the administration can award a subsidy to a limited number of farmers. Farmers who do not get a subsidy one year wait to see if they can get it the next and postpone their investment. More than two-thirds of farmers in our research study who have not invested are aware of the subsidy. Of those two-thirds, 60 percent said they would consider investing if they received a subsidy, but the subsidy was not a necessary precondition for their decision to invest.

Tangible benefits

Based on the results from the AgWater Solutions research study in Dewas District (Box 2), farmers have realized immediate and tangible benefits from constructing rainwater harvesting ponds.

Box 2.
AgWater Solutions Case Study on Decentralized Rainwater Harvesting

- Researchers conducted an assessment of the rainwater harvesting structures based on a random sample of 120 farmers (90 adopters, 30 non adopters in Tonk Khurd and Khategaon blocks of Dewas District).
- Blocks selected with different geologies.
- Researchers examined impacts of adoption, reasons for non-adoption, opportunities and prerequisites for scaling up.

Read the Rainwater Harvesting in India brief.

Decline in fallow land and increase in cropping intensity

Before the construction of water harvesting structures, farmers could cultivate almost their entire operated area during the monsoon season, but more than 75 percent of the cultivable area during the dry season was left fallow. After the construction of water harvesting structures, dry season cultivatable area left fallow is between 4 and 7 percent and annual cropping intensity on adopting farmers' fields has increased from about 122 percent before construction to about 196 percent afterwards.

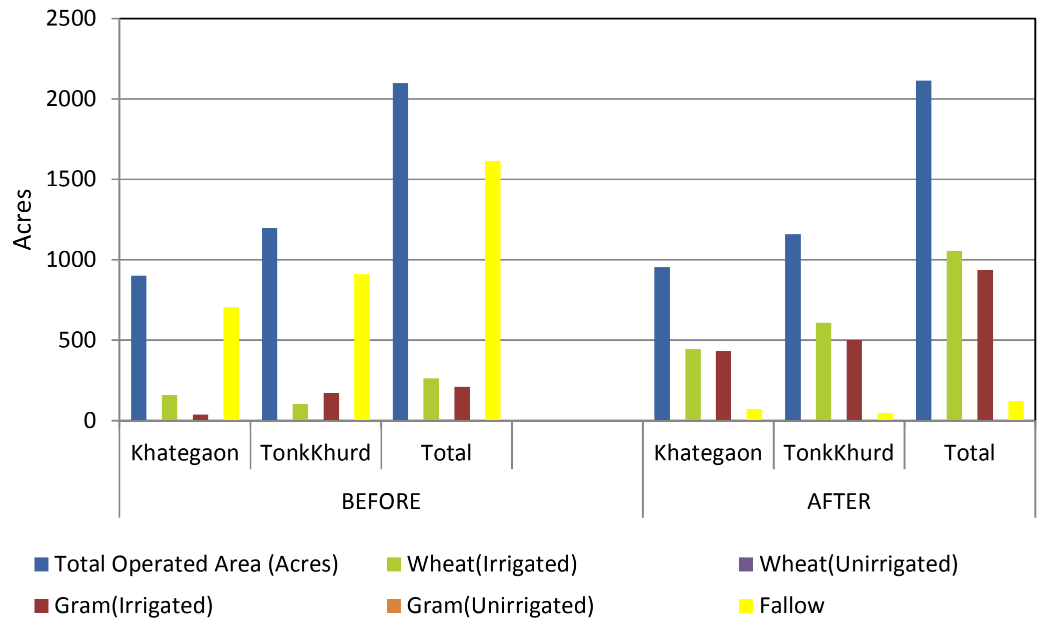
Changes in cultivation practices

With irrigation and intensification of farming activity, the pressure on timely completion of crop operations has become more important. A severe shortage of agricultural labor and a high wage rate has encouraged farmers to trade in their oxen for tractors and hire combines for harvesting and threshing operations. The ponds have helped farmers cut costs by reducing the electricity and/or fuel requirements previously needed to operate deep tubewells.

Higher crop yields

Irrigation and improved farming practices along with more intensive use of inputs and better crop varieties have led to increases in crop yields. Yields from irrigated crops were higher after the construction of rainwater harvesting ponds. In the case of a major part of the irrigated area in the dry season, the yield was actually a net addition to crop yield as most of the now cultivated area during the dry season was previously left fallow (Figure 2).

Changes in cropping patterns on sampled farms during the dry season



Changes in crop production on sampled farms in the dry season

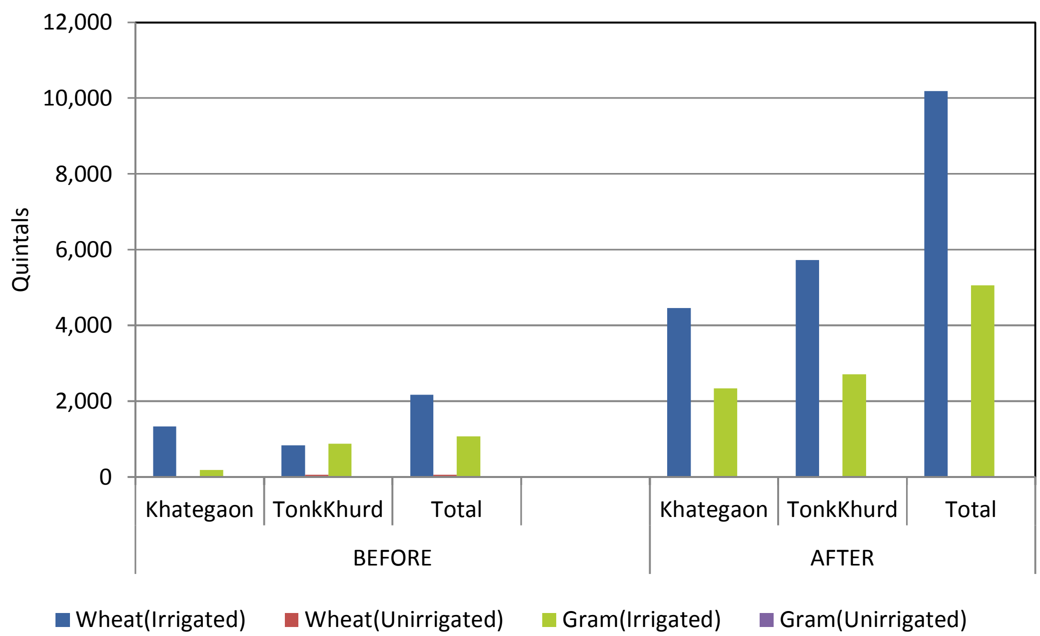


Figure 2. Significant changes in dry season agriculture before and after construction of rainwater harvesting structures

Positive impact on livestock raising

Farmers are now improving and expanding their livestock activity. Without a rainwater harvesting tank, there was no water for dry season irrigation, hence a lack of fodder, therefore little investment in livestock. With water for irrigation, farmers can grow wheat in the dry season, thereby increasing the supply of wheat straw for fodder. Drinking water for cattle is also now much less of a problem than before. Because livestock raising is capital intensive, farmers are investing in improving the quality of their herds by gradually replacing their low milk-yielding stock with improved breeds. The net result has been an increase in milk production by 34 percent in Khategaon and by 11 percent in Tonk Khurd.

Increased income

Farm household incomes have increased significantly as a result of increases in cropping intensity and improved livestock activity. Most farmers have been spending a relatively larger proportion of their increased income on consumption and creating and improving assets. Almost 80 percent of the adopting farming households reported spending at least a part of their increased income on education; more than 70 percent on a tractor or a motorcycle for increased mobility. Other important items are family food consumption and home repairs and construction.

Positive ecological and environmental impacts

Almost 85 percent of the farmers we interviewed for the present study reported that wildlife such as deer, wolves and other large animals has substantially increased as a result of constructing a large number of water harvesting structures. Other ecological changes observed include a perceptible increase in the visibility of birds including the return of migratory birds, and a significant increase in the number of peacocks, ducks and fowl.

Groundwater recharge

Standing water in rainwater ponds has some potential for improving the availability of groundwater through recharge from seepage. The extent of such improvement depends on several factors including soil characteristics, baseline conditions, and time. About 40 percent of the farmers in our case study research reported that they believed that seepage losses from rainwater harvesting ponds had led to some rise in groundwater tables as reflected in the improved availability of drinking water from open wells in the region.

Financial Viability of Investment

The project's benefit-cost analysis of the investments in the structures found them to be highly profitable, with a short payback period. Table 1 below illustrates the financial viability of the investment (both with and without a government subsidy), taking into account only quantifiable direct benefits and costs.

Table 1. Estimated return on investment based on sample survey results

Scenario	Parameter	Study Area 1 (Khategaon)	Study Area 2 (Tonk Khurd)
Assumed Life of Structure (Years)		15	15
Without government subsidy	B-C Ratio	1.92	1.48
	Pay Back Period	2.5	3.1
With government subsidy of INR 80,000	B-C Ratio	2.39	1.72
	Pay Back period	1.9	2.6

Scaling up

The Agwater Solutions project carried out a mapping exercise to identify where in Madhya Pradesh rainwater harvesting is a viable solution. The three-step process built on the results of the Dewas district case study and extrapolated the findings through expert consultations and local level data collection. The output was a series of maps to answer the following questions: 1) what are the primary livelihood activities in the state; 2) where can investment in agricultural water management (AWM) in general have a positive impact on rural livelihoods; and 3) where is rainwater harvesting a suitable investment opportunity given both the livelihood and biophysical settings.

The livelihoods map (Figure 3) locates the different livelihood contexts, focusing on smallholders' livelihood strategies, their water-related problems and other constraints for development, and the role agricultural water management plays in their livelihoods.

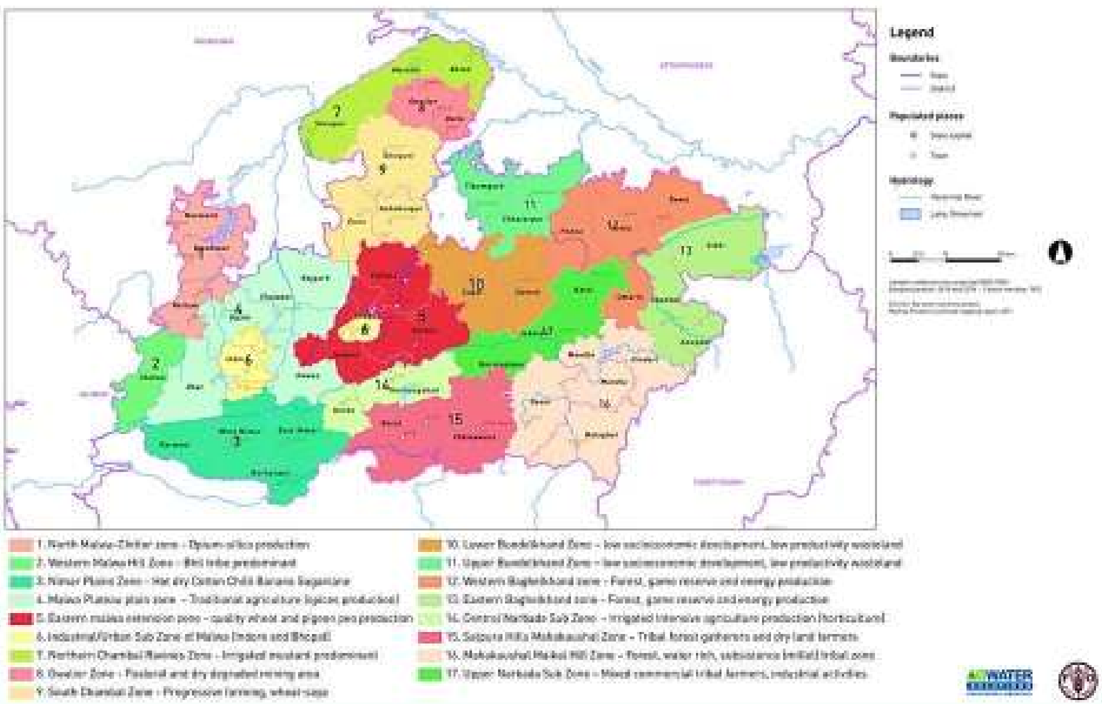


Figure 3. Livelihood zones in Madhya Pradesh[4]

The map in Figure 4 shows where AWM in general can be the entry point for improving livelihoods and where to prioritize investments in AWM to have the maximum impact on rural livelihoods. High potential areas are identified on the basis of three guiding principles: i) where water is available ii) where the target beneficiaries are mostly located; and iii) where water is key for livelihoods. In the case of decentralized rainwater harvesting specifically, high potential areas are in zones with relatively higher vulnerability to droughts and where groundwater sources are partially or totally depleted.

[4] For more details about the map and livelihood zones, please see Santini, G. And Peiser, L. 2012. Investment Brief. Mapping and Assessing the Potential for Investments in Agricultural Water Management: Madhya Pradesh State. Rome, Italy: FAO Water for AgWater Solutions Project.

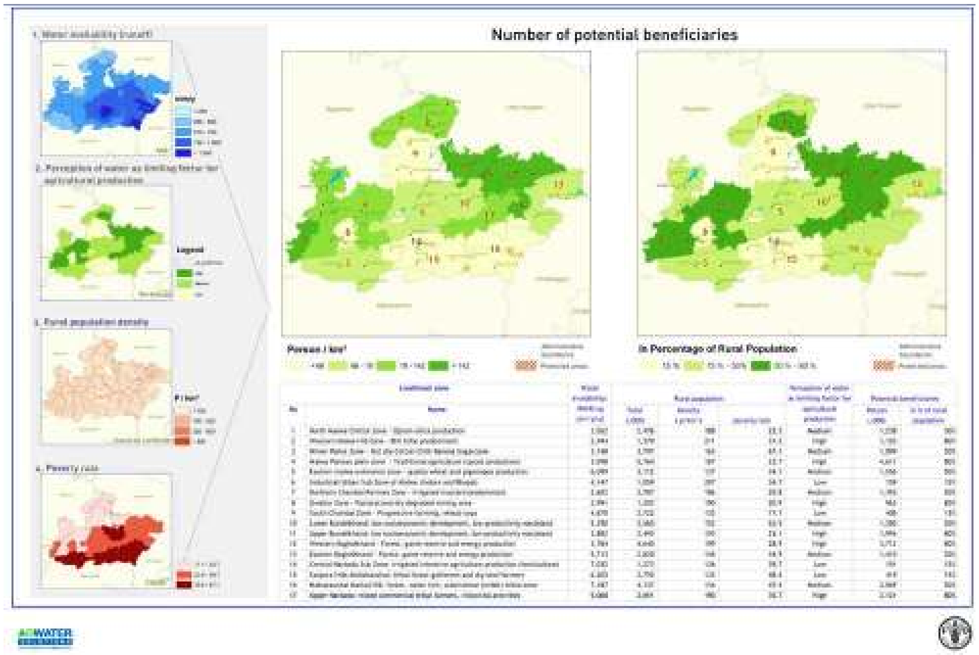


Figure 4. Priority investment areas[5]

Figure 5 illustrates the potential locations for scaling up rainwater harvesting as a specific AWM solution. The criteria used to develop the map reflect bio-physical potential as well as the impact of the solution on rural livelihood across the state. The map shows high and low levels of suitability.

Figure 5. Areas most suitable for rainwater harvesting[6]

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[5] Ibid
[6] Ibid

The business model

In this section we illustrate a business model directed specifically at building water harvesting structures on small farms in Dewas district of Madhya Pradesh, where AgWater Solutions research was carried out. The business model targets 10 percent of the approximately 58,000 smallholder land holdings which are either wholly un-irrigated or partly irrigated (see Table 2). The figure of 10 percent is considered small enough to make the pilot manageable but large enough to demonstrate the principle.

Table 2: Estimated potential in Dewas District of Madhya Pradesh

Farmers with landholdings 1-3 hectares	62,964 (1,731 female headed households)
Average landholding size	1.74 hectares (1.64 for female headed households)
Total area operated	109, 316 hectares (2,829 by female headed households)
Number of wholly irrigated or partly irrigated landholdings	58,061
Area of holdings that are wholly un-irrigated or partly irrigated farms BUT receiving no irrigation	80, 375

Source: India Agricultural Census, 2001

The business model is presented in three parts. First we illustrate the impact of targeting 10 percent of smallholder landholdings in Dewas District. We then describe the investment related requirements, offering three models to establish a line of credit, and the mechanics and management of the invested funds. We conclude by considering the non-financial implications of investing in decentralized rainwater harvesting structures in Madhya Pradesh and elsewhere, taking into account potential indirect impacts, both positive and negative.

Financial impact

With an average farm size of two hectares, the size of a typical water harvesting structure is 1,780 square meters and a depth of about 2.20 meters. The average cost of building one structure of this size is INR 135,580 (USD 2,600). The total cost of 5,800 water structures would be INR 786 million (USD 15 million) (Table 3).

Table 3. Economic impact of targeting 10 percent of identified potential holdings for investments

		Value per farm	Total for 5,800 farms
Size of operated[7] land		2 hectares	NA
Size of harvesting structure (8.8%)[8]		1,780 m^2	NA
Depth of structure		2 meters	NA
Amount of water harvested		3,920 m^3	22.7 million m^3
Cost of one structure (without subsidy)		135,580 INR	786 million INR
Increase in annual production per farm	Per farm (Quintals)	Value per farm (INR)	Total for 5,800 farms
Soybean	-2.38[9]	-4,360	-14 tons
Wheat	21	30,616	122 tons
Gram	7.92	22,259	46 tons
Increase in gross value of crop production (main + by-product[10])		51,426	298 million INR
	Value (INR)		Total for 5,800 farms (million INR)
Increase in net value of crop output per farm (main + by-product)	30,646		178
Increase in gross value of milk production per year per household	11,422		66
Increase in net value of milk per year per household	5,711		33
Increase in gross value of crop and milk output per household	62,848		365
Increase in net value of crop and milk output per household	36,357		211
Loss in annual value of crop production per household (for the land converted to the water harvesting structure)	-3,213		-19
Net Increase in income per household	33,144		637

Benefits to the smallholder household

After accounting for the loss in agricultural production from taking 1,780 square meters of land out of cultivation for a water harvesting structure, the net increase in income per household is estimated at INR 33,144 (USD 637). Taking an average family size of five, this translates into an increase in annual per capita income of INR 6,629 (USD 127).

Benefit to the agricultural sector

Initial investments in a line of credit could lead to an annual increase in wheat and gram production of 122 and 46 tones, respectively (Table 3). In monetary terms, the increase in annual gross value of crop and livestock output works out to INR 365 million (USD 7 million), while the net increase in output (net of paid out costs) works out to INR 211 million (USD 4 million). Note the significant changes in dry (*rabi*) season agriculture as land previously left fallow is now cultivated with wheat.

[7] Not all 'operated' land is cultivated year round; some operated land may be left fallow during part of the year.
[8] 8.8% is an average based on the figures from the farmer survey.
[9] Indicates lost production due to shift in cropping patterns.
[10] For example: wheat + straw used for livestock feed.

The investment requirement

We estimate the total financial requirement to build 5,800 structures is INR 786 million (Table 4). We propose three plausible models to finance these structures. In all three models we assume that farmers will pay from their own resources 20 percent of the estimated cost of the structure. The remaining financial requirements thus work out Rs 629 million. In Model 1 we assume that neither any government subsidy nor loans from financial institutions would be forthcoming and the donors would be willing to lend the money to bridge the financing gap. Model 2 assumes that the government subsidy will continue to be made available but loans from financial institutions will not be forthcoming. Model 3 assumes that both government subsidies and loans, each subject to a financial ceiling of INR 50,000 per structure, will be available. The financial requirement from donors in the three scenarios ranges from INR 629 million (Model 1) to INR 339 million (Model 2) to INR 49 million (Model 3). 'Donors' in the line item "financial requirements from donors" includes private foundations and/or national and international development assistance agencies

Table 4. Investment requirements for building 5,800 structures

Cost of one structure	INR 135,580		
Number of structures	5,800		
Total investment requirement	INR 786 million		
	Model 1 No subsidy (Million INR)	**Model 2** Subsidy of INR 50,000 per structure (Million INR)	**Model 3** Subsidy + loans from financial institutions (Million INR)
Total investment requirement (Million INR)	786	786	786
Farmer's contribution (20%) See Note 1	157	157	157
Government subsidy (INR 50,000 per structure)	0	290	290
Loans from financial institutions (50,000 per structure)	0	0	290
Financial requirements from donors (INR Millions)	629	339	49
Equivalent in USD (Millions)	12	6.5	0.9

Investment mechanics and management

We envisage that donor money can be managed by a reputed micro credit institution, NGO or a privately managed financial institution. The selected management institution would establish a new line of credit, e.g., a "rainwater harvesting loan", with the donor providing the initial capital. These loans would be provided at zero cost to farmers who are willing to invest in building rainwater harvesting structures. Depending upon whether the government subsidy and financial institution support to farmers is available or not, the duration of these loans can vary from one to three years (the maximum payback period required to recover the entire cost of construction). Farmers taking loans start repayment within one year of taking loans. The amount recovered from the farmers is given to the next group of loan applicants and continually rotated accordingly. A set timeframe can be placed on the rotating line of credit (e.g., 10 years), after which the capital is returned to the donor. The cost to the donor is the opportunity cost of the capital invested plus an annual administrative fee it pays to the management institution for managing the funds.

Non-financial considerations

Beyond the financial investment and impacts, a number of potential non-financial implications must be considered. The case study identified a number of indirect benefits from farmer investment in decentralized rainwater harvesting, but the agricultural intensification that would result from further scaling up could likewise have negative impacts. These indirect impacts, both positive and negative, must be carefully considered as part of any pre-investment due diligence.

Positive impacts

In the case study research, positive environmental impacts were noted by farmers in the district following the implementation of rainwater harvesting structures, related to the surrounding ecology as well as, and importantly for the region, groundwater recharge. In addition, enhanced agricultural production due to the construction of the ponds contributes to on-farm and off-farm employment opportunities and reduces out-migration by making it possible to earn income on the farm.

Negative impacts

Environmental impact and resource management

Rainwater harvesting structures adopted on a wide scale may have unforeseen or negative environmental and ecological consequences including loss of soil fertility and pollutants due to over- or inappropriate application of agro-chemicals. As much as possible, these potential impacts need to be anticipated. NGOs, civil society groups and government and publically funded research institutions could help fill this information gap.

Pollution

Increased agricultural production usually leads to increased use of agro chemicals. Over and improper uses are common and are reflected in human and animal health problems and declining water quality.

Greenhouse gas emissions

Increased water use in the dry season could result in an increase in the use of motorized pumps. Any increase in emissions from increased pumping in the dry season would have to be weighed against the increase in carbon dioxide absorption from increased cropping and other social and economic benefits.