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AN EVALUATION OF DRYLAND WATERSHED DEVELOPMENT PROJECTS IN INDIA

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ABSTRACT

India’s semi-arid tropical (SAT) region is characterized by seasonally concentrated rainfall, low agricultural productivity, degraded natural resources, and substantial human poverty. The green revolution that transformed agriculture elsewhere in India had little impact on rainfed agriculture in the SAT. In the 1980s and 1990s, agricultural scientists and planners aimed to promote rainfed agricultural development through watershed development. A watershed is an area from which all water drains to a common point, making it an attractive unit for technical efforts to manage water and soil resources for production and conservation.

Watershed projects are complicated, however, by the fact that watershed boundaries rarely correspond to human-defined boundaries. Also, watershed projects often distribute costs and benefits unevenly, with costs incurred disproportionately upstream, typically among poorer residents, and benefits realized disproportionately downstream, where irrigation is concentrated and the wealthiest farmers own most of the land.

Watershed projects take a wide variety of strategies, ranging from those that are more technocratic to those that pay more attention to the social organization of watersheds. By the mid-1990s annual expenditure on watershed development in India approached $500 million, but there was relatively little information available on the success of different project approaches.

This study addresses three main research questions: 1) What projects are most successful in promoting the objectives of raising agricultural productivity, improving natural resource management and reducing poverty? 2) What approaches enable them to succeed? 3) What nonproject factors also contribute to achieving these objectives? The major hypotheses are that participatory approaches that devote more attention to social organization yield superior project impact, and that favorable economic conditions and

good infrastructure also support better natural resource management and higher productivity.

A detailed survey of Maharashtra and Andhra Pradesh states covered 86 villages under several watershed projects as well as nonproject villages with no project. The projects covered operated under the Ministry of Agriculture, the Ministry of Rural Development, various nongovernment organizations (NGOs), and in collaboration between NGOs and the Government of Maharashtra. The government projects were more technocratic in focus, whereas the NGO projects focused more on social organization, and the government-nongovernment collaborative projects tried to draw on the strengths of both approaches.

The analysis of the Maharashtra and Andhra Pradesh villages compared pre- and post-project conditions in the study villages. Quantitative analysis at the village level addressed performance indicators such as changes in access to water for irrigation and drinking, change in employment opportunities, soil erosion and conservation on uncultivated lands and drainage lines, and change in availability of various products from the common (government revenue) lands. At the plot level, performance indicators included changes in cropping intensity, change in yields, soil erosion on cultivated lands, farmers' land improvement investments, and annual net returns to cultivation. This analysis was supplemented by qualitative information about the effects of the projects on different interest groups in the villages such as farmers with irrigation, farmers without irrigation, landless people, shepherds, and women.

Findings of the empirical study in Maharashtra and Andhra Pradesh lend support to the hypothesis that more participatory projects perform better than their more technocratic, top-down counterparts, and that a combination of participation and sound technical input may perform the best of all. Evidence about the role of economic conditions and infrastructure is more limited.

Despite rhetoric to the contrary, successful participatory projects remain few in number so their impact is limited. In the study area in rainfed areas of Maharashtra's Pune and Ahmednagar districts, for example, the innovative projects operated in only 40 out of over 1000 villages, even though they are particularly highly concentrated in this area compared to the rest of India. Also, the most successful projects enjoyed special treatment that will be difficult to replicate on a large scale. Spreading participatory watershed development throughout the country will not be easy.

One continuing challenge for almost all projects is in designing interventions and organizing communities so that benefits are distributed more evenly to landless people, shepherds and women. These are the least influential community members and their needs and interests require special attention. Otherwise watershed projects can actually make them worse off than before by restricting their access to resources that contribute to their livelihoods. Unstructured interviews with these groups suggested that all of the Maharashtra projects have room for improvement in serving their needs. Some NGOs in Andhra Pradesh have developed innovative ways to build everyone's interests into the projects in advance, and other projects would gain by learning from them.

CONTENTS

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1. INTRODUCTION

Rainfed agriculture in India's semi-arid tropics (SAT) is characterized by low productivity, degraded natural resources, and widespread poverty. Most of the hundreds of millions of people living in the Indian SAT depend on agriculture and natural resource management for their livelihoods, so development planners are eager to implement productive, environmentally sustainable land and water management systems.

Watershed development projects are designed to harmonize the use of water, soil, forest and pasture resources in a way that conserves these resources while raising agricultural productivity, both through in situ moisture conservation and increased irrigation through tank- and aquifer-based water harvesting. Watershed projects have become widespread in rainfed areas in recent years, with a current annual budget from all sources that exceeds US $500 million (Farrington et al. 1999). This study examines the experience of watershed projects in Andhra Pradesh and Maharashtra.[1]

The literature on watershed development in India is growing rapidly, but most of it is confined to qualitative descriptions of success stories. Some of these contain excellent insights into the social processes that contribute to successful watershed development, but there is little frank discussion of less successful projects. The few quantitative studies available tend to be based on a small number of heavily supervised projects, with no information about long-term impacts. Benefits after the first year or two

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[1] This study was originally conducted under the Indian Rainfed Agricultural Research and Development Project, jointly sponsored by the World Bank and the Indian Council of Agricultural Research. That project also included a companion study on watershed development that reviewed the literature on watershed projects and drew upon the findings of a rapid rural appraisal of new projects in Karnataka, Rajasthan, and Orissa (Kolavalli 1998).

were typically assumed and, not surprisingly, cost-benefit findings were almost always favorable. At the same time, the vast majority of projects were never subject to evaluation and there were good reasons to suspect that most of them had little impact (Kerr and Sanghi 1992).

With this background, the current research was commissioned to analyze the determinants of agricultural productivity, natural resource management and poverty alleviation under a wide range of watershed projects. The study is mainly quantitative but also incorporates qualitative data, explicitly examining the effects of non-project factors such as infrastructure, access to markets, social institutions in the villages, agroecological conditions, etc. This broad framework not only controls for the effects of these factors but also enables identification of other policy-relevant determinants of improved natural resource management and economic development. It also discusses the approaches taken by different projects in order to understand the essential elements of successful projects and make recommendations for the future. To summarize, the study addresses three related questions: 1) which projects perform the best, 2) what approaches enable them to succeed, and 3) what additional characteristics of particular villages contribute to achieving the objectives of improved natural resource management, higher agricultural productivity and reduced poverty.

OUTLINE OF THE PAPER

After introducing the problem and presenting a conceptual framework in Section 1, Section 2 describes the broad approaches to watershed development in Maharashtra and Andhra Pradesh and introduces the specific projects operating there. Section 3 describes the data on which this study is based, and Section 4 presents the analytical model. Characteristics of villages in which each project operates are analyzed in Section 5, while Sections 6-8 analyze project performance in terms of achieving various objectives related to agricultural productivity, natural resource management and poverty alleviation. These include the work conducted by watershed projects on protecting and developing nonarable land, recharging groundwater, improving the management of agricultural land, and raising agricultural production. These sections also analyze the role of nonproject factors, such as infrastructure development, on outcomes of interest, and they examine watershed project activities in relation to villagers' development priorities. Section 9 concludes with policy implications and recommendations.

Conceptual Framework

Two main hypotheses guided this research. One is that watershed projects cannot succeed without full participation of project beneficiaries and careful attention to social organization. This is because the costs and benefits of watershed interventions are location-specific and unevenly distributed among the people affected. The second hypothesis is that a variety of factors determine the incentives for people to manage and protect natural resources and invest in increased agricultural productivity. These factors may have as great an impact as a watershed project in determining the outcomes that projects seek to achieve. The issues underlying these two hypotheses are explained next.

Watershed Management as a Social Organization Problem

A watershed (or catchment) is a geographic area that drains to a common point, which makes it an attractive unit for technical efforts to conserve soil and maximize the utilization of surface and subsurface water for crop production. A watershed is also an area that contains administrative and property boundaries, lands that fall under different property regimes, and farmers whose actions may affect each others' interests. Human-defined boundaries, however, normally do not match biophysical ones. In watershed management projects, mechanical or vegetative structures are installed across gullies and rills and along contour lines, and areas are earmarked for particular land use based on their land capability classification. Cultivable areas are put under crops according to strict principles of contour-based cultivation. Erosion-prone, less favorable lands are put under perennial vegetation. This approach aims to optimize moisture retention and reduce soil erosion, thus maximizing productivity and minimizing land degradation. Improved moisture management increases the productivity of improved seeds and fertilizer, so conservation and productivity-enhancing measures are complementary.

Excess surface runoff water is harvested in irrigation or percolation tanks while subsurface drainage recharges groundwater aquifers, so conservation measures in the upper watershed have a positive impact on productivity in the lower watershed. Reducing erosion in the upper reaches also helps to reduce sedimentation of irrigation tanks (ponds) in the lower reaches. The watershed approach enables planners to internalize such externalities and other linkages among agricultural and related activities by accounting for all types of land uses in all locations and seasons. This systems-based approach is what distinguishes watershed management from earlier plot-based approaches to soil and water management.

Socioeconomic relationships among people in a watershed can complicate efforts to introduce seemingly straightforward technical improvements. This is because, as mentioned above, a watershed contains multiple decision-makers whom watershed development affects unequally. When a watershed project is introduced, often the bulk of the work is done in the upper reaches while the benefits accrue primarily in the lower reaches. For example, revegetating the upper reaches involves banning grazing and felling trees so that plants can establish. As a result, the people who utilize the upper watershed—typically relatively poor people with little or no land—bear the brunt of the costs of watershed development, which mainly benefits wealthier farmers in the lower watershed. Those who are made worse off by a watershed project can undermine its efforts if they refuse to go along with it. Herders, for example, might refuse to abide by grazing bans and trespass on the common lands if they are able to. In general, watershed technologies are likely to fail if they divide benefits unevenly but require near-universal cooperation to make them work. In this case, equity becomes a prerequisite to efficiency (Kerr and Sanghi 1992).

While early watershed projects failed to recognize the socioeconomic dimensions of watershed development, this has changed significantly in the last decade. In recent years there has been a growing appreciation of the need to organize communities to work collectively, make sure that beneficiaries have an interest in the work that is done, and ensure that everyone benefits from the project. In the 1990s, every project was designed to include the “participation” of local people; however, they all defined “participation” differently. For government programs, typically it meant making the effort to convince people of the soundness of an approach that was essentially pre-designed without any input from those who would be affected. Taking people's involvement a step further, in such projects local committees were established to mobilize laborers for moving earth and planting vegetation, and to facilitate communication within the village to improve the management of common lands. On the other extreme, many new projects operate under the assumption that local people know best how to care for their land and simply need outside assistance to help them organize and gain access to resources, including funds and social services.

Approaches to participation are discussed in detail in Section 2, and implications of alternate approaches for project outcomes are revealed by the analytical findings presented in Sections 6-8. Based on these findings and various observations from the field, recommendations for how projects should pursue participation in the future are presented in Section 9.

How Economic Forces Can Determine Project Outcomes

As mentioned above, performance in improving agricultural production, natural resource management, and human welfare depends on economic factors beyond the control of a watershed project. Throughout the world, both today and historically, it is easy to find areas with a broad range of performance in agricultural growth, natural resource management and poverty alleviation. For example, evidence abounds of areas in India with stagnant agricultural production, low real incomes, and environmental degradation. On the other hand, both the literature and folk wisdom are full of examples of places in India where villagers manage their natural resources particularly well and the local economy is unusually vibrant. What determines why some areas are more productive than others?

Induced innovation theory helps explain the conditions under which agricultural development will take place along paths that degrade or conserve natural resources.

Induced innovation theory holds that, over time, technological innovations and institutional changes take place to economize on scarce resources and utilize abundant ones (Hayami and Ruttan 1984). The theory helps explain why traditional farming systems have evolved differently in different places. For example, in sparsely populated areas traditional farming systems were bush-fallow, with forest land being cleared and farmed for a few years before being left for 20 to 30 years of nutrient-restoring fallow. On the other hand, in land-scarce areas such as the intensive rice growing areas of Southeast Asia, elaborate terraces, irrigation systems and nutrient management systems enabled continuous cultivation without degradation. In the widely cited case of Machakos, Kenya (Tiffen et al. 1994), rising population density, good access to markets and off-farm income created incentives and provided resources to raise productivity and conserve natural resources.

In India, farmer-led agricultural intensification is also widespread. In semi-arid areas the most obvious example is that of private irrigation investments, which are typically accompanied by land leveling and application of substantial organic matter and commercial inputs. On rainfed lands the successes are less dramatic, but evidence shows that private tree planting has grown steadily in recent years (Chambers et al. 1989), and that many farmers invest in indigenous soil and water conservation measures independently of special project efforts (Kerr and Sanghi 1992). Likewise, some villages have designed social institutions for managing common property resources in ways that raise their productivity and protect against long-term resource degradation (Wade 1988).

Several exceptional case studies of successful watershed development have been well-publicized in India, but the common perception is that they remain just that: exceptional. Success is often attributed to the efforts of a charismatic leader or some other set of social conditions that would be difficult or impossible to replicate on a wide scale. There is undoubtedly a great deal of truth in this perception, but to date there has been little systematic effort to examine the extent to which policy-relevant factors have played a role in causing some areas to be characterized by better resource management and higher agricultural production than others. Leaving aside unusual success stories like Ralegan

Siddhi (Hazare et al. 1996) and Sukhomajri (Chopra et al. 1990; Patel-Weynand 1997), are there village-level or regional differences in natural resource conditions, agricultural productivity and household incomes that can be explained by induced innovation theory?

From the induced innovation perspective, assessing the performance of watershed development projects requires examining the effects of such factors as market access, population density and the economic policy environment. Induced innovation theory suggests that if market access is favorable and population density is high, people will be more receptive to projects seeking to conserve soil resources and intensify agricultural production. In fact, even in the absence of a special project, the economic environment may be sufficient to induce farmers to adopt resource-conserving, productivity-enhancing technologies. On the other hand, even a well-designed watershed development project might be unable to achieve long-term success if enabling conditions are lacking. In such a case, farmers would have insufficient motivation to adopt and maintain practices needed to promote sustainable agricultural intensification.

ANALYTICAL APPROACH

This study examines performance in improving agricultural productivity, natural resource management, and human welfare. Data on performance indicators, which are described in subsequent sections, come from a survey of 86 villages reflecting a variety of project approaches, including villages with no project. Quantitative data collected at the village, plot and household level provide the basis for econometric analysis of the determinants of changes in pre- and post-project conditions. Open-ended discussions provide further qualitative information on the impact of projects on people from various interest groups, such as farmers with and without irrigation, livestock herders, etc.

This research was originally designed to examine only completed projects where the staff had withdrawn. However, despite the large literature on watershed development in India, the number of projects in which work has actually been completed is quite small, so the intended approach was not feasible. Instead, the study covers mainly well-established projects, with a few that have been completed.

Selection Criteria under each Project

The criterion by which each project selects participating villages is of critical importance to the present analysis. If, as argued above, numerous factors can determine a village's performance in agricultural production and natural resource management, then it is important to know how these factors are distributed across villages in different project categories. Otherwise, if villages in different project categories vary in their endowment of factors that can affect performance, then it is difficult to know whether to attribute differences in performance to project activities or to the effects of pre-existing village characteristics. For example, Pitt et al. (1993) describe a case in Indonesia that showed that villages covered for several years under a major family planning program actually had higher fertility rates than those outside of the program. One could jump to the conclusion that the family planning program had failed miserably, but Pitt et al. explain that the difference was not surprising given that the program consciously worked in villages where fertility had been higher to begin with. In the absence of the family planning program, the difference in fertility between the two sets of villages might have been even greater.

An analogous situation could apply in the present study since programs may choose to operate in particularly favorable or unfavorable villages, either intentionally or unintentionally.

Section 2 describes each project in detail, including its rules for selecting villages. In Section 5 the data are analyzed to assess the extent to which different projects adhere to their published guidelines and to identify any other factors that may characterize villages under each category.

Project Categories Covered in the Analysis

All categories of projects operating in Andhra Pradesh and Maharashtra are covered by this research. They include the following:

- ***Ministry of Agriculture (MOA):*** projects that focus primarily on technical aspects of developing rainfed agriculture. These include the National Watershed Development Project for Rainfed Areas (NWDPRA), the Indian

Council of Agricultural Research's Model Watershed Projects, and the World Bank-assisted Pilot Project for Watershed Development in Rainfed Areas.[2]

- ***Ministry of Rural Development (MORD):*** Engineering-oriented projects that focus on water harvesting through construction of percolation tanks, contour bunds, and other structures. These fall under the Maharashtra Department of Soil and Water Conservation projects (Jal Sandharan) and the Drought Prone Area Project (DPAP).[3]
- ***Non-government organizations (NGOs):*** projects that typically place greater emphasis on social organization and less on technology relative to the government programs.
- ***NGO-Government collaboration:*** projects operated jointly by government and non-government organizations (Indo-German Watershed Development Programme (IGWDP), Adarsh Gaon Yojana (AGY)) that seek to combine the technical approach of government projects with the NGOs' orientation toward social organization. These projects are found in Maharashtra but not Andhra Pradesh.
- ***Control:*** villages with no watershed project.

All of these project categories are discussed in detail in the next section.

[2] The more recent World Bank-assisted Integrated Watershed Development Project (IWDP) did not operate in either Maharashtra or Andhra Pradesh, so it is not covered in the quantitative analysis. This paper draws on other analysis of that project, including a companion to this study by Kolavalli (1998), to discuss this later generation of World Bank watershed projects.

[3] In 1995, the DPAP guidelines were restructured under radical new, participatory guidelines. However, only pre-reform DPAP projects are included in the quantitative research since little progress had been made in implementing the new guidelines at the time of the fieldwork for this research. Other studies including Kolavalli (1998) and Farrington et al. (1999) help provide information about this more recent set of projects.

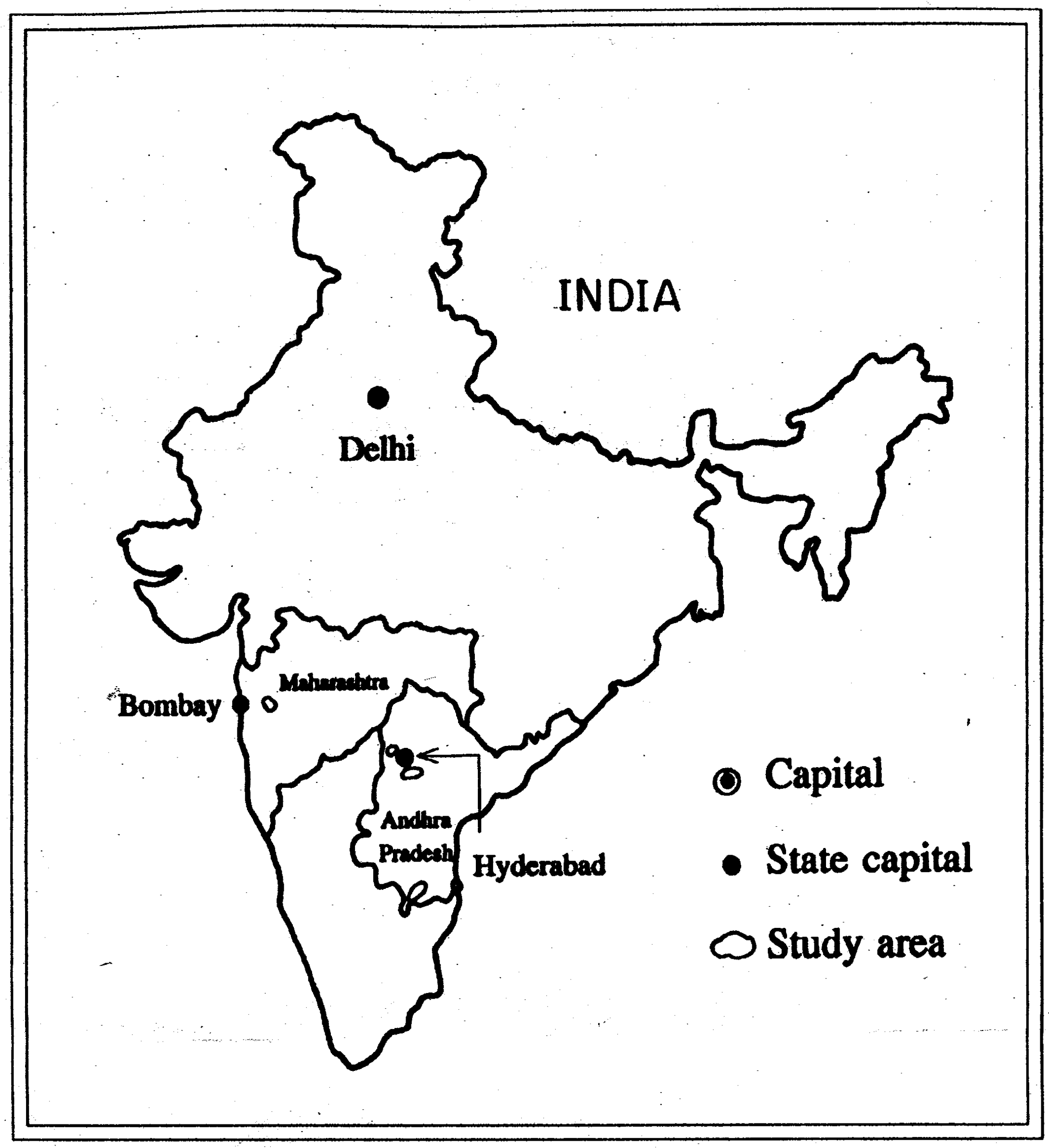
2. APPROACHES TO WATERSHED DEVELOPMENT IN MAHARASHTRA AND ANDHRA PRADESH

This section begins by describing the agroclimatic characteristics of the study region and characterizing two alternative technical approaches that have been used in watershed development. It then describes each of the projects covered in this study, focusing on their guiding principles and the relative emphasis on social organization compared to technical assistance. There is also a discussion of how each project selects the sites where it works, the amount of money they invest, and their policies regarding cost-sharing with intended beneficiaries.

AGROCLIMATIC CONDITIONS IN MAHARASHTRA AND ANDHRA PRADESH

Maharashtra and Andhra Pradesh both have highly diverse agroclimates. In Maharashtra, a narrow coastal plain separates the Arabian Sea from the Western Ghat Mountains. On the eastern side of the mountains, the majority of the state is spanned by the large Deccan Plateau, which covers much of south-central India. Rainfall is very high in the coastal mountains, but the western part of the Deccan Plateau (in the rain shadow of the Ghats) is very dry. The wettest district of the Western Ghats receives an annual average rainfall of over 4000 mm, while the driest areas of the rain shadow zone (only about 150 km to the east) receive about 500 mm. The topography of this transitional zone from wet to dry is a series of tablelands, or flat plateaus that drop sharply to plains below. Conditions for rainfed agriculture in the driest zones are difficult, and this is where watershed projects are most concentrated. Moving toward eastern Maharashtra, average annual rainfall rises gradually to over 1000 mm, making conditions for rainfed agriculture quite favorable.

Figure 1: Map of Maharashtra and Andhra Pradesh States, India



Andhra Pradesh contains similar diversity. The long coastal plain along the Bay of Bengal receives over 1000 mm average annual rainfall, and much of it is irrigated by the major canal systems of the Krishna and Godavari rivers. Moving west from the coast and over the Eastern Ghats (which are much smaller than the western Ghats), inland areas on the Deccan Plateau are divided into the Rayalseema and Telengana regions. Rayalseema is the southernmost part of the state; it is highly drought prone with average annual rainfall as low as 500 mm in some areas. South Telengana (which is south of Hyderabad) is also drought prone, though not to the same extent, with average annual rainfall in the 600-700 mm range. Both Rayalseema and south Telengana vary in their topography, with small hills and valleys that are suitable for traditional irrigation tanks that capture runoff from rainfall for lowland irrigation. The predominantly red soils of these regions also favor tank irrigation. North Telengana (which is north of Hyderabad), on the other hand, is flatter, has black soils, and receives around 800-1000 mm average annual rainfall. Conditions are much better for rainfed agriculture, comparable to the conditions across the state border in eastern Maharashtra.

Thus, rainfed agriculture in both states varies between areas of high and low potential and this heterogeneity has important implications for the approaches to watershed development.

HOW DIFFERENT PROJECTS APPROACH RAISING AGRICULTURAL PRODUCTIVITY

There are fundamental differences between watershed projects that focus on developing rainfed agriculture and those that focus on increasing access to irrigation.

Projects that Focus on Increasing Irrigation

In western Maharashtra, the scarcity of water and favorable topography make water harvesting a high priority and the focus of most projects. Where plateaus slope down to the plains, there are many opportunities to capture water behind small dams for irrigation in the flat lands below. Soils in these areas are relatively porous and favor percolation of harvested water into groundwater aquifers; it must be pumped for use as irrigation. By contrast, in Telengana and Rayalseema regions of interior Andhra Pradesh, irrigation tanks store water on the surface for irrigation by gravity.

Agricultural engineering to build and protect water-harvesting structures is the key feature of most watershed projects in western Maharashtra. The structures include mainly check dams in drainage lines and continuous contour trenches in the uncultivated catchment areas. Since almost all the structures are built on nonarable lands with common access by all village inhabitants, the projects also promote collective action to protect vegetation in the catchment area. This reduces erosion and limits the silting that would reduce the storage capacity of water harvesting structures.

In these projects there is relatively little focus on plot-level management. This is because once irrigation is in place, farmers have sufficient knowledge and incentive to manage a plot and improve its productivity. Rainfed agriculture is a low priority where projects are successful in increasing irrigated area. For example, Shri Anna Hazare, known as the “father” of watershed development in the well known success story of Ralegan Siddhi, explained that watershed efforts there focus exclusively on increasing irrigation and protecting nonarable lands. Virtually no attention is paid to developing rainfed agriculture (personal communication 1996). This approach has proven highly successful in Ralegan Siddhi, where irrigated area went from virtually zero to about 70% of the cultivated land over the last 25 years. Average annual rainfall is barely 500 mm, so conditions are not favorable for rainfed agriculture. Project designers clearly perceive that the real payoffs in such areas lie in irrigation development.

Projects that Focus on Rainfed Agriculture

In areas with limited opportunity for water harvesting, watershed projects typically devote more attention to developing rainfed agriculture. This is the situation in eastern Maharashtra and northern Andhra Pradesh, where the terrain is flatter and the climate less arid. Watershed projects in these areas promote on-site soil and water conservation measures that improve the resource base for rainfed agricultural production. This is intended to pave the way for adoption of crop varieties that are responsive to increased moisture. These projects often build water harvesting structures such as check dams and percolation tanks, but they cannot offer the spectacular increases in irrigation achieved in places like Ralegan Siddhi, because the terrain does not provide the same opportunities for harvesting water.

In southern Andhra Pradesh, the most obvious opportunities for water harvesting have long since been exploited in the form of traditional irrigation tanks. Some opportunities remain, but often they lie in the catchment of an existing tank, thus interfering with the traditional system. This helps explain why most projects in Andhra Pradesh focus more on rainfed agriculture than irrigation. (The DPAP is the exception.)

Table 1 lists the projects in the sample area according to their primary orientation toward water harvesting vis-à-vis rainfed agricultural development.

Table 1: Primary orientation of projects in the study toward either water harvesting or rainfed agriculture

Primary orientation of the technical work	Projects and locations
Primarily water harvesting	• DPAP (with pre-1995 guidelines) and Jal Sandharan, Maharashtra and Andhra Pradesh • NGOs in Maharashtra • Adarsh Gaon Yojana and Indo-German Programme (government-NGO collaboration)
Primarily rainfed agriculture	• NWDPRA, both Maharashtra and Andhra Pradesh study sites • World Bank Pilot Project • ICAR Model Watershed projects
Both rainfed agriculture and water harvesting	• NGOs in Andhra Pradesh

PROJECTS COVERED UNDER THIS STUDY

Government Projects that Focus Primarily on Water Harvesting

This discussion of the different watershed projects operating in the study area begins with the project sponsored by the Government of Maharashtra, because the Maharashtra projects represent the roots of watershed development in India. The Jal Sandharan program is the result of several decades of experience with watersheds in the state.

Watershed projects in Maharashtra:[4] The elements of watershed development date back to the 1942 Bombay Land Improvement Schemes Act. This initiative resembled modern watershed projects in its focus on soil and water conservation, improved rainfed farming methods, and controlled grazing. Watershed management gathered momentum in Maharashtra following the severe 1972 drought. The Government of Maharashtra launched the Employment Guarantee Scheme (EGS), which aimed to provide work to anyone who needed it while also creating permanent assets such as infrastructure. One important objective was to “drought-proof” the land by building water harvesting structures that would provide drinking water and irrigation throughout the year.

In 1982, the Government of Maharashtra initiated the Comprehensive Watershed Development Program (COWDEP). This program was intended to combine the budgetary resources of the EGS and the technical provisions of the 1942 Bombay Land Improvement Schemes Act for a large-scale watershed development effort. One notable problem was that work undertaken by COWDEP was administered by several government departments, and coordination among them proved to be difficult.

Following COWDEP and other experiments in watershed development, the GOM launched the Jal Sandharan Program in 1992. It represents an effort to take a more comprehensive approach to watershed development, with the key innovation being that the four government departments involved in the work were brought under one umbrella. The Jal Sandharan, which became a department in itself, would also handle the funds from the centrally-sponsored Drought Prone Area Program (DPAP), Jawahar Rojgar Yojana (JRY), and National Watershed Development Project for Rainfed Areas (NWDPRA).

The Jal Sandharan program treats the village as the unit of planning, implementing the work in microwatersheds that lie within village boundaries. Emphasis is given to raising the water table to protect and enhance drinking water sources and provide protective irrigation for at least one crop. The program is implemented by a

[4] This discussion of state government programs in Maharashtra draws on Pangare and Gondhalekar (1998).

committee at the district level representing all the government agencies involved in the project. The work in each selected village proceeds with the consent of the village *sarpanch* (elected leader) after a meeting of villagers is held to discuss the project.

The Jal Sandharan shows the signs of lessons learned from several decades of state government experience in watershed development, but it also shows clearly the difficulties of coordinating large-scale activities across government departments. In particular, coordination in the upper levels of bureaucracy does not always translate into coordination at the village level, where all the departments involved have separate budgets and targets (Pangare and Gondhalekar 1998).

Drought-Prone Areas Programme*:* The Drought Prone Areas Programme (DPAP) is sponsored by the Ministry of Rural Development in the central government. The DPAP can be traced back to the Rural Works Programme initiated in 1971-72. It has evolved gradually over time, initially covering a wide range of labor-intensive activities such as soil and water conservation, afforestation, and development of irrigation and infrastructure. Over time the program gradually focused more sharply on area development for drought-proofing. By the late 1980s, the DPAP became exclusively a watershed development program focusing on soil conservation, water harvesting, pasture development and afforestation. A small amount of funds were earmarked for associated activities such as livestock development, sericulture and horticulture.

As with other government-funded watershed programs, the DPAP was strictly a technical program in which local people played little or no role. Many NGOs, meanwhile, had moved toward a more fundamentally participatory approach in which villagers shared in developing and implementing watershed plans. In 1995, the Ministry of Rural Development adopted this approach on the basis of the well-known Hanumantha Rao Committee Report (GOI 1994a). Under the guidelines subsequently drafted, (GOI 1994b), plans were to be developed by the villagers, with an emphasis on the use of local technologies. Funds would go directly to the village, with villagers working hand in hand with an independent project-implementing agency that could come from the government, nongovernment or even corporate sector. A strong effort was made to move away from the physical target orientation that characterizes most government programs. This radical restructuring of the program has taken time to operationalize, and by 1997 almost no work had been undertaken in Maharashtra. Progress was better in Andhra Pradesh, but insufficient work had been done to warrant analysis of any post-1995 DPAP villages. As a result, this study covers villages covered by the DPAP in its pre-1995 guidelines. In Maharashtra the pre-1995 DPAP is synonymous with the COWDEP and Jal Sandharan, and in Andhra Pradesh the approach is very similar. In fact, before the implementation of the new DPAP guidelines the Jal Sandharan drew most of its budget from the DPAP.

Government Projects that Focus Primarily on Rainfed Agriculture

While the water harvesting and afforestation approach to watershed management was gathering momentum in Maharashtra and in the DPAP, alternate approaches were being introduced that focused more on developing rainfed agriculture through on-site soil and water conservation practices. These approaches were led in India by on-station research undertaken by the Indian Council of Agricultural Research (ICAR) institutes such as the Central Research Institute for Dryland Agriculture (CRIDA), and also by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

***Indian Council of Agricultural Research Model Watersheds**:* In the mid-1980s, ICAR decided to implement the findings of its dryland agricultural research in 47 model watersheds around the country. Many of these pilot sites were treated as research watersheds, where the work undertaken was closely monitored and changes in land and water conditions were analyzed. Physical costs of the watershed works were relatively low, but supervision was intensive, with persistent efforts to introduce new varieties and other improved technologies and management practices.

CRIDA took up three such watersheds in Andhra Pradesh. One of them, Chevella, is included in the present study. The other two, both of which are close to Hyderabad, could not be included because they have since been converted to housing developments. At least one model watershed was launched in Maharashtra, but it was in the eastern portion of the state not covered by the present study.

World Bank Pilot Project for Watershed Development in Rainfed Areas*:* The World Bank Pilot Project for Watershed Development was initiated in 1984 in Karnataka, Madhya Pradesh, Maharashtra and Andhra Pradesh. Like the ICAR model watersheds, this project sought to introduce improved rainfed agricultural technology. The project's guiding philosophy was that low-cost soil and water conservation measures, including improved agronomic practices like contour cultivation and vegetative rather than mechanical bunds, could make a strong contribution to rainfed agricultural development at a relatively low cost (World Bank 1988). While the work was undertaken on a watershed basis, additional emphasis was given to proper treatment *within* each plot as the project's design team felt this was missing from the watershed approach pioneered in western Maharashtra. A major thrust of this program would be to promote contour-based cultivation, which would conserve soil and concentrate moisture at very little monetary cost. The improved soil moisture regime in turn would make improved seeds, fertilizers and other inputs more productive.

The project also applied lessons learned from earlier projects regarding institutional approaches. Efforts were made to streamline state government operations to support the project; special offices were established at both the central and state level in order to coordinate the administrative needs of the project.

Like other early government projects, the Pilot Project aimed for universal implementation of a single, centrally-developed plan, with efforts made to convince local people of its merits. The project document stressed the need to adapt proven technologies to local conditions, but in practice there was little flexibility. Techniques not pre-approved under the project were not supported. Concerning pasture development and afforestation, it was recognized that the work would have no lasting impact unless people supported it; accordingly, no pasture development work would be undertaken without local people's consent. But that was about the extent of participation.

When the Pilot Project ended in 1991, a second phase of the World Bank project was introduced. This project was called the Integrated Watershed Development Project (IWDP), with separate components in the hills and plains. The plains portion of the project was undertaken in Rajasthan, Orissa and Gujarat. The IWDP, representing the next generation after the World Bank Pilot Project, took essentially the same approach to developing rainfed crop production as the earlier project. Its main difference was that it focused greater attention to developing and strengthening local organizations as the means of garnering people's participation and collective action for protecting common pasture areas. The project's administrative approach was also restructured. Project evaluations suggest, however, that the IWDP suffered from the same problems of poor participation and inflexible technology choice as the Pilot Project (ICRISAT 1996; RAU 1999; personal communication with Director of Watersheds, Rajasthan). Since the present study is confined to Andhra Pradesh and western Maharashtra, the analysis addresses only the Pilot Project.

National Watershed Development Project for Rainfed Areas: The National Watershed Development Project for Rainfed Areas (NWDPRA) is the Ministry of Agriculture's counterpart to the World Bank-funded Pilot Project and IWDP. Similar in approach to the World Bank projects, the NWDPRA promoted the same low-cost vegetative bunding techniques and contour-based cultivation. Vegetative and other low cost measures were also used in the nonarable lands (Government of India 1991a). The NWDPRA is centrally funded and operates through state-level Departments of Agriculture or Watershed Development. In 2000, the NWDPRA adopted the MORD's more participatory guidelines, and in the coming years the two projects are to be implemented with common guidelines. This study covers villages developed under the NWDPRA's earlier approach.

Another similarity to the World Bank projects is that the NWDPRA works on a watershed basis, where watersheds do not necessarily correspond to village boundaries. The NWDPRA watersheds are only about 500-5000 ha, or around 5-20% of the area of the World Bank watersheds. As a result, the NWDPRA watersheds typically cover one village entirely or nearly so, plus parts of one or two neighboring villages. This approach is considered to make the most sense from a land and water management perspective, but it raises administrative complications because project staff have to deal with multiple village administrations in one relatively small area. Also, organizing local institutional arrangements for managing nonarable common lands is complicated when working across village boundaries. The World Bank Pilot Project and IWDP shared this same problem and had difficulty in making it work (ICRISAT 1996).

The NWDPRA project guidelines mentioned the issues of people's participation and institution-building, but they presented no clear strategy and only a small budget for addressing them (GOI 1991a). It appeared that the project's intentions were in line with modern views about the benefits of participation but that the mechanisms for ensuring them were not fully developed. This is discussed further in Kolavalli (1998).

In western Maharashtra, implementation of the NWDPRA was strongly influenced by the fact that the project was implemented by the same agency that plans and implements the engineering-based approaches of the COWDEP, Jal Sandharan and DPAP. In particular, the primary focus remained on treating drainage lines and catchment areas to promote infiltration of water. One of the most notable differences was simply that the technologies in use were much less expensive. For example, drainage line structures under the NWDPRA contained no cement and were limited to a maximum cost of Rs 25,000 per structure, whereas under other projects individual water harvesting structures might cost seven or eight times as much. As a result, water harvesting was not the NWDPRA's strength.

In Andhra Pradesh, the NWDPRA was operated by the Department of Agriculture and more clearly matched the approach envisioned in the project guidelines.

Nongovernment Organizations: A Focus on Social Organization

NGO programs are by no means uniform, but they share the common feature of a strong emphasis on social organization. Their guiding principle is that without proper social organization, efforts to introduce watershed technology will be fruitless.

The two features that most distinguish NGO watershed programs from government programs are their scale of operations and their staffing structure. While government programs have huge budgets and work in hundreds of villages, most NGOs work in only a handful of villages. They devote more staff time per village, and they often work on a variety of activities in addition to watershed management. Second, while government employees concerned with watershed management are almost exclusively trained in agricultural sciences and engineering, NGO staff members include many more nontechnical staff trained in community organization. They believe that social organization contributes as much to successful watershed development as technical input. Some NGOs collaborate with government agencies that provide technical expertise, but others do not.

It is important to note that NGOs vary a great deal. Some are large and well established, with access to substantial funding, whereas others are smaller, less experienced, and underfunded.

NGOs in Maharashtra:[5] Watershed management in Maharashtra has roots in the nongovernment sector that go back nearly as far as those in the government programs. In the early 1980s two villages became well known for their watershed management programs: Ralegan Siddhi in Ahmednagar district and Adgaon in Aurangabad district. Many current government and NGO initiatives draw inspiration from them.

In the 1970s, Ralegan Siddhi was a poorly developed village almost devoid of trees and grass and a haven for liquor dens. Anna Hazare emerged as a local leader and brought about various social changes in the village, particularly family planning, a ban on alcohol, protection of nonarable lands against open grazing and felling of trees, and *shramdan*, or voluntary labor for community welfare. Around the same time he also learned about the benefits of soil conservation and water harvesting. The social changes brought order and a sense of community to the village, while soil and water conservation work (implemented by COWDEP) and protection of the common lands helped restore the natural resource base. This was the beginning of people's participation in watershed development.

Among the many NGOs working in watershed development in Maharashtra, one of the best established is Social Centre, founded in Ahmednagar in 1969 by Jesuit priests. Between the period 1969-1988, it was engaged in various activities such as small loans, community lift irrigation schemes, community health programs, etc. In 1988 it shifted its

[5] This discussion of NGO projects in Maharashtra draws on Pangare and Gondhalekar 1998).

focus towards motivating and organizing entire villages to undertake ecological regeneration of their own watersheds. The Social Centre played a key role in launching and designing the statewide Indo-German Watershed Development Programme, discussed below.

NGOs in Andhra Pradesh: NGOs in rural Andhra Pradesh have traditionally focused on the problems of lower caste communities. Caste structure is more dichotomized than in Maharashtra, with more villages in which one or two large land owning families control large tracts of land while many others remain landless. As a result, NGOs typically focused on non-land based activities such as developing and strengthening local credit institutions. With the rise of watershed development as a focal point for rural development, some NGOs gradually adopted it into their project portfolio (Sanghi personal communication).

In recent decades Andhra Pradesh has had successive waves of large-scale privatization of common lands in which landless and near landless people were given legal but nontransferable title to formerly common lands (Pender and Kerr 1999). Many NGOs expanded their work from credit and other income generation activities to support agriculture on the privatized land, much of which is of low quality. As they expanded to a watershed approach they also began to work with other farmers with higher quality land. But their primary orientation toward helping poor, landless people means that these watershed agencies tend to be more committed to making landowners pay for work done on their own property. For example, while most projects in Maharashtra and the centrally funded government programs typically ask for no more than a 10% contribution from farmers for work done on their private lands, some NGOs in Andhra Pradesh require a more substantial contribution for work done on private lands. Some of the implications of this policy are discussed below, in the discussion on land improvement investments.

One interesting difference between the works conducted by MYRADA, an NGO operating in Andhra Pradesh, and that by the Maharashtra NGOs is MYRADA's greater focus on trying to build consensus among different interest groups in a watershed. As discussed above, the costs and benefits of watershed development can be spread unevenly. This raises difficulties in project implementation, especially where socioeconomic diversity is relatively high. MYRADA addresses this problem by trying to organize communities to develop mechanisms to compensate those who lose so that they will go along for the greater good (Mascarenhas et al. 1991; Fernandez 1993, 1994).

In all of its rural development projects, MYRADA organizes people in small, homogeneous groups to work toward one common purpose. In the context of watersheds, the first step is to work in "miniwatersheds" of no more than a few hundred hectares and a hundred farmers. Second, MYRADA helps form small subgroups of farmers based on homogeneity of location, socioeconomic conditions or interests. These groups all belong to a larger miniwatershed group. This preserves the participatory and socially functional character of the smaller, homogeneous subgroups while also retaining advantages of scale in planning watershed works and interacting with government agencies, banks, and input suppliers. The larger group provides a vehicle for airing complaints and settling disputes among people from different subgroups.

Government-NGO Collaborative Programs in Maharashtra

The most intriguing aspect of watershed development in Maharasthra in recent years is the rise of collaborative programs between government and non-government agencies. The two main examples are the Adarsh Gaon Yojana (Ideal Village Scheme, or AGY), and the Indo-German Watershed Development Programme.

Adarsh Gaon Yojana:[6] The AGY is a major initiative that seeks to replicate the Ralegan Siddhi model in 300 villages by combining the technical staff of the Jal Sandharan program with the social orientation of NGOs.

The key elements of the AGY are government-NGO collaboration and strict guidelines for social organization. Villages participating in the AGY must undertake to follow the five social principles of Ralegan Siddhi: family planning, a ban on alcohol, a ban on open grazing, a ban on cutting trees, and *shramdan.* The idea is that adherence to these five principles can lead the village towards self-sufficiency by helping them meet their needs for water, food, fuel and fodder within their own village. The philosophy also

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[6] This discussion of the AGY draws on Pangare and Ghondhalekar (1998).

promotes a set of values that encourages self-discipline and a willingness to overcome social barriers and political factionalism to work for the common good.[7]

Shramdan is intended to foster a spirit of self-sufficiency and self-dependence. The idea is that when villagers observe the benefits of the physical works carried out for watershed development, it gives them a sense of satisfaction and achievement. They also feel responsible for the maintenance of the structures for which they have invested their own labor. *Shramdan* is also seen as a good way of getting people together to work for the welfare of the entire community.

Nongovernment organizations play an important role in the AGY. People in each village select a local NGO to help them implement the different development activities and adhere to the social principles. The NGO also maintains records and accounts, and monitors the project activities. In addition, the NGO coordinates with the government departments at the state level to access funding and technical guidance. The Jal Sandharan Department, meanwhile, implements the technical work.

Funds under the project are to be used for two main types of activities, namely, watershed development (the core activity) and other development activities (non-core activities). The latter are carried out by the government agencies in question, as listed above, in consultation with the people of the village. Government departments are supposed to give AGY villages preference in providing services. Steps are undertaken to reduce corruption and peripheral expenses.

Indo-German Watershed Development Programme: The Indo-German Watershed Development Programme (IGWDP) is another example of collaboration between government and nongovernment organizations that seeks to scale up the success of small NGO programs (Farrington and Lobo 1997; WOTR 2000; NABARD 1995). Initiated in 1993, the IGWDP develops microwatersheds in a comprehensive manner

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[7] It is important to note that *shramdan* has a long history in Maharashtra and is considered culturally appropriate. In other areas, other means of promoting cooperation and social discipline may be preferred. In southern Rajasthan, for example, Seva Mandir insists that villagers reverse all illegal encroachment on common lands before they will undertake work there (Seva Mandir 1999; Ahluwalia 1997).

through the initiative taken by village groups. Its guiding philosophy is the need for collaboration among village level organizations, NGOs skilled in social organization, and government organizations skilled in technical work. Further, it accepts that although indigenous knowledge and practices are important, they need to be augmented by modern techniques and management practices. The IGWDP has developed elaborate procedures to cut through bureaucratic turf wars and red tape, ensuring that funds move quickly (Farrington and Lobo 1997). As of July 2000, the IGWDP has developed 123 villages covering about 130,000 ha, with the involvement of 74 NGOs (WOTR 2000). Plans are being considered to spread this program to other states.

Investment in physical capital under the IGWDP begins only after evidence of social organization suggests that people will work together to maintain the investments on both private and community land. As with the AGY, there is as strong an emphasis on developing the village's social capital as its natural and physical capital, and the villagers must submit to similarly strict social conditions.

The work begins with 12 to 18 months of social organization work. This is almost 12 to 18 months longer than the social organization phase of a typical government watershed program, but it is shorter than that of many NGOs, which conduct work on several other areas of village development before venturing into watershed development. One important early project activity under the IGWDP is to plant trees and grasses in the catchment area. This is done prior to building water harvesting structures in order to force the inhabitants of the village to show that they can enforce social fencing to protect natural vegetation. Only after people demonstrate such social discipline does the project invest larger amounts of funds in new watershed structures.

The NGO helps organize and develop a Village Watershed Committee (VWC), which is essentially a village-based NGO. The idea is that the VWC will eventually outgrow the need for support from the original NGO.

INVESTMENT COSTS PER HECTARE UNDER EACH PROJECT

Information about the cost per hectare under different projects is helpful in assessing their cost effectiveness. It also helps in interpreting the findings of quantitative analysis presented later in this paper; it should not be surprising if one project that spends twice as much as another also has more measurable impact.

Unfortunately, measuring project costs is difficult. Some projects, including the NWDPRA and the World Bank, have expenditure guidelines that can be taken as a broad indication of the level of investment per hectare. Others require calculating estimates based on the total expenditure and the total area covered, but records are difficult to obtain. For example, officials of the Jal Sandharan project say that their budgets are constructed on the basis of structures to be built and vegetation to be planted, not the area of the watershed. Accordingly, calculations of cost per hectare are only approximate.

NGOs tend to keep poor records about costs per ha, and calculating them is very difficult because NGOs tend to undertake a variety of activities in addition to watershed development. So even when costs can be calculated, it is not always clear what to attribute them to. One certainty is that NGOs have much higher administrative costs than government projects, since they devote much more time to social organization for which expenditures are not directly tied to treated area.

In Maharashtra, since nearly all projects operate in ex-COWDEP villages, calculating costs requires taking the sum of expenditures under both the old and new programs. Records from the old projects are poor, so the cost figures are only approximate.

Rough estimates of project costs per hectare by project category are presented in Table 2. For the NWDPRA and World Bank Pilot Project the upper range is the cost listed in the project guidelines, while for the Jal Sandharan and COWDEP it is based on the total number of structures built divided by the area covered. AGY and IGWDP costs are calculated similarly but there are higher staff costs. The NGO figures are based on estimates by the officials interviewed.

Table 2: Estimated cost per ha of watershed development under different programs

Project category	Approximate cost per ha in 1998 Rs.	
	excluding COWDEP	Including COWDEP
NWDPRA	2500-3500	4000-6000
Jal Sandharan	2500-4000	4000-6500
NGOs	4000-6000	5500-8500
AGY/IGWDP	3500-5500	5000-8000
World Bank	5500-6500	5500-6500

3. DATA

Evaluating watershed projects requires baseline and monitoring data for comparison of pre- and post-project conditions, but unfortunately no such information was available for this study. As a result, the quantitative analysis is based on some secondary data available for both the pre-project period (1987[8]) and the present (1997), primary data of current conditions based on interviews and visual assessments, and primary data of past conditions based on recall by local inhabitants. Inevitably there are weaknesses in the data that limit the study's analytical power.

A major component of the research was the development and collection of data on various indicators of performance in natural resource conservation, agricultural productivity, and equitable distribution of project benefits. These data were collected through direct observation, group discussions, and published records. Quantitative data were also collected on the background characteristics of the projects, villages, households and plots covered under the study. Some of the village-level information came from public sources, but most of it was collected from group and individual interviews in each village. In addition, qualitative data were collected regarding the natural resources people use to earn their livelihoods, the social institutions that govern access to those resources, and any changes in access to them resulting either from changes in their

[8] Work in the World Bank and ICAR project villages began in 1986; in villages under these projects the baseline period was the year before the project began.

quantity or changes in social institutions. This information was collected in open-ended discussions with members of specific interest groups in each village, such as farmers with irrigated land, farmers with rainfed land, landless people, herders, and women.

The village, rather than the watershed, was selected for analysis of community level indicators of natural resource management and economic performance. This is because most projects in the sample worked at the village- or sub-village level, people are organized around villages, and secondary data are recorded at the level of the village. In some cases, particularly in Andhra Pradesh, villages are disaggregated into hamlets, in which case primary data were collected at the hamlet level.

PERFORMANCE INDICATORS

There is no single indicator of successful watershed development, so the most feasible approach is to compare the performance of a variety of indicators. The various performance indicators also reflect the diversity of project objectives. These include, among other things, raising rainfed agricultural productivity, recharging groundwater for drinking and irrigation, raising productivity of nonarable lands, reducing soil erosion, skewing benefits toward poorer members of society, creating employment (directly and indirectly), promoting collective action, and building or strengthening social institutions. All the projects surveyed shared most of these objectives but, as described in Section 2, they differed in their relative emphasis.

As mentioned above, the indicators vary in their level of rigor and reliability, which is inevitable given the lack of baseline or monitoring data in the study villages. Table 3 presents an overview of performance criteria, ideal indicators, and the indicators actually used in the current study, and Table 4 shows the level at which they operate.

Table 3: Performance indicators used to compare project performance

Performance criteria	Ideal indicators[a]	Proxy indicators used in this study
Soil erosion	• measurement of erosion and associated yield loss	• visual assessment of rill and gully erosion (current only)
Measures taken to arrest erosion	• inventory, adoption and effectiveness of soil and water conservation (SWC) practices	• visual assessment of SWC investments and apparent effectiveness (current only) • adoption of conservation-oriented agronomic practices • expenditure on SWC investments
Groundwater recharge	• measurement of groundwater levels, controlling for aquifer characterisitcs, climate variation and pumping volume	• approximate change in number of wells • approximate number of wells recharged or defunct • change in irrigated area • change in number of seasons irrigated for a sample of plots • change in village-level drinking water adequacy
Soil moisture retention	• time series, intrayear and interyear variations in soil moisture, controlling for climate variation	• change in cropping patterns • change in cropping intensity on rainfed plots • relative change in yields (higher, same or lower)
Agricultural profits	• net returns at the plot level	• net returns at the plot level, current year only
Productivity of nonarable lands	• change in production from revenue and forest lands (actual quantities)	• relative change in production from revenue and forest lands (more, same or less than pre-project) • extent of erosion and SWC on nonarable lands
Household welfare	• change in household income and wealth • nutritional status	• perceived effects of the project on the household • perceived change in living standard (better, same, worse) • change in housing quality • change in percentage of families migrating • perceived changes in real wage and availability of casual employment opportunities (higher, same, lower)

Note: [a] All ideal indicators would be collected both before and after the project.

Table 4: Performance domains and the units of analysis at which they operate

Type of performance	Level of measurement		
	Village	Plot	Household
Social organization	• institutions to protect common lands • use of voluntary community labor		• membership in village organizations
Natural resource conservation	• irrigated area and drinking water supply • soil erosion and conservation • products from common lands • habitat for wild animals and migratory birds	• irrigated area • population of improved dairy cattle	• drinking water supply
Agricultural productivity	• soil erosion and conservation	• irrigation • cropping intensity • adoption of new varieties • crop yield • returns to cultivation	
Equity and poverty alleviation			• assets (wealth) • access to employment • standard of living • condition of housing

Determinants of Project Performance

Village level: Data collected at the village level are based on a survey covering background information such as access to markets, land use patterns, natural resource management practices, and description of social institutions operating in the village. Most background information is available for both 1987 and 1997. A village-level survey was conducted to obtain most of this information, and additional background variables were obtained from the 1991 census. Performance indicators at the village level include some variables from the village survey, but also visual observations of natural resource conditions from village level transects covering a cross-section of broadly representative land types and uses.

Plot level: A plot-level survey was conducted to collect data on agricultural productivity and adoption of improved technologies and practices. This provides information about changes resulting from the watershed projects and other determining factors. The sample includes both irrigated and rainfed plots, and both plots covered and not covered by watershed projects. Village-level information related to each plot is available from the village survey. Some household-level information for each plot's operator was also collected as a part of the plot survey.

Household level: A household-level survey supplied detailed information about household characteristics and changes in household welfare. This provides indications of how watershed projects and changes in a variety of village- and household-level conditions have affected household welfare. This survey recorded concrete changes in living standards, such as ownership of durable goods and quality of housing, as well as respondents' subjective assessments of changes in their well-being. The household survey was conducted using a different set of respondents from the plot survey, but in the same villages.

Interest group level: A fourth set of interviews focused on different interest groups within the village, such as farmers with irrigation, farmers without irrigation, landless people, and women. The information provided by these interviews offers a qualitative assessment of project performance from the viewpoint of the intended beneficiaries, and it provides further insights about how project benefits and costs are distributed across different groups of people within the village.

Sampling

Sampling villages for data collection was a major undertaking in itself. The situation in Pune and Ahmednagar districts of western Maharashtra provides a good example of the difficulties. Despite widespread publicity about the success of the watershed approach to agricultural development, hard data were quite limited. A few widely known success stories were easy to locate, but others were not. This was the case for two reasons. First, the 1991 Census lists over three thousand villages in the two districts, but the famous success stories accounted for no more than a handful. Second, a complete list of villages where projects have operated did not exist. The most active watershed agency in the area, the Maharashtra Department of Soil and Water Conservation, kept good records of the villages where work was currently underway, but lists of villages where work had been completed were archived and could be accessed only with difficulty. Some government programs, like the NWDPRA, maintained lists of project locations only at the taluka level. NGOs maintained their own lists, which could be obtained by visiting the head office. As a result, simply identifying project villages required a great deal of legwork. The resulting list of project villages was then checked against the complete list of all villages from the national census so that nonproject villages could be selected as a control against which to compare project performance. All the sampled villages were visited to confirm their project status.

The Maharashtra study villages were all located in Pune and Ahmednagar districts in the western part of the state, where there was a relatively high concentration of watershed project sites. The eastern side of this study area is drought-prone, while the area closer to the Western Ghat mountain range has higher rainfall. In Andhra Pradesh the projects were less concentrated, so the sample villages covered 4 districts: Anantapur in the far south of the state and Medak, Mahbubnagar and Ranga Reddy, all of which are in the north, near Hyderabad.

Based on available knowledge about project status of villages, the sample was selected at random, stratified by the project categories listed above and, in Maharashtra, by geographic location. With five project categories and two geographical zones, there are ten strata in Maharashtra. A small amount of resampling was done to replace villages incorrectly classified as "control" after visits to the villages revealed that watershed projects had operated there in the 1980s. In Andhra Pradesh, where only sixteen villages were sampled, geographic stratification was omitted to ensure that each stratum has at least two observations. Thus Andhra Pradesh has only five strata.

As shown in Table 5, data were collected in 70 villages in Maharashtra and 16 villages in Andhra Pradesh. A full set of quantitative and qualitative data at the village, household and plot level were collected in a random, stratified subsample of 13 of the

Maharashtra villages and all 16 Andhra Pradesh villages, for a total of 29. In the remaining 57 Maharashtra villages only village level data were collected. The village-level analysis is confined to the 70 Maharashtra villages, while the plot-level analysis covers the 29 villages from both states where more detailed data were collected. The qualitative data cover primarily these same 29 villages.

Table 5: Location of the study villages

Type of analysis	Maharashtra	Andhra Pradesh	Total
Total	70	16	86
Village-level (quantitative)	57	0	57
Village, plot, household (quantitative) and interest group (qualitative)	13	16	29

Teams of five to seven village investigators spent four days and nights in each of the 29 villages where they collected the full set of quantitative and qualitative data. In the remaining 57 villages in Maharashtra where only village-level data were collected, teams of three to four investigators spent two to three days.

CHARACTERISTICS OF THE SAMPLED VILLAGES AND PLOTS

Village Characteristics

Village-level analysis is presented for Maharashtra. Conditions in the two states are sufficiently different to make it useful to analyze them separately, and the Maharashtra sample of 70 villages facilitates the analysis.

Villages are characterized by a variety of factors that might affect performance in agricultural productivity, natural resource management and living standards. Table 6 defines the variables representing these characteristics.

Table 6: Definitions of variables for analysis at the village level[a]

Description of variable	Years for which data are available	Source of data
Indicators of performance		
Change in percent area irrigated between 1987 and 1997		
Overall rill erosion status by land use type	1997	visual observations from the transect survey
Soil conservation investment status by land use type	1997	visual observations from the transect survey
Overall condition of drainage line	1997	visual observations from the drainage line transect
Extent and conditions of bunds lining the drainage line	1997	visual observations from the drainage line transect
Extent of breaches in the sides of the drainage line	1997	visual observations from the drainage line transect
Condition of junctions between drainage lines in the main drainage line	1987 to 1997	visual observations from the drainage line transect
Change in % of families migrating for at least one month	1987 to 1997	primary data
Change in availability of fodder and fuel from the common revenue land (Rs/ha)	1987 to 1997	primary data
Determinants of performance of the project and/or selection of a village for inclusion in a project		
Location: state, district,		
Altitude range of the village from highest to lowest point (meters)		government statistics
Position in the macrowatershed (lower, middle or upper reaches)		government statistics
% of village area under Forest Department	1987 to 1997	government statistics
Distance to taluka headquarters (km)	1987 to 1997	primary data
Distance to nearest bus stop (km)	1987 to 1997	primary data
Visits by an extension agent (number per year)	1987 to 1997	primary data
Number of communities in the village	1997	primary data
Percentage of villagers who are low caste	1990	national census
Percentage of villagers in different occupations	1990	national census
Distance to bank (km)	1987 and 1997	primary
Restrictions against grazing on common revenue land (yes/no)	1987 and 1997	primary
Illicit grazing is punished (yes/no)	1987 and 1997	primary
Shramdan (voluntary communal labor) is practiced in the village (yes/no)	1987 and 1997	primary
History of development projects that have operated in the village	1987 and 1997	primary
Strong leader who promotes social and economic development (yes/no)	1997	primary
Watershed project operating in the village	1987 and 1997	agency records and primary

Table 6 continued

Description of variable	Years for which data are available	Source of data
Percent of the village actually covered by the project		agency records
Money spent by the project (Rs/ha)		agency records
Year project began and ended		agency records
Population density (inhabitants per square km),	1990	national census
Distance to nearest industrial unit (km)	1987 and 1997	primary
Distance to regulated market (km)	1987 and 1997	primary
Informal credit groups (yes/no)	1987 and 1997	primary
Number of functional water-harvesting structures	1997	primary
Social restrictions on water use for irrigation (yes/no)	1987 and 1997	primary
Nominal daily wage (Rs)	1987 and 1997	primary
Average annual rainfall at the nearest taluka headquarters (mm)		government records

[a] Data from 1987 are based on respondents' recall

Table 7 shows the number of sampled villages in each project category and also the total number of villages in the study area. The relatively small number of sampled villages under the NWDPRA, NGO and AGY/IGWDP categories reflects the fact that these projects were not very widespread at the time of the study; the sample includes nearly the entire population for the projects.[9] The Jal Sandharan and nonproject villages in the sample, on the other hand, represent only a small fraction of their total populations.

Table 7: Number of villages in the Maharashtra village-level survey, by project category

Project category	Number of villages sampled	Total population of villages in the study area
NWDPRA	10	11
Jal Sandharan/DPAP	17	201
NGO	12	13
Government/Non-government collaboration	14	27
No project	17	361
Total	70	613

Project Characteristics: As discussed in Section 2, projects vary in various characteristics such as the percentage of village area that they cover, the number of years they operate, the amount of funds they spend, and the training of their staff. Table 8 presents the approximate mean values of such information for the sampled villages in Maharashtra. The figures in the table show that the percentage of each village covered and total expenditure per hectare in each village[10] are slightly less under the NWDPRA than other projects, but these differences are not significant. As discussed in Section 2, an important difference is the fact that the NWPDRA projects cover multiple villages while the other projects work in only one village at a time.

[9] Subsequent expansion of the Indo-German project and the Drought Prone Area Project raised the number of villages in these categories. Under its new guidelines, the DPAP works mainly through NGOs, so the number of NGO-led projects in the study area is slated to rise quickly.

[10] Total expenditure per hectare is calculated as the cost per hectare treated multiplied by the percentage of the village covered by the project.

Villages are also differentiated by the amount of time in which they have undergone watershed work. This is so for both the current or most recent watershed project and earlier work (if any) in the 1980s done by the Maharashtra Department of Soil and Water Conservation under COWDEP. Table 8 shows that, by either measure, the average duration of projects is not significantly different across watershed project categories. With the exception of the nonproject villages, all but two villages in the sample also had work done under COWDEP in the 1980s. The amount of work actually performed by COWDEP varied by village, but the figures in Table 8 are still striking: in one form or another, watershed development has taken place in these villages for a long time.

Finally, perhaps the most noticeable point in Table 8 is the difference across projects in the percentage of staff members trained in social organization skills. In the two government programs (NWDPRA and Jal Sandharan) no staff members had any training in social organization, while in those with an NGO component nearly half of them did. This reflects the differences in relative orientation toward social organization vs. transfer of technology described in Section 2.

Table 8: Project operations in villages under each project category, Maharashtra[a]

	NWDPRA	DPAP/Jal Sandharan	NGO	NGO/Govt collaboration	No project
Mean area of the village (ha)	2102	1422	1209	1144	905
Number of villages in which COWDEP previously worked (out of total sample)	9/10	16/17	11/12	14/14	0/17
Mean % area covered by the old project (COWDEP)	38	49	43	46	--
Mean % area covered by new projects	36	39	42	38	--
Mean % area covered by both old and new projects	74	88	85	84	--
Mean % of staff members with training in social organization[b]	0	0	42	45	--
Mean number of years since the most recent project ended	0	0	0.25	0	--
Mean number of years of work under COWDEP	7.2	8.4	7	8.7	--
Mean number of years under the new project	5.9	4.9	6	5.1	--
Mean number of years under both projects	13.1	13.3	13	13.8	--
Mean cost/ha actually treated under new project (Rs)	4500	4783	4989	4963	--
Mean expenditure/ha for entire village under COWDEP (Rs)	1880	2355	2148	2310	--
Mean expenditure/ha for entire village under new project (Rs)	1622	2006	2207	1874	--
Mean expenditure/ha for entire village under both projects (Rs)	3501	4361	4355	4185	--

Notes: [a] Most figures are approximate, based on calculations from official records.
[b] Analysis of variance (ANOVA) test shows that group means differ significantly across project category (excluding nonproject) only for the percentage of staff members with training in social skills ($F=45$, 3 df, $p<.001$). No other variables listed in this table show significant difference across project types.

Plot Characteristics

Approximately 12 plots were sampled in each of 13 villages in Maharashtra and 16 in Andhra Pradesh. The villages were stratified by watershed project category; the resulting sample of villages selected is shown in Table 9. Within each village, plots and households were selected at random, stratified by land capability classification and irrigation status. Every third plot was selected from the transect line that crossed representative areas of the village, until four plots were selected in each of three land capability classes, with three rainfed and one irrigated plot within each category.[11]

Table 9: Number of villages covered in the plot survey, by state and project category

Project category	Number of projects	
	Maharashtra	Andhra Pradesh
World Bank/ICAR	0	4
NWDPRA	2	3
Jal Sandharan/DPAP	2	3
NGO	3	3
AGY/IGWDP	3	0
No project	3	3
Total	13	16

As shown in Table 10, about 30 percent of the plots are irrigated, with the proportion of irrigated land higher on better quality land. (About 21 percent of plots were irrigated at the start of the study period in 1987.) 62 percent of class II lands are irrigated, while the corresponding figures for class III and class IV lands are 37 percent and 7 percent, respectively. This distribution arises for two reasons. First, given the choice farmers will irrigate their better lands first, since water will give higher returns when applied to better soil. Second, land class is somewhat endogenous with respect to irrigation, since irrigated plots tend to be leveled and receive higher organic matter inputs. As a result, it is possible for a given plot to change to a higher land classification after it becomes irrigated.

[11] In some villages, the sampling approach was altered somewhat because there were not enough plots with the desired irrigation status or land capability classification. For example, in some villages land quality could only be divided into two categories, and in others there were no irrigated plots on land of below average quality.

Table 10: Number of plots in the plot survey, by irrigation and land capability classification

Irrigation status	Land capability classification			Totals
	II	III	IV	
Rainfed	22	99	125	246
Irrigated	37	59	9	105
Total	59	158	134	351

Sampled plots were not stratified by the farmer's total land holding size, but as shown in Table 11 the sample is distributed fairly evenly across respondents of different land holding size. It is important to note that the sampling approach oversampled large plots relative to small ones, because the transect line was more likely to cross a large plot than a small one. However, plots are not large overall; the mean size is 0.72 ha and the median is 0.42 ha.

Table 11: Sample for the plot survey, categorized by land holding size

Category	Hectares operated	Number
Small	0-2	118
Medium	2-4	114
Large	>4	119
Total		351

The sampling approach led to a reasonably even distribution of plots across categories when classified by soil, irrigation and land size holding. Other factors were not controlled, however; for example, village and household characteristics that may affect productivity and natural resource conditions at the plot level may vary across project category. Data were collected to incorporate these factors in the plot-level analysis. Table 12 presents the various characteristics to be examined in the plot-level analysis and the source of data used for this study.

Table 12: Plot, household, village and project characteristics that potentially determine performance at the plot level[a]

Description of variable	Years data are available	Source of data
Biophysical and management characteristics of the plot		
Plot area (hectares)	1987 and 1997	primary
Average annual rainfall measured at the nearest taluka headquarters (mm)		secondary data
Land capability classification: sample includes plots of class II, III, and IV		investigator's visual assessment
Irrigation status in 1987 and 1997: 1 if it is irrigated at least one season, 0 if it is rainfed		primary
Slope: 1 if slope is 0-2%, 2 if slope is 2-4%, 3 if slope is 4-8%	1997	primary
Characteristics of the farm household		
Total hectares of land owned by the household	1987 and 1997	primary
Total number of adult workers in the household (men, women and long term hired workers)	1997	primary
Highest number years schooling of any male household member	1987 and 1997	primary
Highest number years schooling of any female household member	1987 and 1997	primary
% income from off-farm sources	1997	primary
Change in percentage of off-farm income between 1987 and 1997		primary
Tenure status: 1 if the farmer owns the plot, 0 if the operator is a tenant or sharecropper	1997	primary
Land title status: 1 if the farmer has a transferable title, 0 if not		primary
Plot rank (relative to farmer's other plots): 1 if it is the farmer's only plot or a better than the average quality plot in his holding, 2 if it is an average quality plot, 3 if it is below average.	1997	primary
Farmer interacted with project staff: 1 if the farmer has interacted with the project staff, 0 if not.	anytime between 1987 and 1997	primary
Project staff made technical recommendations to farmer: 1 if the project staff made technical suggestions, 0 if not.	anytime between 1987 and 1997	primary
Farmer adopted technologies or practices recommended by project staff: 1 if the farmer adopted the agency's suggestion, 0 if not.	anytime between 1987 and 1997	primary
Village level		
Village, taluka, district, state		
Altitude range between highest and lowest point in the village (meters)		secondary
Position in macrowatershed (lower, middle or upper reaches)		secondary
Distance to taluka headquarters (km)		primary
Distance to district headquarters (km)		
Distance to a large city (Pune in Maharashtra, Hyderabad or Bangalore in Andhra Pradesh), km		secondary
Type of road connecting the village (highway, paved road, good unpaved road, bad unpaved road, bullock cart path)	1987 and 1997	primary
Distance in km to nearest bus stop (km)	1987 and 1997	primary data
Number of visits to the village by an extension agent per month	1987 and 1997	primary
Distance to the nearest bank (km)	1987 and 1997	primary

Table 12 continued

Description of variable	Years data are available	Source of data
Strong leader in the village promotes social and economic development (1 if yes, 0 if no)	1997 only	primary
Population density (inhabitants per square km.)	1990	1991 census
Distance to nearest industrial unit (km)	1987 and 1997	primary
Distance to nearest regulated market (km)	1987 and 1997	primary
Nominal daily wage (Rs)	1987 and 1997	primary
Percentage of houses in the village with an electrical connection	1987 and 1997	primary
Project level		
Type of watershed project operating in the village, if any		project records
Number of years the current or most recent watershed project operated in the village		project records
Combined number of years under the most recent watershed project and another previous project		project records
Approximate percentage of the village's area covered under the project		project records

Notes: [a] Primary data for 1987 are based on respondents' recall in 1997.

CHARACTERISTICS OF HOUSEHOLD AND INTEREST GROUP RESPONDENTS

In addition to demographic and socioeconomic data collected for the household operating each sampled plot, an additional detailed household survey was conducted to learn about the welfare impacts of watershed projects and other factors potentially influencing development. 347 respondents were sampled randomly, stratified by land holding size. These respondents differed from those in the plot survey in that about 20% of them were entirely landless; the remaining respondents also had smaller holdings on average than those in the plot survey. This report does not draw much on the household survey, so it is not described in detail here.

Group interviews to collect qualitative data were collected in the same 29 villages as the plot data. The respondents for these interviews included the village's elected leader, or *sarpanch*, representatives of the watershed agency, and specific interest groups in the village such as farmers with irrigated land, farmers without irrigation, landless people (often herders), people from low castes, etc. Men and women were interviewed in separate groups. Facilitators of these discussions had a list of unstructured questions to ask, but they also encouraged participants to address other issues of importance to them.

4. METHODS

This section discusses the approach taken to identify the contribution of watershed projects to agricultural productivity, natural resource management and poverty alleviation, taking into account the contributions of other factors such as infrastructure development, agroclimatic conditions and village-level social capital. The analysis is structured around the basic program evaluation question: what would have been the state of agricultural productivity, natural resource management and poverty in the absence of the project interventions? Answering this question is complicated, because one never observes the same villages (or households or plots) both participating and not participating in the program at the same time. As a result, care is needed to identify other factors that may have contributed to observed outcomes. These include contemporaneous events, such as changes in infrastructure and market access, and systematic biases in where the projects choose to operate or which villages (or people) choose to participate. Since projects are not placed randomly, differences in project outcomes may depend on pre-existing village characteristics in addition to project activities.

Historically, the evaluation profession has been characterized by a split between quantitative and qualitative researchers. Recent years, however, have seen a growing appreciation of the benefits of combining the approaches of both (Greene and Caracelli 1997; Patton 1997). Quantitative evaluation uses statistical analysis to disentangle project effects from intervening factors, relying mainly on theory to explain how the project activities lead to impact. It follows the logical positivist belief that a single, objective truth exists independently of the observer. Qualitative evaluation, on the other hand, tends to make fewer assumptions about how a project affects individual behavior. It focuses on the mechanisms of change while also yielding qualitative measures of impact. Combining the two types of information can yield a particularly thorough understanding of project impact.

This study uses mainly quantitative analysis, but it also draws on qualitative information to better understand the relevant research questions, identify projects' unintended consequences and the mechanisms though which they operate. This sets the stage for a better-informed quantitative investigation, with greater confidence that statistical analysis addresses the most important questions and incorporates the most relevant variables. Subsequent qualitative investigation then helps interpret the findings of the statistical analysis and rule out competing explanations for observed differences across projects. This is particularly important given limitations in the data.

ASSESSING ENDOGENEITY IN PROGRAM PLACEMENT

The critical problem in quantitative evaluation is endogeneity, which arises if some factors affect the project placement and the outcome simultaneously. This makes it difficult to distinguish the effect of the project from the underlying factors that determined where the project operated. The only way to solve this problem completely would be to observe the same individual at the same point in time, both with and without the project. Of course this is not possible, so the evaluator must try to set up one group of observations affected by the project treatment, and a control group not affected by the project but identical in every other way. This follows the standard experimental design of the natural scientist. In practice, in many social science settings it may be possible to identify *similar* but not *identical* treatment and control groups, so the social scientist's experimental design can never be perfect (Manski 1995). This is discussed below with respect to watershed projects.

Evaluators follow three main approaches to establishing control and treatment groups: randomization, or pure experimental design; quasi-experimental design, and non-experimental design (Ezemenari et al. 1999). Randomization refers to randomly placing individuals into two groups—one that receives the project treatment and one that does not. This solves the endogeneity problem by ensuring that the two groups are statistically equivalent, so that any difference in average outcomes after the project can be attributed to the project. In the present context, five separate randomly placed groups would be needed: four for the different watershed projects and one control. Obviously the randomization must take place before the projects begin. In the case of Indian watersheds, the different projects operated independently and little or no advance thought was given to evaluation, so the randomization approach is not possible.

Quasi-experimental design involves matching program participants with a comparable group of individuals who did not participate in the program. This simulates randomization but need not take place prior to the intervention. For example, Pitt and Khandker (1996) used such an approach to estimate the effects of microcredit programs in Bangladesh. They matched program and nonprogram villages and then devised an elaborate set of matched groups in both sets of villages based on eligibility requirements for participating in the programs. In another example, Jalan and Ravallion (1998) took advantage of a large existing data set to estimate the probability that households participated in a public works program in Argentina. They then constructed treatment and control groups by matching participating and nonparticipating households that had the same predicted probability of participation (Ezemenari et al. 1999).

In the present study villages in each project category were matched geographically, but there was insufficient data to match them in a more rigorous manner. A nonexperimental design was used instead.

Several nonexperimental approaches are possible. One way comes from the Pitt et al. (1993) study of Indonesian poverty programs referred to in Section 1. Because those programs were intentionally located in the poorest areas, purely cross-sectional analysis would have suggested mistakenly that the programs actually increased poverty. More formally, the simple approach that yielded the incorrect finding was as follows:

$$Y = a + bW + cX + e \qquad (1)$$

where the outcome (Y) is a function of the watershed project treatment effect (W) and other determining factors (X), a is the intercept and e is the error term. This approach is valid if the other factors (X) include all possible determinants of treatment effect and if program placement is independent of treatment effect. Since this is unlikely to be the case, the estimated effect of the treatment is likely to be biased. In the case analyzed by Pitt et al. (1993), the project coefficient b in equation 1 had a negative coefficient; i.e., the analysis suggested incorrectly that the project contributed to poverty.

Pitt et al. approached this problem by estimating the *change* between pre-project and post-project poverty conditions as a function of the *change* in hypothesized determining factors, such as demographic conditions and access to services and markets. In this model, the nonproject determining factors are grouped into socioeconomic variables (*X*) that vary both spatially and temporally, and environmental variables (*E*) that vary across villages but are fixed over time. The relationship can be expressed as follows[12]:

$$DY = aDW + bDX + cE + De \qquad (2)$$

This approach isolates the changes associated with the project, eliminating the bias associated with the influence of pre-existing conditions on both the program placement and the outcome. However, it presumes availability of panel data (containing conditions both before and after the program), and it presumes that sufficient change occurred in the socioeconomic variables *X* to estimate them. In the present study, over the ten-year study period many socioeconomic variables in question, such as infrastructure conditions and the distance to markets and services, did not change in most villages. As a result, many variables contained mainly values of zero, with insufficient variation within the sample to perform econometric analysis. Wherever possible, variables are expressed in terms of the change during the project period, but for most explanatory variables the value at the start of the project period is used.

Another way to control for endogeneity of program placement in estimating program effects is through instrumental variables. A variety of two-stage models for estimating treatment effects or sample selection bias provide models for this approach (Maddala 1993; Greene 1990). One equation yields the predicted probability that any given case is selected (or self-selects) for treatment under a given program. Then, in a two-stage model, another regression estimates the outcome in question, replacing the endogenous treatment variable *W* with its predicted value , eliminating the endogeneity. In this case the model is as follows:

$$W = a + bX + cZ + e \qquad (3)$$

[12] In this specification *W* may be considered as program expenditure in a given location, so *DW* is the change in program expenditure between two points of time. *W* could also be specified as project dummy variables, in which case *W* would replace *DW* in equation (2).

$$Y = f + g \quad + hX + e \tag{4}$$

where *X* is a set of variables correlated to both the outcome *Y* and the placement of project treatment *W*, and *Z* is a set of variables that affect *W* but not *Y*.

In the present context, equations (3) and (4) can be written more specifically as:

$$W = a + bV + cZ + e \tag{5}$$

$$Y = f + g \quad + hV + iH + jP + e \tag{6}$$

where: *W* is a categorical variable indicating one of five watershed project categories; is the predicted probability that the project falls in each watershed project category; *Y* represents outcomes defined in terms of the performance indicators introduced in section 3; *V* is a set of village-level explanatory variables; *H* is a set of household-level variables; and *P* is a set of plot-level explanatory variables. Both *H* and *P* are omitted from village-level analysis.

Equation 5 is a multinomial logit model because *W* is categorical. Equation 6 takes different forms depending on the nature of the performance indicator in question; these variables may be continuous, binary or ordinal. In most of the models equation 6 is an ordinal logit model, in some it is a binary probit, and in a few it is a tobit or an ordinary least squares regression. In all of these cases, the models are adjusted for the use of complex survey data (Stata 1999).

A remaining shortcoming of the model is that, for technical reasons, the standard errors could not be corrected for the fact that predicted values were used in the regressions. The author is not aware of formulas to correct the standard errors for the complex two-stage regressions used in the analysis. Bootstrapping was not justifiable due to the small number of observations per stratum. Pender and Scherr (1998) faced this same problem; they examined the robustness of their findings by comparing their regression results using actual vs. predicted values. This study follows the same approach, and the findings are discussed below.

Qualitative Analysis

Qualitative investigation took the form of detailed, open-ended discussions, mostly at the group-level with people from different interest groups. The findings from this work helped identify some of the questions posed in the quantitative analysis, and it also helped interpret the findings. This study was primarily quantitative, so the qualitative data played mainly a supporting role. In a few cases data limitations prevented the quantitative analysis from yielding any useful information, so the qualitative analysis became the sole source of insight from the fieldwork. However, time constraints limited the scope of the qualitative investigation to less than would be ideal. In particular, it would have been desirable to engage in a more thorough qualitative investigation after having analyzed the quantitative data.

Qualitative data were recorded in written notes and yielded a variety of forms of data. Some findings from these interviews could be translated into numeric data, while others helped to explain the specific problems that people faced or the ways that projects affected them. Findings from these interviews are presented in this report alongside those from quantitative analysis as a means of providing additional insight.

5. HOW PROJECTS CHOOSE WHERE TO OPERATE

As explained in Section 4, how a project selects villages in which to work can have a major impact on what it can achieve since, as introduced above, a variety of conditioning factors can have a strong influence on people's incentives to invest in land improvement. This section reviews each project's published site selection criteria and then examines the data to characterize villages under each project.

PROJECT SITE-SELECTION GUIDELINES

DPAP*:* The pre-1995 DPAP focused on small microwatersheds located within predominantly rainfed villages with relatively little irrigated area. The irrigation threshold varied depending on the village's average annual rainfall; in villages with over

1125 mm average annual rainfall the DPAP could operate if irrigated area was less than 10%, whereas if rainfall was less than 750 mm irrigated area could be up to 20%.

Jal Sandharan: The Jal Sandharan project selected villages according to four conditions.[13] First, they would be selected if COWDEP had operated there and completed more than 50% of the watershed development work. This would enable treatment of the entire watershed to be completed through the Jal Sandharan program within five years. Second, they should have a scarcity of drinking water. Third, they should be located in a taluka (a subdistrict administrative unit containing up to 200 villages) with scarce groundwater (as designated by the state Groundwater Survey and Development Agency). And fourth, they must lie outside of the outside of the command of a canal irrigation project.

World Bank Pilot Project: Unlike the other projects in the study that work in one or two villages at a time, the Pilot Project worked in very large, contiguous areas of about 25,000 ha with at least 750 mm average annual rainfall and little irrigation. Villages in the core watershed area were treated in their entirety, whereas those in the periphery typically lie partly in the watershed and partly outside. In that case only the part of the village lying inside the watershed was treated.

NWDPRA: The NWDPRA operates in areas with less than 30% irrigation, with no criteria concerning average annual rainfall. Preferably sites should be located in the upper reaches of the local macrowatershed. Project sites should be close to the taluka or block headquarters in order to facilitate supervision by officials based at headquarters, and close to markets so that "farmers from nearby areas can assemble and see the process and feel the impact of the project interventions (GOI 1991a)." Project sites should be located on the main road, easily accessible to government officials and other visitors. To quote the guidelines, "Just a pause on the road would give an opportunity to have a bird's eye view of the project area. This will ensure visual impact on intentional and unintentional visitors (GOI 1991a)."

NGOs: NGOs all have their own guidelines, but virtually all of them stress working in poverty-stricken areas, often inhabited by tribal groups. MYRADA's

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[13] Where DPAP funds are used its criteria are also followed.

guidelines are instructive. It operates in remote, unfavorable areas, usually in the border areas of a state, far from the state capital, that are relatively neglected by state-level development programs. They have the worst land, the worst infrastructure, and the least well-off inhabitants. The typical MYRADA village has practically opposite characteristics of those in NWDPRA project sites described above.

AGY: Any village is eligible for participation in the AGY if it is located in a drought-prone area of Maharashtra, with no more than 30% cultivated area under irrigation. The villagers must meet in the Gram Sabha (assembly of all adults in the village) to pledge to accept and abide by the five social principles listed above. 70 percent of the Gram Sabha must agree to participate before the application can go through.

IGWDP: Villages are selected for the project should be in a drought prone area with less than 20 percent area under irrigation and overall water scarcity; they should lie in the upper part of a macrowatershed and have noticeable erosion, land degradation and resource depletion problems. Village boundaries should coincide to the greatest extent possible with watershed boundaries, and the topography should offer good opportunities for water harvesting. Villages should be predominantly poor with a high proportion of scheduled castes and scheduled tribes in the population, and land holdings within selected villages should be relatively equally distributed. Beyond this, the villagers should commit to the social conditions outlined above. The key factor is that villagers should demonstrate their capacity for collective action and their concern for resource conservation. Finally, the village is represented by a village watershed committee that is selected on the basis of consensus in the Gram Sabha (NABARD 1995; Farrington and Lobo 1997).

Comments on the Site Selection Criteria

The site selection criteria reveal a great deal about each project's orientation. All of the projects share a bias towards working in areas that are less favored agroclimatically, although it is stronger in some than others. Agroclimatic conditions are the most lenient in the NWDPRA due to its interest in developing rainfed agriculture.

The NWDPRA is also the only project that does not seek to work in villages that are least well off socioeconomically. Selecting the most easily accessible villages reveals the NWDPRA's orientation toward planning and supervision by people from outside the village, as well as an optimistic view about the process of dissemination of project benefits. More subtly, the approach also leads to an apparently unintentional bias in selection of project sites towards more densely populated areas with better access to transport and markets. In accordance with the conceptual framework outlined in the introductory section, these conditions may well be especially favorable for the promotion of rainfed areas. In this sense the project's technical interventions may complement other features of the project sites.

The AGY and IGWDP reveal the greatest focus on social discipline. In many respects the villages under this project are self-selected for collective action. Many of them practiced the required social restrictions prior to the onset of the program. Villages that are not prepared to ban grazing and tree-cutting or to practice *shramdan* shy away from these programs. The IGWDP takes the additional step of selecting only villages with topography favorable for constructing water harvesting structures.

Another point about selecting villages for success is that in the start-up phase of the IGWDP, which is covered under this study, only well-established NGOs were selected that were already familiar with the community in which they initiated the project. That means that they were already working there prior to the start of the IGWDP, and many ongoing activities were simply brought under the flag of the IGWDP. A similar situation holds for the AGY, where many project villages are led by disciples of Anna Hazare and tried to follow his development philosophy even before the project began.

ANALYSIS OF DETERMINANTS OF PROGRAM PLACEMENT

This section investigates how published site-selection guidelines translate into actual program placement in the study villages. As mentioned above, it focuses on Maharashtra due to data limitations in Andhra Pradesh.

Table 13 presents mean values of variables that describe the villages in Maharashtra covered by the village survey. The data suggest that the projects do in fact follow the principles laid out in their guidelines. NGO and NGO-government collaborative projects tended to have the lowest levels of infrastructure in the pre-project period, while

NWDPRA villages had the highest. Conditions in nonproject villages were similar to those under the NWDPRA. All of the NGO-government collaborative project villages practiced *shramdan*, as did 75% of the NGO villages. Less than half of the remaining villages practiced *shramdan*. None of the projects had a significantly lower percentage of area irrigated than the nonproject villages, but this is because virtually all villages in the study area have relatively little irrigation, and also because the government projects target their work based on the level of irrigation at the taluka level, not the village level.

As mentioned above, nearly all projects take advantage of work done by the COWDEP project in the 1980s, although only Jal Sandharan advertises this fact in its published guidelines. Only three project villages in Maharashtra—one each under the NWDPRA, DPAP and NGO categories—were not previously treated under COWDEP. For NGOs, selecting COWDEP villages is sensible because technical work that was already undertaken can be made more productive by developing complementary social institutions. At the same time, it makes it somewhat difficult to determine how much of the success of the program stems from the project's current work and how much depends on earlier watershed structures built under COWDEP. It may have implications for the time frame required for watershed development interventions when the project expands to areas beyond those covered by COWDEP.

Table 13: Mean values of selected Maharashtra village characteristics in 1987, by project category[a,b]

Village characteristic	All	NWDPRA	JS	NGO	AGY-IG	No project
Average annual rainfall	578	601	566	593	583	578
Altitude range	49	67	54	51	44	37
% Irrigated area	13	24	13	9	16	11
% of villages located in the upper reaches of the macrowatershed	59	70	47	75	64	47
% of villages located in the middle reaches of the macrowatershed	23	20	41	17	0	29
% of villages located in the lower reaches of the macrowatershed	19	10	12	8	36	24
% of villages located on a highway	4	0	12	0	7	0
% of villages located on a paved road	34	50	29	42	21	35
% of villages located on a good unpaved road	24	30	18	17	43	18
% of villages located on a bad unpaved road	29	20	35	25	14	41
% of villages located on a bullock cart path	9	0	6	17	14	6
Distance to nearest regulated market[c]	11.7	13.9	11.6	16.8	8.1	9.8
Distance to taluka headquarters	20.6	18.4	18.9	24.7	22.1	19.5
Distance to district headquarters	65.6	60.8	61.6	65.4	69.1	69.7
Distance to large city[d]	77.8	56.8	94.7	88.3	65.8	75.7
Distance to nearest bus stop	1.2	.9	.9	1.7	1.4	1.3
Number of extension agent visits per month	1.6	1.4	1.5	1.3	2.2	1.6
Distance to industrial unit	24	19.8	25.4	28.7	26.8	20.7
Distance to bank[e]	6.0	3.5	5.7	9.2	6.7	4.9
Population density (from 1991 census)	135	162	123	118	131	145
% of villages with a public health service office	16	50	20	10	0	10
Distance to nearest public health service	6.9	3.7	7.2	7.5	9.4	6.0
% of houses with an electrical connection	27	32	25	24	21	32
% of villages with electricity to power irrigation pumps	89	100	88	92	78	88
% of villages that had informal credit groups	24	60	12	25	0.0	35
% of villages that had adequate drinking water (i.e. did not need tankers to deliver it)	53	70	35	50	43	71
% of villages containing some common (government revenue) land	57	60	59	33	57	71
% of villages that had some land coming under the Forest Department	76	80	71	83	86	65
Overall adult literacy rate, % (1991 census)	53	58	54	46	52	56
Male literacy rate, % (1991 census)	68	73	69	62	67	73
Female literacy rate, % (1991 census)	37	43	37	30	38	40

Table 13 continued

Village characteristic	All	NWDPRA	JS	NGO	AGY-IG	No project
Distance to nearest veterinarian	5.4	3.2	5.5	5.9	6.9	4.9
% practicing *shramdan* (voluntary community labor)[f]	54	20	35	75	100	41
% in which fuel was available from government revenue land[g]	40	33	40	50	63	25
% in which grass fodder was available from government revenue land[g]	83	83	90	50	88	83
% in which tree fodder was available from government revenue land[g]	40	50	40	50	50	25

Notes: [a] Analysis of variance statistics are reported for continuous variables with significance level p < .10.
[b] Kruskal-Wallis statistics for ordinal categorical variables are reported for variables with significance level p < .10 (Agresti 1997).
[c] Distance to nearest regulated market: F = 2.80, 4 df, p < .03.
[d] Distance to nearest large city: F = 2.84, 4 df, p < .05.
[e] Distance to nearest bank: F = 2.07, 4 df, p < .1.
[f] Whether *shramdan* (community voluntary labor) is used: chi-square = 21.9, 4 df, p < .001.
[g] These measurements cover only those villages that had government revenue land in both 1987 and 1997.

Another interesting observation in Table 13, not revealed by published guidelines, is that in all the project categories, a smaller percentage of villages contain common land (owned by the government) than in nonproject villages. The difference is particularly large in NGO villages; only 33% contain government revenue land compared to 71% for nonproject villages and 57% overall. Such land usually lies in the upper watershed and is used as grazing commons; as discussed in Section 1, watershed projects aim to restrict access by grazing animals to this land. Throughout India, government revenue is in a notoriously degraded, open access state. Accordingly, the organizational requirements of watershed development may be significantly less complicated in villages without government revenue land. Another kind of common land is owned by the Forest Department, which uses its own resources to restrict access. More project villages than nonproject villages contain Forest Department land, most likely because they are located in more hilly terrain with more forested area.

Econometric Analysis of the Determinants of Project Placement

A multinomial logit model is used to examine in more detail the determinants of which project category a particular village falls into. The dependent variable is the categorical project variable covering the five categories found in Maharashtra: National Watershed Development Project for Rainfed Areas (NWDPRA), Jal Sandharan, NGOs, and Adarsh Gaon Yojana and Indo-German Programme (AGY/IGWDP—combined into one category), and nonproject.

Explanatory variables: Conditions prevailing in 1987, before the projects began, represent the potential determinants of a village's selection by a given project. Altitude range (the difference between the highest and lowest points, in meters) is important since many projects seek to work in areas with high potential for water harvesting. Infrastructure variables include the distance to taluka headquarters, the population density in 1990,[14] percent area irrigated, adequacy of drinking water availability, distance to market, distance to the nearest bus stop, and distance to the nearest public health center. Other infrastructure variables are omitted due to high correlation with those included.[15] The existence of an old COWDEP project in the village is omitted from the analysis because it perfectly predicts the existence of a current project, making the multinomial logit analysis infeasible. Variables representing social conditions and social institutions are whether the village practiced *shramdan* and the number of communal groups. The literacy rate was considered but excluded because it is highly correlated with some of the infrastructure variables.

Results: The findings of the multinomial logit analysis are presented in Table 14. The analysis supports most of the descriptive findings about project selection and raises some additional points. With nonproject villages as the base category, the analysis shows the following.

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[14] Population data come from the 1990 census (GOI 1991b); they are not available for 1987.

[15] An effort was made to build an index of infrastructure quality, but it had limited explanatory power.

Table 14: Determinants of project category in Maharashtra[a]

Multinomial logit regressions (standard errors in parentheses)

Variable	Project category			
	Min of Agriculture	Min of Rural Development	NGO	NGO/government collaboration
Distance to nearest bus stop in 1987 (km)	0.83	-0.16	0.16	-0.34
	(.34)**	(0.27)	(0.32)	(0.29)
Paved road in 1987 (dummy)	0.29	-1.58	0.41	-2.49
	(1.27)	(1.63)	(1.11)	(1.53)
Whether the village contained government revenue land, 1987	-0.32	-2.10	-4.96	-1.16
	(1.16)	(1.22)*	(1.17)***	(0.88)
Number of communal groups in the village	1.18	0.76	0.85	0.13
	(0.25)***	(0.29)**	(0.30)***	(0.35)
Altitude range (‘00 meters)	3.34	1.93	2.44	2.16
	(1.02)***	(1.00)*	(1.06)**	(1.34)
Distance to taluka headquarters (km)	0.21	0.01	0.35	-0.03
	(0.05)***	(0.05)	(0.43)	(0.04)
Population density in 1990 (‘00 persons/sq km)	3.71	0.88	-1.81	-0.59
	(0.82)***	(1.76)	(-1.43)	(0.88)
Percent area irrigated in 1987	2.90	-2.39	8.29	1.94
	(3.28)	(5.76)	(3.55)**	(4.52)
Whether the village had sufficient drinking water in 1987 (dummy)	3.31	-1.35	0.26	0.93
	(1.38)**	(1.27)	(1.54)	(1.49)
Distance to nearest public health center, 1987 (km)	-0.38	0.17	0.18	0.33
	(0.15)**	(0.15)	(0.15)	(0.14)**
Distance to market for agricultural inputs in 1987 (km)	-0.15	0.23	0.34	0.10
	(0.11)	(0.15)	(0.16)**	(0.13)
Village practiced community voluntary labor in 1987 (dummy)	-2.01	-1.31	1.57	8.42
	(1.10)*	(1.51)	(1.57)	(2.35)***
Area of the village (‘00 ha)	0.17	1.29	0.09	0.30
	(0.13)	(1.34)	(0.13)	(0.13)**
Approx. % of households with at least one seasonal migrant, 1987	-0.10	-0.06	-0.10	0.09
	(0.03)***	(0.04)	(0.06)	(0.03)***
% of inhabitants of low caste	0.047	0.08	0.12	-0.03
	(0.025)*	(0.03)***	(0.03)***	(0.06)

Note: [a] Reference category is control (no project); variables reflect values in the pre-project period. 70 observations. Model is not corrected for choice-based sampling, i.e. that the sample is stratified on the dependent variable. Coefficients and standard errors are adjusted to account for sampling weights, stratification and finite population size. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

All projects have a greater range in altitude between the highest and lowest point in the village compared to nonproject villages, and this difference is significant for all except the NGO/government collaborative projects. This is to be expected since hilly areas are most suited for water harvesting.

The AGY/IGWDP villages were significantly more likely to practice *shramdan* in 1987. NWDPRA villages actually practiced significantly less *shramdan* than nonproject villages; the reasons for this finding are not known. NWDPRA, Jal Sandharan and NGO villages all had more communal diversity and more people of low caste than nonproject villages, and the latter is consistent with published guidelines. The AGY/IGWDP, on the other hand, had no significant differences from nonproject villages in communal diversity and low caste people. If the analysis is conducted using the AGY and IGWDP as the base category (not shown) the communal diversity and population of low caste people are significantly lower than other project categories. The IGWDP requires consensus-based decision making, which may be easier with communal homogeneity, and the two projects require a ban on open grazing and tree-cutting, which may be more difficult for poor, low caste people to accept because they rely on products from the commons for their livelihoods. NGO and Jal Sandharan villages were significantly less likely to contain government revenue land, possibly suggesting that these projects sought to operate in such villages to make their work easier. NWDPRA and AGY/IGWDP villages also were less likely to contain government revenue land, but the difference is not statistically significant.

NWDPRA villages were likely to have significantly fewer seasonal migrant workers, while AGY/IGWDP villages were likely to have significantly more. A higher number of migrant workers can be an indication of poor economic conditions locally. AGY/IGWDP villages are also significantly larger in area; the reason for this difference is not clear.

NWDPRA villages were likely to be more densely populated while others were likely to be less densely populated than nonproject villages, but this difference is significant only for the NWDPRA villages. This is consistent with the NWDPRA's published guidelines, which call for working in more accessible, visible villages. Again, this probably reflects a nonrandom selection process. NWDPRA villages are also closer to public health clinics and markets, though only the former is significant. NGO villages, on the other hand, were significantly likely to be located further from markets and the taluka headquarters, and AGY/IGWDP villages were significantly farther from the nearest public health office.

Finally, only Jal Sandharan/DPAP villages were more likely to have a drinking water shortage, consistent with the project's mandate, but the difference was not statistically significant.

6. NATURAL RESOURCE MANAGEMENT AND PRODUCTIVITY ON UNCULTIVATED LANDS

Most nonarable lands in the study region are managed either as government revenue land or Forest Department land. While the latter is managed by the Forest Department and access is heavily restricted (at least in principle), government revenue land is typically in a state of open access to all users. Protecting it requires village-level management institutions based on widespread commitment to improvement of this resource.

Watershed projects seek to develop nonarable lands for a variety of reasons. In projects oriented toward water harvesting, the ultimate reason is that nonarable lands are typically in the upper reaches of the watershed, which act as the catchment area for water harvesting structures downstream. If the upper reaches are poorly maintained, erosion will silt the water harvesting structures, rendering them useless. So developing and protecting nonarable lands is a prerequisite to the primary objective of raising the water table.

Developing nonarable lands also has direct benefits, particularly increasing the long-term availability of products such as fuel and fodder that historically were supplied by these lands. Soil and water conservation trenches are dug to concentrate water and soil, with trees and grasses planted in the trenches. In the early years after planting, the common lands must be strictly protected against grazing so that plants can establish. After that, they can supply a steady stream of fodder and fuel as long as grazing and harvesting are restricted.

The typical scenario on the common lands in rural India has been one of gradually declining productivity due to overexploitation, which in turn resulted from institutional arrangements that were inadequate to encourage people to protect and develop these lands (Singh 1997). Historically, management of common lands followed at least three different patterns (Gadgil and Guha 1992). In some places they were accessible to all, with insufficient pressure on resources to lead to severe degradation until the last several decades. In others, management was enforced by powerful landowners such as *zamindars*, who acted as "gatekeepers" to make sure that the common lands were not overexploited (Gadgil and Guha 1992; Bentley 1984). While this system was good for the condition of the land, it was inequitable, with benefits dominated by the landlords. In a third kind of situation, democratic village-level institutions resulted in sophisticated, equitable ways of sharing both rights and responsibilities for managing common lands (Agarwal and Narain 1989). Although this latter situation is sometimes presented as the historical norm in rural India, there is little evidence that it prevailed beyond a minority of villages. It is often said anecdotally, however, that such systems are still common in tribal areas.

WHAT THE PROJECTS DO

The idea behind most current watershed project efforts on common lands is to use a combination of technical and institutional means to move the supply of products such as fuel and fodder from a low-level equilibrium to a high-level one. In addition to installing soil and water conservation works and planting vegetation, most projects today seek to develop institutions for managing government lands based on principles of common property resource management. They typically encourage villagers to establish users' committees that are expected to develop and enforce management plans in a way that satisfies the needs of every interest group. In short, they try to create the kind of ideal, democratic arrangement mentioned above.

As described in Section 2, the AGY, IGWDP and NGO projects all devote relatively large efforts to social organization, and particularly to mechanisms to reduce pressure on common lands. The IGWDP and AGY, for example, only work in villages that promise to ban grazing and cutting trees. All of these projects also promote "social fencing," or social mechanisms to achieve protection of the common lands. Their efforts may include encouraging everyone to comply with restrictions on the commons, devising arrangements to guard them if necessary, etc. The NWDPRA and Jal Sandharan guidelines cover the same issues but in a more cursory way, and unlike the other agencies they do not make it a central component of their work. The fact that none of their staff members have any training related to social organization helps ensure this. The NWDPRA and Jal Sandharan may contract this part of the work out to NGOs, but only for a few weeks, after which social organization is expected to take care of itself.

An important feature of project investment on common lands is that it is entirely subsidized. Some projects require a 10% in kind contribution (in terms of donated labor), but this is more than offset by the fact that the projects pay above the market wage. At the very least, donating 10 percent of one's labor to gain a day of employment is a break-even proposition. The AGY and IGWDP, along with some NGOs, obtain a local contribution to developing the common lands through the practice of *shramdan*. Approximately 16% of the costs should be contributed through *shramdan,* with half the value returned in cash to a village development fund for maintaining watershed development infrastructure.

The indicators presented in this section help identify of the extent to which various types of watershed projects have succeeded in developing and protecting common lands. The section on common lands is divided into discussions of four sets of indicators. One type of indicator is the introduction of social fencing institutions to encourage protection of the commons, and the other three are rough measurements of natural resource conditions, including erosion and conservation status of the main drainage line, erosion status of nonarable lands, and changes in availability of fodder and fuel. The analysis of the condition of the drainage line covers the 64 Maharashtra villages that have a main drainage line, while the remaining analysis covers the 40 villages that contain government revenue land, since this is the common land over which villagers have the authority to manage as they please.

SOCIAL FENCING INSTITUTIONS

The most common social fencing institutions are bans on grazing and cutting trees. Many villages impose such bans in name, but whether or not they are adhered to may be another question. Investigators who stayed in each village for 2-4 days sought to distinguish whether grazing bans and tree cutting bans were active or just in name only.[16]

Table 15 lists the number and percentage of villages in each project category that had banned grazing, as well as the number that actually imposed penalties on offenders of rules against grazing and tree cutting. A traditional penalty against illicit grazing, for example, is to impound the grazing animals in the panchayat (village government) office and release them only upon payment of a fee. Panchayats or watershed user organizations keep records of such payments, so it is not difficult to identify whether or not such punishment systems were enforced in 1997.

The table shows the presence of grazing and tree cutting bans for both the pre-project period and the present. It shows that in both 1987 and 1997, banning grazing on the commons was the exception, not the rule. Only 5 out of 40 villages (12.5%) had banned grazing before the projects, rising to 35% after introduction of the projects. The respective numbers for imposing punishments for illicit grazing were even less, with 5% in 1987 and 22% in 1997. The numbers for punishing illicit cutting of trees are similar at 5% in 1987 and 20% in 1997. Two details in the table are particularly interesting. First, even some of the nonproject villages have imposed grazing bans; clearly this is not something that necessarily requires a watershed project. The second is that while none of the AGY and IGWDP villages had imposed bans or penalties in 1987, by 1997 50 percent of them had done so. They are the only category of villages with a statistically significantly higher percentage than the nonproject villages. At the same time, the 50 percent figure is low in comparison with these projects' target of universal compliance with bans on grazing and cutting trees.

No regression analysis is performed on the determinants of banning grazing and tree cutting, because so few villages actually imposed these restrictions.

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[16] For example, if a pasture is protected against grazing there should be no traces of cow dung on the ground.

Table 15: Number and (percentage) of villages with restrictions on access to common (government revenue) lands, by project category, 1987 (pre-project) and 1997 [a,b]

Type of restriction	NWDPRA	DPAP/Jal Sandharan	NGO	NGO/Govt collab.	No project	Total
Open grazing restricted, 1987	1 (17)	2 (20)	0 (0)	0 (0)	2 (17)	5 (13)
Open grazing restricted, 1997	2 (33)	4 (40)	1 (25)	4 (50)	3 (25)	14 (35)
Open grazing restriction introduced after project began	1 (17)	2 (20)	1 (25)	4 (50)	1 (8)	9 (23)
Punishment for open grazing, 1987	0 (0)	1 (10)	0 (0)	0 (0)	1 (8)	2 (5)
Punishment for open grazing, 1997	1 (17)	2 (20)	0 (0)	4 (50)	2 (17)	9 (23)
Punishment for open grazing introduced after project began	1 (17)	1 (10)	0 (0)	4 (50)	1 (8)	7 (18)
Punishment for cutting trees, 1987	1 (17)	1 (10)	0 (0)	0 (0)	0 (0)	2 (5)
Tree cutting restricted, 1997	1 (17)	2 (20)	1 (25)	4 (50)	0 (0)	8 (20)
Tree cutting restriction introduced after project began[c]	0 (0)	1 (10)	1 (25)	4 (50)	0 (0)	6 (15)

Notes: [a] This table is based on the 40 Maharashtra villages that had government revenue land both in 1987 and 1997.
[b] Figure in parentheses is percentage of category total. Category totals are NWDPRA: 6, Jal Sandharan: 10, NGO: 4, AGY/IGWDP: 8, No project: 12.
[c] Kruskall-Wallis test shows that differences across categories are significant for introduction of punishment for cutting trees (Chi-square = 11.1, 4 df, $p < 0.027$). Other differences are not statistically significant.

EROSION AND CONSERVATION STATUS OF THE MAIN DRAINAGE LINE

By definition, the main drainage line is where runoff water concentrates, so it is highly vulnerable to soil erosion. The drainage line is also usually on government land. As mentioned above, government land tends to be managed poorly compared to privately operated land, so the drainage line faces management challenges borne of both biophysical and social causes. (Out of the 64 villages, 40 have government revenue land and most of the remainder have Forest Department land.)

Field investigators trained in soil survey methods conducted a transect of the main drainage line in each village, making several visual observations of its condition and the extent of erosion on its banks. The transect was divided into segments of equal length (100 meters), and investigators made an assessment of its overall condition. This is determined by whether it appears to be under control and not expanding into adjoining fields; the extent and condition of bunds on the sides of the drainage line, and the extent of breaches in the sides of the drainage line. Each segment was assigned one of three possible scores for each of these characteristics: 3 for "good or high," 2 for "intermediate," and 1 for "poor or low." Overall scores for each village were then calculated by taking the simple average of all the segment scores. This visually-based scoring system was the best that could be achieved given the resources available to the project and the lack of existing data. While it is obviously subjective, the scores should be consistent across villages within each state because only two teams of people conducted the transects and the members rotated regularly in an effort to make sure they all used the same standards. Also, the 1 to 3 scale, while reducing the ability to make fine distinctions across observations, reduces the likely variation in scoring standards across data collection teams.

Drainage line transect scores are analyzed in both tabular and econometric form. First, average values of the drainage line scores are shown in Table 16.[17] This table shows that the kind of project operating in the village has a small but statistically significant effect on the drainage line, with AGY/IGWDP villages having the best average score and nonproject villages having the worst. (Note that even the best average score is only 2.00, indicating intermediate condition.) The same table shows stronger evidence that the duration of the watershed project and the percentage of the village covered by a project have a positive effect on the condition of the drainage line, regardless of the project category. This appears to suggest that some kind of watershed activity is better than none in determining the condition of the drainage line.

Drainage line scores are also analyzed through multivariate econometric analysis, which is used to identify village- and project-level factors that determine the drainage line scores. Each village's score represents the mean value of scores for all the 100-meter

[17] Strictly speaking, the scores are ordinal, not cardinal, but average scores are shown here for ease of presentation and interpretation. An average score of 2.00 means that average condition is intermediate; less than 2.00 means the average score is low, and greater than 2.00 means the average score is high.

segments of the drainage line, so the scores take continuous values ranging from 1 to 3. A Tobit model is appropriate in this case.

Table 16: Drainage line transect scores at the village level by project category and other factors

Village characteristic	Average score for condition of the drainage line[a]
All villages	1.70
Project category	
NWDPRA	1.78[b]
Jal Sandharan	1.60[b]
NGO	1.79[b]
AGY/IGWDP	2.00[b]
No project	1.40[b]
Total number of years under old and new watershed projects	
0 (no project)	1.40[c]
13 or less	1.60[c]
14 or 15	1.82[c]
Percentage of village covered by the project	
0 (no project)	1.40[d]
20-80	1.78[d]
100	1.78[d]

Notes: [a] Possible drainage line scores are 1, 2 and 3. Strictly speaking, they are ordinal categorical variables, not cardinal, but average scores are shown here for ease of presentation. An average score of 2.00 means that average condition is intermediate; less than 2.00 means the average score is low, and greater than 2.00 means the average score is high. The Kruskal-Wallis test for ordinal categorical variables shows that the following variables are significant at 10%:
[b] Overall condition of the drainage line varies significantly among project categories (chi-square = 8.7, 4 df).
[c] Overall condition of the drainage line varies significantly by number of years under old and new projects (chi-square = 8.0)
[d] Overall condition of the drainage line varies significantly by percentage of village covered by project (chi-square = 6.0, df =2)

Explanatory variables: 1987 variables are used in the model of determinants of the condition of the drainage line, since its stabilization through soil and water conservation measures is a long-term process. 1997 values would not be the correct explanatory variables to explain the effectiveness of conservation measures that took place prior to 1997. Agroclimatic variables include the village's altitude range, which is reflected in the course of the drainage line and determines susceptibility to erosion. Average annual rainfall also determines susceptibility to erosion, but it is highly correlated to altitude range (>.6), with more hilly areas having higher rainfall, so rainfall is omitted from the model.

Social institutions and characteristics include the number of different communal (caste and religious) groups in the village, the percentage of households in the village that derive their income primarily from herding sheep, and a dummy variable indicating whether the village contains government revenue land. It is hypothesized that a higher proportion of shepherds will bring increased resistance to protecting the commons and thus poorer condition of the drainage line. The practice of *shramdan* is excluded because it is highly correlated with the predicted probability that the AGY or IGWDP operates in the village. The presence of government land almost certainly indicates that the drainage line runs through common land, which is more difficult to manage.

Economic factors include infrastructure, such as the presence or absence of a paved road, distance in km to the nearest bus stop, distance in km to the taluka headquarters, population density (inhabitants per sq km), and the percentage of people in the village who earn most of their income from a source other than cultivation, livestock or agricultural labor. Population density, infrastructure and access to markets can increase the pressure on natural resources, but they can also raise the returns to better land management. Off-farm income also has an ambiguous effect; it can help finance land improvement or it can lead people to focus their interests elsewhere, making them less willing to participate in social action to develop the village's natural resources (Gebremedhin et al. 2000; Pender and Kerr 1998). Finally, as discussed above, the project inputs are represented by predicted values of the dummy variables for each project category and the average project expenditure per hectare in village as a whole.

Results: Table 17 presents the results for two cases, once in which the predicted project category is interacted with (multiplied by) the project expenditure per hectare, and

Table 17: Determinants of drainage line erosion status[a]

Interval regression

Variable	Coefficients in model 1[b]	Coefficients in model 2[c]
Whether the village contained government revenue land in 1987 (dummy)	0.42 (0.12)***	0.42 (0.11)***
Altitude range (‘000 meters)	-4.32 (8.03)	-5.85 (7.88)
Distance to nearest bus stop in 1987 (km)	0.04 (0.04)	0.04 (0.04)
Paved road in 1987 (dummy)	0.15 (0.12)	0.17 (0.12)
Population density in 1990 (‘00 persons/sq km)	0.06 (0.13)	0.07 (0.14)
Distance to taluka headquarters (‘0 km)	-0.06 (0.05)	-0.06 (0.06)
% inhabitants working primarily in nonagricultural sector	-0.01 (0.01)	-0.01 (0.01)
% inhabitants working primarily as shepherds	-0.07 (-0.04)*	-0.06 (0.04)*
Mean project expenditure per hectare (‘000 Rs)	0.06 (0.02)***	
NWDPRA	0.24 (0.20)	
DPAP/Jal Sandharan	0.007 (0.27)	
NGO	0.58 (0.40)	
AGY/IGWDP	0.67 (0.25)***	
Mean expenditure per ha in NWDPRA village (‘000 Rs)		0.10 (0.05)**
Mean expenditure per ha in DPAP/Jal Sandharan village		0.07 (0.04)
Mean expenditure per ha in NGO village		0.17 (0.06)***
Mean expenditure per ha in AGY/IGWDP village		0.27 (0.05)***

Notes: [a] 64 observations. Possible transect scores range from 1 to 3. Coefficients and standard errors are adjusted to account for sampling weights, stratification and finite population size. *, **, and *** indicate statistical significance at the 1%, 5% and 10% level, respectively. Predicted values based on the multinomial logit regression in Table 14 are used for the four project category variables. Standard errors are not adjusted for use of predicted values.
[b] Model 1: mean expenditure per hectare and project category are expressed as separate variables. $F(13,42)=6.64$ ($p>.0000$); $R^2 = 0.38$.
[c] Model 2: mean expenditure per hectare is expressed separately for each project category. $F(12,43)=6.20$ ($p>.0000$); $R^2 = 0.38$.

once in which these variables are specified separately. There are only 64 observations because 6 villages have no main drainage line. The models have highly significant F-statistics, but both R^2 values are about 0.38, so the extent of variation explained by the model is not high. When expenditure and project category are specified separately, expenditure per hectare is highly significant, but only the AGY-IGWDP project category variable is.[18] The dummy variable indicating the presence of government revenue land is positive and statistically significant, which was unexpected. The percentage of households earning their livelihoods as shepherds is negative and statistically significant, as expected. Most other variables have the expected sign but are insignificant. These include the percentage of people working outside of agriculture or livestock (-), distance to the taluka headquarters (-), population density (+), and existence of a paved road in 1987 (+). The latter three signs are consistent with the induced innovation hypothesis that better market access may raise the incentives to manage land better.

When the model is respecified so that project expenditure and the project category variables are interacted, all the project expenditure variables are positive, and all are statistically significant except the Jal Sandharan/DPAP, which is nearly significant. This lends support to the notion, expressed above, that all the projects are successful in improving the condition of the drainage line. The AGY-IGWDP category has a much higher coefficient than the other categories as well as a higher level of statistical significance, so these projects appear to perform the best. For every rupee spent by the AGY or IGWDP, the drainage line score rises by 0.27 on a scale from 1 to 3; for NGOs it is 0.17; and for government projects the increase is less than 0.10. Other significant variables remain the same as in the previous specification of the model. A very similar result is obtained with the use of actual project dummy variables, except with a smaller effect of each rupee spent (not presented).

EROSION OF UNCULTIVATED LANDS

Field investigators conducted a separate transect covering a route perpendicular to the main drainage line, designed to cover a representative tract of the village's area, with variations in soil types, slopes, and land use.[19] The route was selected based on discussions with the *sarpanch*, groups of farmers, and a soil map of the village where it was available.

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[18] Note that the standard errors have not been corrected for the use of predicted values of the project category.

[19] The straight line design of the field transect oversamples plots close to the center of the village relative to those at the periphery, which are more likely to be hilly and degraded.

The investigators delineated the transect route into separate segments whose boundaries were defined by changes in either land use (nonarable, rainfed, irrigated), land capability classification, or the extent of soil erosion and soil conservation measures.

This section examines the findings regarding the extent of soil erosion on uncultivated lands in the transect, which refers to visible signs of rills and gullies. This is a rough measure that cannot identify imperceptible sheet erosion processes, but it is sufficient to identify any form of rill or gully erosion. Inhabitants of the study villages accompanied the field investigators on the transect to tell them the tenure status of the land (private, Forest Department or government revenue). The transect scoring system is the same as in the drainage line transect, with 1=low erosion, 2=medium, and 3=high erosion. The score was recorded for each segment along with the length of the segment. Weighted averages of the erosion score for each segment can then be summed to give aggregate village-level scores, which can be expressed either as an overall score for the entire village, or as separate scores for different land uses and different land capability classifications.

As shown in Table 18, the mean transect scores for uncultivated land show no significant differences across project categories; nor are any other village characteristics significantly associated with the erosion score in this bivariate tabular analysis. In fact the scores are marginally better in nonproject villages than they are for each of the other categories. One possible explanation for this is that nonproject villages are flatter than project villages and so less susceptible to erosion. A related interpretation would be if the project villages were intentionally selected because they had the most problems, so that nonproject villages are in the best condition today because they were in the best condition when the projects began.

Table 18: Erosion scores for uncultivated land from the village transect, by project category[a,b]

Project category	Erosion score
All villages	2.29
NWDPRA	2.41
Jal Sandharan	2.32
NGO	2.25
AGY/IGWDP	2.37
No project	2.15

Notes: [a] Possible transect scores are 1, 2 and 3. Strictly speaking, they are ordinal variables, not cardinal, but the average scores are shown here for ease of presentation. An average score of 2.00 means average condition is intermediate; less than 2.00 means the average score is low, and greater than 2.00 means the average score is high.
[b] Kruskal-Wallis ordinal variables test shows no significant difference between project categories or any other village characteristics

Econometric analysis is required to gain a more detailed understanding of the determinants of soil erosion on uncultivated land. The unit of observation for the econometric analysis is the transect segment rather than the village level average; this allows controlling for land tenure status. The model specification accounts for the fact that observations "clustered" within villages are not independent of each other (Stata 1999). An ordinal probit model is used because the transect scores are ordinal values of 1, 2 or 3. The observations are not weighted by segment length because that would prohibit weighting them for sampling weights and clustering.[20]

The variables used in the analysis are nearly the same as in that for the determinants of the drainage line scores. One additional variable that was not applicable in the analysis of drainage lines is the ownership status of the segment of land in question; a dummy variable indicates whether land is private or common (government revenue or Forest Department land).

Table 19 displays the regression results. As in the drainage line analysis, the analysis is conducted twice, once in which the project category variables are specified

[20] When the analysis was conducted without accounting for the survey data, there was practically no difference in the analysis when weighted or unweighted by segment length.

separately from the funds invested per acre, and once in which they are interacted. When they are specified separately, all the project category variables have a negative coefficient, indicating that the extent of erosion is reduced. The coefficient is significant only for the NGO category, but it is nearly significant for the AGY/IGWDP category.[21] This is consistent with the finding that these projects are more successful than others in protecting the common lands, and also that many of the villages where NGOs operate have no common land. Expenditure per hectare is statistically significant, suggesting that the specific project category may be less important than the fact that at least some kind of investment takes place. The only other significant variable is population density; higher density indicates lower erosion, which is consistent with the induced innovation hypothesis that land will be better managed when it is more scarce. Infrastructure variables are insignificant. Neither the property rights status of the plot nor the number of shepherds in the village is significant, but both are nearly so and both have the expected sign.

The results are similar when the predicted project category and expenditure per hectare are interacted. In this case expenditure under any project reduces erosion, but it is only statistically significant for the NGOs, the AGY-IGWDP, and the DPAP. It is nearly significant for the NWDPRA. The NGO and AGY-IGWDP coefficients have a much greater magnitude than those of the other projects.

The use of actual project dummy variables (not shown) yields very similar results. All project categories have statistically significant coefficients, but the degree of significance and the magnitude of the coefficient is higher for NGOs and the AGY-IGWDP.

[21] The standard errors are not corrected for the use of predicted project categories.

Table 19: Transect scores: erosion status of uncultivated lands[a]

Ordered probit regression

Variable	Coefficients in model 1[c]	Coefficients in model 2[c]
Altitude range (‘000 meters)	0.23	0.33
	(1.44)	(1.40)
Distance to nearest bus stop in 1987 (km)	0.00	-0.02
	(0.05)	(0.05)
Paved road in 1987 (dummy)	0.36	0.31
	(0.33)	(0.33)
Population density in 1990 (‘00 persons/sq km)	-0.65	-0.66
	(0.22)***	(0.21)***
Distance to taluka headquarters (‘0 km)	0.05	0.04
	(0.10)	(0.09)
% inhabitants working primarily in nonagricultural sector	0.005	0.008
	(0.016)	(0.017)
% inhabitants working primarily as shepherds	0.06	0.04
	(0.05)	(0.05)
Whether the land is operated privately (dummy)	-0.59	-0.57
	(0.36)	(0.36)
Mean project expenditure per hectare (‘000 Rs)	-0.17	
	(0.06)***	
NWDPRA	-0.41	
	(0.78)	
DPAP/Jal Sandharan	-0.34	
	(0.46)	
NGO	-1.91	
	(0.75)**	
AGY/IGWDP	-1.18	
	(.72)	
Mean expenditure per ha in NWDPRA village (‘000 Rs)		-0.20
		(0.14)
Mean expenditure per ha in DPAP/Jal Sandharan village		-0.20
		(0.07)***
Mean expenditure per ha in NGO village		-0.35
		(0.17)**
Mean expenditure per ha in AGY / IGWDP village		-0.45
		(0.13)***

Notes: [a] 174 observations from 70 villages. Possible transect scores are 1, 2 and 3. Coefficients and standard errors are adjusted to account for sampling weights and stratification. *, **, and *** indicate statistical significance at the 1%, 5% and 10% level, respectively. Predicted values based on the multinomial logit regression in Table 14 are used for the four project category variables. Standard errors are not adjusted for use of predicted values.
[b] Model 1: mean expenditure per hectare and project category are expressed as separate variables. F(13,42)=3.56, p>.001.
[c] Model 2: mean expenditure per hectare is expressed separately for each project category. F(13,42)=3.45, p >.002.

Change in Availability of Fuel and Fodder from the Common (Government Revenue) Lands

Information on products collected from the common lands was obtained as part of the village-level survey. Respondents were asked in groups about what kinds of products were available today, what kinds were available in 1987, and whether and in which direction the quantity had changed between 1987 and 1997. The questions covered grass fodder, tree fodder, fuel, timber, and building materials, and respondents mentioned several other products. However, only grass fodder, tree fodder and fuel were found in more than a few villages, so the analysis presented here is restricted to those commodities. The mean values of responses by project category are presented in Table 20; it covers only the subset of 40 Maharashtra villages that had government revenue land in both 1987 and 1997.

The table shows no significant differences across project categories or any other village characteristics. For grass fodder, most villages reported that there was less available in 1997 than 1987, and this was the case for all project categories except NGOs, which had closer to the same amount in both years. For tree fodder and fuel, most villages reported having the same amount in both years, but more villages reported a decline than an increase. It appears that the watershed projects have had difficulty in raising availability of these products on the government revenue lands.

Econometric analysis is needed for more thorough examination of the determinants of changes in access to products of the commons. Ordered probit models are used to analyze the determinants of whether a village has more, less or the same amount of grass fodder available from the government revenue lands. The explanatory variables are the same as in the analysis of the condition of the drainage line, with the addition of a dummy variable indicating whether or not grass fodder was available in 1987. As in the earlier analyses, the model is run both with the predicted project category variables expressed separately from the expenditure per hectare, and with them interacted.

Table 21 shows that the projects have led to reduced access to grass fodder compared to nonproject villages. The variables for expenditure per hectare and the AGY/IGWDP and Jal Sandharan/DPAP project categories have negative, statistically significant signs. Where the expenditure and project category variables are interacted, the AGY/IGWDP and DPAP variables remain significantly negative, while the other project categories are insignificant.[22] The AGY-IGWDP coefficient also has a much higher magnitude.

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[22] The standard errors are not corrected for the use of predicted project categories.

Table 20: Village-level change in availability of various products from common revenue lands between 1987 and 1997, by project category[a,b]

Project category	Number of villages	% villages with different directions of change in availability of grass fodder			% villages with different directions of change in availability of tree fodder			% villages with different directions of change in availability of fuel		
		More	Same	Less	More	Same	Less	More	Same	Less
All villages	40	20	27.5	52.5	7.5	62.5	33.3	5	60	35
NWDPRA	6	16.7	16.7	66.7	16.7	50	33.3	10	60	30
Jalsandharan	10	30	10	60	20	60	20	0	50	50
NGO	4	25	50	25	0	50	50	12.5	50	37.5
AGY/IGWDP	8	25	37.5	37.5	0	62.5	37.5	0	75	25
No project	12	8.3	33.3	58.3	0	75	25	5	60	35

Notes: [a] This analysis covers only those villages in the sample that had common revenue land in both 1987 and 1997. The number of villages in each project category is as follows: NWDPRA: 6/10, DPAP: 10/17, NGO: 4/12, AGY/IGWDP: 8/14, no project: 12/17.
[b] Kruskal-Wallis test for ordinal variables was conducted to identify variables significantly associated with changes in fuel and fodder supply. The tests show that fuel and fodder supply do not vary significantly across project categories or any other village-level characteristics.

Table 21: Econometric analysis of determinants of change in availability of grass fodder and fuel on government revenue lands[a]

Ordered probit regression

Variable	Grass fodder		Fuel	
	Model 1[b]	Model 2[c]	Model 1[b]	Model 2[c]
Availability of grass fodder (fuel) in 1987	2.13 (0.64)***	2.09 (0.61)***	1.92 (0.55)***	1.46 (0.83)*
Altitude range (‘00 meters)	3.76 (1.26)***	3.71 (0.96)***	0.04 (0.01)***	0.02 (0.11)**
Distance to nearest bus stop in 1987 (km)	0.34 (0.16)	0.53 (0.19)***	-0.10 (0.17)	-0.08 (0.15)
Paved road in 1987 (dummy)	0.75 (0.56)	0.92 (0.66)	-0.40 (0.51)	-0.36 (0.42)
Population density in 1990 (‘00 persons/sq km)	-0.75 (0.23)***	-1.06 (0.51)**	-0.64 (0.41)	-0.36 (0.21)*
Distance to taluka headquarters (‘0 km)	0.05 (0.04)	0.33 (0.33)	-0.06 (0.04)*	-0.06 (0.02)*
% inhabitants working primarily in nonagricultural sector	0.11 (0.03)***	0.10 (0.04)**	0.04 (0.03)	0.04 (0.02)**
% inhabitants working primarily as shepherds	0.69 (0.19)***	0.62 (0.17)***	0.13 (0.18)	0.12 (0.13)
Mean project expenditure per hectare (‘000 Rs)	-0.43 (0.17)**		-0.71 (0.37)*	
NWDPRA	0.90 (2.70)		7.56 (2.80)**	
DPAP/Jal Sandharan	-2.40 (1.41)*		5.15 (1.6)***	
NGO	7.95 (12.75)		7.75 (6.62)	
AGY/IGWDP	-5.23 (2.06)**		2.26 (2.41)	
Mean expenditure per ha in NWDPRA village (‘000 Rs)		0.06 (0.60)		0.60 (0.36)
Mean expenditure per ha in DPAP/Jal Sandharan village		-0.89 (0.31)***		0.32 (0.16)**
Mean expenditure per ha in NGO village		1.35 (2.29)		-0.71 (1.39)
Mean expenditure per ha in AGY/IGWDP village		-2.04 (0.38)***		-0.33 (0.31)

Notes: [a] 40 observations. Possible transect scores range from 1 to 3. Coefficients and standard errors are adjusted to account for sampling weights, stratification, and finite population size. *, **, and *** indicate statistical significance at the 1%, 5% and 10% level, respectively. Predicted values based on the multinomial logit regression in Table 14 are used for the four project category variables. Standard errors are not adjusted for use of predicted values.
[b] Model 1: mean expenditure per hectare and project category are expressed as separate variables.
[c] Model 2: mean expenditure per hectare is expressed separately for each project category. F-statistics: Fodder: F(13,19)=6.27 (Model 1); F(13,19) = 6.88 (Model 2); Fuel: F(13,19)=2.94, p>0.02 (Model 1); F(13,19) = 2.06, p > 0.08.

This finding is consistent with those presented above showing that the AGY and IGWDP are particularly successful in restricting access to common lands and reducing erosion in the drainage line and pasture lands. Improving the condition of these lands requires restricting access to them, and Table 21 suggests that access is in fact still restricted. Several other variables are significant as well. Population density has a negative sign, while the variables with positive signs include availability of grass fodder in 1987, altitude range, distance to the nearest bus stop in 1987, percentage of households working primarily outside of agriculture, and percentage of households working primarily as shepherds. The highly significant, strongly positive coefficient for shepherds is again consistent with the finding that it was more difficult to reduce erosion in the villages with the most shepherds, presumably because access restrictions were difficult to enforce. The positive sign for altitude range may reflect high rainfall, which is omitted because it is highly correlated with altitude range. High rainfall stimulates rapid growth of natural vegetation, so it may be that access restrictions can be less strict in these villages. The negative sign for population density either means that availability of fodder has declined due to population pressure, or that more densely populated villages were more likely to impose access restrictions. The positive sign for the percentage of households working outside of agriculture means either that this caused less competition for fodder, or that there was less pressure to impose restrictions in these villages.

When actual project dummy variables are used (not shown), the result is very similar when the project dummies and expenditure per hectare are interacted. When they are not interacted, all of the project variables have positive signs but none are significant (while expenditure per hectare is negative and statistically significant).

Table 21 also shows the determinants of changes in availability of fuel from government revenue lands. Most of variables have the same signs as in the model for changes in grass fodder, and most of the same variables are significant. One notable difference is that the NDWPRA and DPAP project categories have significantly greater availability of fuel than the nonproject villages, while the AGY/IGWDP villages have less. The finding for the AGY and IGWDP is consistent with that for grass fodder, while that for the government projects could signify that they succeeded in planting trees and getting them established, but then did not enforce their protection. It is important to note that these results are not duplicated when actual project dummies are used; in that case the NWDPRA coefficient is insignificant and all the others are negative.

The results for tree fodder are similar to those for fuel, which is not surprising since trees are the main source of fuel. These results are not shown.

The strong finding of reduced availability of fodder from the common lands deserves more detailed investigation, as does that for reduced fuel in the AGY/IGWDP project category. Findings from qualitative investigations provide further insight into this issue. In particular, women and livestock herders in many project villages complained in group interviews that they had suffered from loss of access to common lands sealed off to promote regeneration.

Herders: Livestock herders in many project villages complained in group interviews that they had suffered from loss of access to their traditional grazing lands, which were sealed off to promote regeneration. All of the projects had provided employment opportunities to the herders, but they said it was not enough to compensate their loss. This problem commonly arose in Maharashtra, where landless, low caste people are a small minority in most villages and the decision to close the common lands was usually based on a majority-rule vote. In the IGWDP villages the decision to begin the project is based on consensus, but some landless people stressed in the group interviews that it was not feasible for them to stand up to the will of a more powerful majority.

In some villages herders said that they had been promised that access restrictions would be temporary while vegetation was allowed to regenerate. However, they complained that regeneration had already taken place yet the common lands remained off-limits to them. As mentioned above, such inequity is more likely to be a problem where projects succeed in productivity and environmental objectives. In other places, herders were able to ignore grazing restrictions, protecting their immediate livelihoods but undermining project objectives. These findings from qualitative discussions are consistent with the result in the quantitative analysis that a high population of shepherds raised the extent of erosion but also raised access to grass fodder, compared to other villages. To reiterate, this does not necessarily mean that these villages are more productive, just that grass fodder from the commons was more readily available at the time of the survey, possibly due to lack of restrictions.

Additional data from open-ended questions at the household level support these findings. Table 22 shows that in 13 Maharashtra villages, respondents' perception that they had benefitted from the projects rose with land holding size. Table 23 shows that landless people were much more likely to indicate that the project had harmed their interests; among landless people the unanimous complaint was lost access to common lands.

As revealed in Section 5, NGOs and the Jal Sandharan project in Maharashtra appear to have dealt with this problem by selecting many villages that have no government revenue land, thus avoiding the issue. Obviously this approach provides no lessons about how to address the problem in the majority of villages that do have government revenue land, but it may be an intelligent approach for agencies with limited budgets that can only operate in a limited area.

Table 22: Percentage of respondents in Maharashtra who say they benefited from the watershed project, by project category and landholding size[a]

		Landholding size category			
Project category	All respondents	Landless	0-1 ha	1-2 ha	> 2 ha
All projects	26	12	19	26	45
NWDPRA	8	0	17	0	17
JS/DPAP	17	0	0	33	20
NGO	39	29	44	25	63
AGY/IGWDP	31	14	0	33	60

Notes: [a] Findings based on household survey; 120 respondents in Maharashtra.

Table 23: Percentage of respondents in Maharashtra who say they were harmed by the watershed project, by project category and landholding size[a]

		Landholding size category			
Project category	All respondents	Landless	0-1 ha	1-2 ha	> 2 ha
All projects	11	19	8	10	7
NWDPRA	4	0	17	0	0
JS	13	33	0	11	0
NGOs	8	14	0	8	13
AGY/IGWDP	17	29	14	17	10

Notes: [a] Findings based on household survey; 120 respondents in Maharashtra.

On the other hand, a few NGOs, such as Chaitanya and MYRADA in Andhra Pradesh, have explicitly aimed to develop innovative solutions to the problem of managing common lands. They try to try to build the interests of different groups into the project design at the outset. For example, in some projects landless people are granted fishing rights in the water bodies protected by soil conservation and revegetation of the common lands. Unlike in Maharashtra, landless and near-landless respondents in Andhra Pradesh unanimously reported having benefitted from NGO projects.

Social Centre, a Maharashtra NGO, grants fishing rights to landless people in some villages including Mendhwan, covered under the current study (WOTR 1999). Some projects encourage farmers without irrigation to dig group-owned wells so that they have an interest in promoting groundwater recharge. Outside of the study area in the famous Sukhomajri and Pani Panchayat projects, landless people even own rights to water for tank or lift irrigation, which they utilize by leasing in farmland or, in the case of Sukhomajri, sell to other farmers (Chopra et al. 1990; Patel-Weynand 1997). And in several Andhra Pradesh villages not covered by any kind of project, shepherds lease cultivated land and manage it as pasture. Such an arrangement could be made in a watershed project: if shepherds had exclusive rights to grazing lands they would have an incentive to invest in raising their productivity, and this would likely include reduced grazing pressure and thus reduced erosion. A wide assortment of such arrangements can be devised to spread the benefits of watershed development and, as a consequence, increase its chances of success.

Finally, watershed agencies argue that if their work is successful, landless people will benefit in the long term. In the famous Adgaon watershed, annual employment rose from 75 days to 200 days, and laborers' incomes rose above those of small farmers according to an NGO involved in the project (WOTR 1999). Social Centre found that after 4 years of watershed management, laborers in Mendhwan village could find eight months of employment whereas previously they could only find three months. In Sherikoldara, landowners began to lease land to laborers rather than pay the high wage costs (WOTR 1999).

Respondents in this study were asked whether they obtain more, less or the same number of employment days than before the project period. No distinction was made between short-term work generated as part of the project and long-term changes in demand for labor. Table 24 shows that respondents in the AGY-IGWDP and NGO project villages indicated with much greater frequency that employment opportunities had risen, whereas those under the NWDPRA, the DPAP-Jal Sandharan, and in nonproject villages indicated that employment had declined.

Table 24: Reported changes in number of days of employment between 1987 and 1997, by project category[a,b]

	% of respondents indicating more, less or same access to employment		
Project category	More	Same	Less
All villages	33	61	6
NWDPRA	9	91	0
Jalsandharan	29	65	6
NGO	43	47	10
AGY/IGWDP	72	17	11
No project	18	78	4

Notes: [a] Findings from household-level interviews; n = 85. 35 respondents who do not engage in wage labor did not respond.
[b] Kruskal-Wallis test for ordinal variables shows that change in number of employment days varies significantly across project categories (Chi-square = 13.6, 4 df, p < .01)

Women:[23] Project officials rarely understood that watershed projects can increase women's workloads. This happens for two reasons. First, if a project succeeds in raising agricultural production, women will have to devote more labor to various cultivation operations. Second, restrictions on collecting fodder and fuelwood from common lands forces women to collect these resources elsewhere, increasing the time they must allocate to these tasks.

[23] This section on women and watershed projects draws on Pangare (1998).

Women had little opportunity to voice their concerns about watershed projects. Guidelines for all projects contain language about promoting women's welfare, but in practice virtually no projects created a role for women or addressed their interests. For example, in about half the villages surveyed the actual watershed committees had no women members, and most of the remainder had only one or, occasionally, two. In every case a lone woman committee member proved to be a token to fill a bureaucratic requirement. This is not surprising, as an individual woman on a male-dominated committee in rural India will always find it difficult to make her voice heard. Moreover, women are a heterogeneous group whose diverse interests cannot normally be represented by just one or two women.

Just as some projects have taken innovative steps to incorporate the interests of landless people and herders and give them a role in project management, all projects can do the same for women. A few simple steps that can be easily adopted are to ensure that women attend all project meetings (in part by scheduling meetings at times when women are available to attend), give them 50% representation in project committees, listen to them to find out their interests and concerns, identify the contributions they can make, and train them in various watershed activities, among other things. The findings regarding project impacts on women and recommendations for improvement are presented in more detail in Pangare (1998).

7. PROMOTING IRRIGATION DEVELOPMENT

Raising the water table to promote irrigation development is a primary objective of most watershed projects operating in Maharashtra, and a secondary objective of those in Andhra Pradesh. The projects achieve this through soil and water conservation (SWC) and revegetation measures that encourage rainwater to infiltrate into the soil, gradually augmenting groundwater. Primary among the SWC investments are large structures placed in the main drainage lines that impound water; they range from small "gully checks" to major structures such as percolation tanks or check dams. Outside of the drainage line, projects dig contour trenches along uncultivated hillsides.

This section examines the projects' impacts in promoting irrigation development. Data limitations concerning the irrigation potential of each village make it impossible to estimate precisely the contribution of the watershed projects in promoting irrigation, so the analysis relies on several sources of information. It begins with a presentation of changes over time in the mean irrigated area in the villages under each project category, and the change in the number of seasons irrigated on the plots sampled in the study. Econometric modeling to identify the determinants of these changes did not yield any insight, so findings from qualitative investigations are presented to gain additional information.

CHANGES IN IRRIGATION

It is important to acknowledge weaknesses in the data used in this analysis: not all of the numerous factors that determine irrigated area could be incorporated into this analysis. In particular, the hard rock aquifers of the Deccan Plateau are known for high spatial variation in irrigation potential. In some villages—or in some areas within some villages—the potential for raising irrigated area is quite favorable, but in others it is minimal. Unfortunately no data are available on the nature of aquifers in each village.

Changes in Irrigated Area at the Village Level

At the village level, the relevant measure of increased irrigation is the change between 1987 and 1997 in the percentage of cultivated area that is irrigated.[24] This information is recorded each year for every village and stored at the taluka headquarters. Table 25 shows that in 1987, prior to the introduction of the current projects, NWDPRA villages had by far the highest area irrigated. This is consistent with their higher level of infrastructure, such as electricity to power irrigation pumps and access to markets to sell irrigated produce. The table also shows that during the period under study, nonproject

[24] Virtually all arable land was under cultivation by 1987, the total area under cultivation was roughly constant between 1987 and 1997.

villages actually enjoyed the highest average increase in percent area irrigated, more than doubling their 1987 level by 1997. This may be due to the fact that the nonproject villages had relatively good infrastructure but relatively undeveloped irrigation in 1987. They are relatively flat and half of them are in the lower and middle part of the macrowatershed; these characteristics are more likely to be associated with a higher water table.

Table 25: Average change in village-level percent irrigated area, by project category

Project category	% area irrigated, 1987	% area brought under irrigation, 1987-1997	% increase in irrigated area, 1987-1997
All villages	12.9	7.1	55
NWDPRA	23.7	5.2	22
Jal Sandharan	12.9	4.8	37
NGO	8.5	4.0	47
AGY/IGWDP	16.0	8.6	54
No project	10.5	10.9	104

Note: Analysis of variance shows no significant difference between project categories or any other village characteristics.

AGY/IGWDP villages are the only other category with above-average increase in irrigated area; with 50% more irrigated area in 1997 than 1987. This probably reflects strong improvements in infrastructure in these villages during the period, including electricity to power irrigation pumps. NWDPRA villages began the study period with the highest level of irrigation, so they may have had less room for further expansion. Also, the NWDPRA places less emphasis on irrigation development than the other projects as is made clear by the exclusion of large water harvesting structures from its portfolio of project activities. Villages under Jal Sandharan, which focuses especially on water harvesting, had a particularly low increase in irrigated area. However, this might indicate that the Jal Sandharan works in the most water-scarce areas.

Changes in Cropping Intensity through Increased Irrigation

Plot-level data provide more disaggregated information about irrigation development. In particular, data on changes in cropping intensity give additional detail regarding more subtle changes in irrigated area. For example, a plot that was irrigated for one season in 1987 may be irrigated for two seasons in 1997, but the village level data on gross irrigated area would not show the change.

The indicator for increased cropping intensity measures the change in the number of seasons irrigated for each plot in the sample. For example, if a plot was rainfed in 1987 but irrigated two seasons in 1997, its score is +2. This information is collected through the recall of the plot’s owner.

Table 26 shows the average change in cropping intensity by state and project category. Irrigation intensity increased much more in Maharashtra than Andhra Pradesh, with a mean increase of 0.35 in Maharashtra compared to 0.20 in Andhra Pradesh. The difference across project categories is significant only in Andhra Pradesh, where plots under the World Bank project had the highest increase in cropping intensity. In Maharashtra, plots under the AGY/IGWDP had the highest irrigation increase, but this difference was not statistically significant. As in the Maharashtra village level data, nonproject villages had a higher mean increase in cropping intensity than most projects.

Table 26: Mean increase in number of seasons irrigated 1987-1997, by project category

Plot characteristic	Mean increase in seasons irrigated	
All plots	Maharashtra	Andhra Pradesh
	.35	.20
Project category		
NWDPRA	.37	.10
DPAP or JS	.33	.00
NGO	.25	.11
AGY or I-G	.44	n.a.
World Bank or ICAR	n.a.	.49
No project	.25	.21

Note: Kruskal-Wallis test shows that differences across project categories are statistically insignificant.

Multivariate analysis is needed to gain more detailed information about the determinants of increases in irrigation development. Unfortunately, analysis at both the village and plot levels failed to reveal any additional information; this is due almost certainly to the lack of data on such important confounding variables as the nature of the aquifer. Regression findings are not presented here due to their inability to provide additional insight.

RESPONDENTS' PERCEPTIONS OF PROJECTS' EFFECTS ON IRRIGATION DEVELOPMENT

Qualitative discussions revealed that respondents are keenly aware that water-harvesting structures in the drainage line can raise the groundwater level, thus promoting irrigation development. In several villages they indicated that water levels in open wells had risen visibly following the construction of water harvesting structures. In several of the Maharashtra villages, respondents indicated that low rainfall in recent years made it difficult to discern the effectiveness of water harvesting. And in some villages, respondents reported that certain water harvesting structures leaked water, making them ineffective.

As mentioned above, all of the Maharashtra projects focused on water harvesting, whereas in Andhra Pradesh the World Bank, ICAR and NWDPRA devoted only minimal attention to it. Only the DPAP focused primarily on water harvesting, and two of the three NGO projects also included water harvesting as a major project activity. In Andhra Pradesh, group discussions with owners of irrigated land revealed a good impression of the DPAP's efforts in this regard.

Discussions in both states revealed a keen sense among farmers of the types of structures that could promote water harvesting. For example, the DPAP and Jal Sandharan, for which water harvesting was the main project objective, had large budgets for gully structures and they built the largest and most solid, impermeable structures. The NWDPRA and World Bank projects, on the other hand, were not designed with water harvesting in mind and so they budgeted much smaller amounts for mainly vegetative or loose stone structures. Respondents were keenly aware of these differences, especially in Maharashtra where they could compare the NWDPRA gully structures with those built under COWDEP in the 1980s. They did not perceive that the NWDPRA's work had much impact.

A similar issue arose among NGOs. As discussed in Section 5, projects vary in the number of technically trained people on their staff. Some NGOs, like Chaitanya, employ no technically trained staff and focus exclusively on social organization, relying on indigenous technical knowledge in the design of their watershed interventions. Some other NGOs, like MYRADA, employ engineers to oversee the technical work. Similar differences are found in Maharashtra. Not surprisingly, respondents reported better water-harvesting impact where projects employed technical experts. In the Chaitanya village, for example, the water harvesting structure was not effective because it leaked. Such a finding underscores the philosophy behind the AGY and IGWDP, which sought to combine the technical expertise of government agencies with the social organization skills of NGOs.

In a semi-structured interview as part of the household survey, respondents were asked to list the kinds of benefits they perceived from the project operating in their village. Table 27 shows the number of respondents who mentioned irrigation benefits and displays this as a percentage of 1) the total number of respondents, 2) the number of respondents who are farmers, and 3) the number who are farmers with irrigation. In fact all of those who reported benefitting had irrigation. They are best suited to explain whether they thought project activities had helped raise the water table. Figures in the table show that a much higher percentage of respondents perceived benefits in Maharashtra than Andhra Pradesh, and this is consistent with project objectives in the two states. In Maharashtra only the NWDPRA had low reported benefits among irrigated farmers, and this is consistent with that project's lack of focus on water harvesting; they are highest for the AGY and IGWDP. In Andhra Pradesh, perceived irrigation benefits are very low for all projects.

Table 27: Number and percentage of respondents reporting that water-harvesting investments improved their access to irrigation

	State	All respondents	Farmers	Farmers with irrigation
Maharashtra	21	18	23	46
NWDPRA	2	8	11	13
DPAP	3	13	17	50
NGO	6	17	21	60
AGY-IGWDP	10	28	37	71
Andhra Pradesh	9	6	8	13
NWDPRA	2	6	8	22
DPAP	3	8	11	18
NGO	2	6	7	9
World Bank / ICAR	2	4	5	11

One obvious point in the table is that perceived benefits from irrigation are highly concentrated among farmers with access to irrigated land. There are also indirect benefits, such as higher employment demand, that respondents did not refer to. In any case, the skewed distribution of the most valuable project benefits to those who already have the most prized asset (irrigated land) is a source of concern to many project officials and other commentators. There has been much discussion of what can be done to distribute project benefits more evenly. For example, as mentioned in Section 6, in some projects outside the current study area all village inhabitants share equally in water resources generated by the project. No project in this study undertook such ambitious steps, but some of them did try to help spread the benefits of irrigation. In particular, the IGWDP agreed to take up work only in villages that agreed not to drill any borewells, which draw more water than traditional open wells and would appropriate harvested water disproportionately. For similar reasons, the IGWDP also insists that no farmers may take up water-intensive crops such as sugarcane in response to higher water supplies. Sugarcane farmers would draw more water from their wells, reducing the water level in other wells. Also, farmers with excess water might choose to sell it to their neighbors if they cannot grow water-intensive crops. A few other NGOs mentioned similar restrictions, but most did not. None of the government projects tried to impose any such restrictions.

Another approach to sharing the benefits of water harvesting is to help resource-poor farmers invest in their own wells. India has quite a bit of experience in this regard; a centrally sponsored program, for example, digs individual private wells for landless, low caste farmers. Some projects have invested in group owned wells, but the most common experience was that groups had difficulty in working together to manage and maintain their wells cooperatively. This matches the experience of state-owned cooperative tubewells (Shah 1993). In the villages in this study, there were numerous cases of group-owned wells, but in nearly every case they were jointly owned by brothers who inherited the well from their father. There was one recorded case of some neighbors (not relatives) who jointly invested their own funds in a well, but within a few years a dispute emerged and the case ended up in court. Against this backdrop, most projects are hesitant to invest in group wells. In the current study, only one NGO, Gramayan, invested funds in a group-owned well. According to respondents it is managed effectively.

8. NATURAL RESOURCE MANAGEMENT AND PRODUCTIVITY OF RAINFED AGRICULTURAL LAND

As introduced in Section 2, raising the productivity of rainfed agriculture is the most important objective for some watershed projects, particularly the NWDPRA, the ICAR model watersheds, and the World Bank's Pilot Project and IWDP (Plains). It is particularly important where opportunities for water harvesting are limited, as with many Andhra Pradesh project locations. The watershed approach to raising the productivity of rainfed agriculture begins with conserving soil on rainfed plots, which also implies retaining soil nutrients and concentrating moisture. This in turn creates opportunities for planting high yielding varieties that require more water and nutrients, or, in some areas with black soils and high rainfall, may enable farmers to harvest an additional crop each year.

This section examines the experience of the projects in promoting rainfed agricultural development. Following a review of projects' subsidy policies for developing private land, it investigates the nature and extent of interaction between project staff and farmers, since technical assistance for rainfed agriculture presumably involves working closely with farmers. It then focuses on efforts to conserve soil and moisture, both through improved agronomic methods and investment in soil conservation structures. Analysis of rainfed farmers' adoption of new varieties and their net returns to cultivation follows. Because of the focus on rainfed agriculture, the quantitative analysis focuses on plots that were unirrigated in 1987 and 1997.

PROJECT SUBSIDIES TO PARTICIPANTS UNDER EACH PROJECT

Subsidies are a contentious and increasingly complex issue in watershed projects. Approaches have evolved over time, with significant trial and error. In the early days of the Bombay Land Improvement Scheme, bunds were installed on some farmers' fields without their consent, yet they were expected to repay the bank for the cost of the work undertaken. They were listed as defaulters if they refused (World Bank 1988).

In some watershed projects, the opposite approach is taken today; with watershed works being heavily subsidized and no thought given to cost recovery. The rationale for this approach is that farmers who benefit from canal irrigation did not have to pay for the canal, so why should rainfed farmers who benefit (much less) from watershed projects have to pay for the works undertaken? This argument is really a matter of opinion, but it matters because rainfed farmers often are not interested in the measures introduced under watershed projects and have no intention to maintain them once the project ends (Kerr et al. 1996; Sanders et al. 1999). Under these circumstances, it is important to require some kind of payment or other sacrifice by "beneficiaries" simply to make sure that they really want the work and are likely to maintain the assets created. Otherwise the project will simply be a waste of money. (This problem does not arise in irrigation projects, because there was never a farmer in India who did not want irrigation!)

There are two main reasons why farmers would allow measures to be taken on their land that they do not really want. The first is that some projects install structures on farmers' plots without their consent, although this practice is diminishing. Watershed officials increasingly appreciate the fact that a structure built in one location can generate on-site costs but only downstream benefits, so in current projects measures are rarely undertaken in farmers' fields without their consent.

A new problem that may lead farmers to "accept" measures they do not want results from the fact that in most projects, watershed works are labor-intensive and very highly subsidized. All projects covered in this study subsidized work on common lands at the rate of 100%, generating ample employment for workers to plant vegetation, dig trenches and build structures. Even on private land, the typical subsidy rate was 90%, and the remaining 10% was not paid in cash but in kind (in the form of labor). Moreover, much of the project work was undertaken in the dry season when labor demand is scarce, and in many projects wages exceeded the slack season market wage. So even if a project paid only 90% of the subsidized wage it may still represent more than the farmer could earn under other available opportunities. Under these circumstances it may well make sense for a farmer to accept an unwanted structure on his field, provided of course that the costs of dismantling it are low.

Subsidy Policy and Practice under each Project

NWDPRA: Project guidelines call for a contribution by farmers only for work undertaken on private lands, except that no single family may receive subsidized assistance worth more than Rs 5000 (GOI 1991a). Specific terms are not mentioned. From the experience of the present study it is not clear how the farmer's contribution works in practice. In the Maharasthra villages, no work was done on private lands, so the issue did not arise. In Andhra Pradesh, work was undertaken on private lands using labor paid for by the project, but respondents did not indicate that they had contributed anything. Kolavalli (1998) found that the NWDPRA collected a small farmer's contribution in only one of the four project sites he visited.

DPAP and Jal Sandharan: These projects had no beneficiary contribution. Most work was conducted on nonarable land, but even the minority of work done on private land was entirely subsidized. Usually this work is done using contracted labor. This increased the possibility that the farmer would not be aware that the work is taking place, but it sharply reduced the incentive for the farmer to “accept” unwanted work.

NGOs: Several NGOs called for a 10% farmer’s contribution for work on private land, paid in kind (in the form of labor). As mentioned above, however, the wage scale was inflated so that employment benefits remained substantial to the farmer. Many NGOs liked to contract farmers to do the work on their own field on the principle that this would raise the quality of the work.

Two NGOs in Andhra Pradesh, on the other hand, required a much more substantial farmer’s contribution on private land. Chaitanya required a 50% contribution while MYRADA recently introduced a requirement of 33%. In some villages not included in this study, MYRADA is experimenting with zero subsidies for work on private land (Fernandez 1998). Chaitanya and MYRADA offered lower subsidies in recognition that the farmer would be the primary beneficiary of the work and that farmers would certainly pay attention to its quality if they helped pay for it. There was no contribution for work done on common land.

AGY and IGWDP: In these projects a private landowner’s contribution was about 8 percent, but this figure was inflated because dry season wages under the project often exceeded existing market wages.

ICAR: Under the ICAR model watersheds, all costs were paid by the project and farmers were provided improved seeds and other inputs free of charge. Little or no employment was generated as part of project implementation.

World Bank: The World Bank Pilot Project and IWDP both called for a farmer’s contribution of 10% on cultivated lands. The contribution was in kind in the form of the farmer’s labor. Farmers also received various free inputs such as improved seeds and fertilizers that more than made up for the value of any contribution. There was no cost-sharing for work on common lands.

INTERACTION BETWEEN PROJECT STAFF AND SURVEY RESPONDENTS

Table 28 shows the percentage of respondent farmers from each project category that interacted with project staff. To distinguish among different types of interaction, it also displays the percentage of respondents who received technical recommendations related to rainfed agriculture, and the percentage who actually adopted some practice recommended by the watershed project staff.

Table 28: Percentage of farmers who interacted with watershed project staff, by project category[a]

Project category	Percentage who interacted	Percentage who received technical recommendations	Percentage who adopted a technical recommendation
	Maharashtra		
Overall	30	17	9
NWDPRA	0	0	0
DPAP/JS	0	0	4[b]
NGO	44	25	8
AGY/IGWDP	56	28	19
	Andhra Pradesh		
Overall	67	53	50
NWDPRA	56	51	49
DPAP/JS	58	22	22
NGO	70	57	54
World Bank/ICAR	78	72	67

Notes: [a] This table excludes respondents from nonproject villages.
[b] Some projects installed watershed measures in farmers' fields without consulting them.

Three main points are worth mentioning from the table. First, overall interaction rates were not very high. This reflects the fact that watershed projects rarely cover every farmer's field in every project site.

Second, interaction was much higher in Andhra Pradesh than Maharashtra, and it was much more likely to include technical recommendations. This reflects the way in which projects operated in the two states. There was less scope for interaction in western

Maharashtra because most projects there focused on soil and water conservation on nonarable lands rather than technical interventions on farmers' fields.

The picture in Andhra Pradesh is very different. Here, the level of interaction between staff and respondents was much higher, and most of that interaction came in the form of technical recommendations for rainfed agriculture. Only the DPAP, whose primary mission was to develop water resources through groundwater recharge, had low levels of technical interaction. The World Bank and ICAR projects had high levels of interaction, almost all of it in the form of technical recommendations.

A third noticeable finding is that in Maharashtra, no farmers in the NWDPRA and Jal Sandharan project villages ever interacted with project staff. This is quite surprising, particularly for the NWDPRA, whose mandate is to promote rainfed agricultural development. Most likely it reflects the focus on water harvesting in the taluka-level line departments that implemented the project. Even so, at first glance it is surprising that there was no interaction based on employment of labor. But this is explained by the fact that the project officials worked through an intermediary in the village who in turn hired workers, so that there was no explicit interaction between project officials and laborers.

NGOs and the AGY and IGWDP projects in Maharashtra had more interaction with farmers, but the figures are still lower than in Andhra Pradesh. They reflect mainly project efforts to facilitate social organization and to mobilize laborers rather than technical assistance for rainfed agriculture.

A fourth point of interest concerns the percentage of respondents who actually adopted a practice or technology recommended by the watershed project on the plot in question. These figures quite closely reflect the figures for technical recommendations. In Andhra Pradesh, almost all farmers who received technical recommendations also adopted them. In Maharashtra there was very little adoption of specific technologies.

These findings suggest that the analysis of project impacts on rainfed agriculture should focus primarily on the Andhra Pradesh villages. Most of the rest of this chapter proceeds accordingly.

ADOPTION OF SOIL AND WATER CONSERVATION PRACTICES

Despite the historic focus of most Indian soil and water conservation programs on mechanical measures, soil scientists and agronomists often stress that there is much more to soil conservation than trapping runoff water behind mechanical or vegetative barriers. Conservation begins with sound agronomic practices such as maintaining soil cover and cultivating across the slope to encourage infiltration and reduce runoff. Accordingly, this section examines farmers' adoption of both approaches to conserving soil.

Agronomic Practices

Respondents were asked about a variety of conservation-oriented agronomic practices, including strict contour cultivation, cultivation across the slope, retaining stubble in the plot, and applying mulches to cover bare soil. Of all of these practices, cultivation across the slope was the only one practiced by more than a handful of farmers. Farmers indicated that they recognized the value of applying mulches and retaining stubble in the fields throughout the dry season, but they rarely carried out these practices due to the high opportunity cost of biomass for use as fuel and feed.

Respondents uniformly said that strict contour farming is impractical except on irrigated land and plots steeper than those covered in this survey. Not a single respondent practiced contour cultivation. This finding echoes the points about contour cultivation made by Kerr and Sanghi (1992). In short, numerous basic features of indigenous rainfed farming systems are integrally linked to quadrilateral plot boundaries, and contour bunds and contour cultivation directly interfere with them. As a result, adopting contour farming carries high opportunity costs. In the 1990s, many watershed projects still officially recommended contour cultivation on rainfed plots, but in practice this was ignored. Efforts were limited to promoting "modified contour cultivation," which simply means cultivating across the slope. Project staff ignored the official instructions to promote contour cultivation because farmers simply would not adopt it, except on irrigated and very steep rainfed plots.

Given the mild slopes and small area of plots in the sample,[25] cultivation across the slope is virtually as effective as strict contour cultivation. Farmers indicated that they traditionally alternate the direction of cultivation each year, going along one boundary one year and the other boundary the next. Where plots are long and narrow, with the long side running along the slope, many farmers cultivate along the slope every year to reduce the number of turns they must make during field operations. This leads to increased runoff and erosion.

Data presented in Table 29 suggests that watershed projects were effective in encouraging farmers to cultivate across the slope, particularly in Andhra Pradesh where interaction between respondents and watershed staff was high. Farmers were significantly more likely to cultivate across the slope in project villages, particularly if they had interacted with project staff. In Maharashtra there was no significant difference between project and nonproject plots.

Regressions to explain adoption of cultivation across the slope did not yield interesting results and so are not presented. Using predicted project dummy variables, the only statistically significant variable is the dummy indicating whether the farmer interacted with the project staff. No plot, household or village characteristics are statistically significant. With actual project dummy variables, the project categories are statistically significant as long as the dummy variable for interaction with project staff is omitted. Including that variable dominates the effect of the project categories and none of them are significant.

[25] 95% of plots surveyed had less than 4% slope, and the median size of rainfed plots was exactly one acre (0.42 ha).

Table 29: Percentage of farmers who cultivate across the slope, by project category, both states[a,b]

	% of farmers who cultivated across the slope			
	All respondents		Respondents who interacted with the project staff	
	Total observations	% of total	Total observations	% of total
Maharashtra				
Overall	86	65	24	58
NWDPRA	12	50	0	n.a.
DPAP/Jal Sandharan	10	90	0	n.a.
NGO	24	63	12	58
AGY/IGWDP	21	62	12	58
No project	19	68	n.a.	n.a.
Andhra Pradesh				
Overall	127	80	76	96
NWDPRA	25	72	13	100
DPAP	27	100	19	100
NGO	22	86	17	94
World Bank/ICAR	33	88	27	93
No project	20	40	n.a.	n.a.

Notes: [a] This table covers only plots with a slope.
[b] Kruskal-Wallis test indicates that project category is significantly associated with cultivation across the slope for Andhra Pradesh but not Maharashtra.
Maharashtra: chi-square = 0.12, 4 df (highly insignificant)
Andhra Pradesh: chi-square = 28.83, 4 df, $p < .001$.

In any case, the tabular analysis strongly suggests that projects are effective in encouraging cultivation across the slope. Farmers in villages covered by the World Bank specifically mentioned this as one of the two most important project benefits. (The other was the introduction of new seeds for improved varieties and horticultural crops.) The high numbers for both those respondents who interacted with project staff and those who did not suggest that cultivation across the slope spread from farmer to farmer, even beyond the scope of the project.

It is surprising that technical assistance could have such a big impact on something so simple as cultivation across the slope; it is also ironic that beneficiaries mention it as one of the most important benefits of an extremely costly watershed development project. Cultivation across the slope can be done with zero monetary cost; most likely this technology can be disseminated without a watershed project.

Investment and Maintenance of Soil and Water Conservation Structures[26]

Data on total SWC investment expenditure between 1987 and 1997 were collected for each plot covered under the study. It is important to stress that expenditure is not synonymous with protection against erosion, for two reasons. First, plots vary in their susceptibility to erosion due to agroclimatic factors (like slope, soil type and rainfall) and to differences in their condition at the start of the study period. Therefore one plot may require more investment than another for protection against erosion. Second, there are many ways to protect against soil erosion, and their effectiveness is not necessarily related to their cost. Vegetative barriers are less expensive than earthen barriers, for example, and agronomic practices like cultivation across the slope cost little or nothing. Despite this caveat, investment levels do provide useful information about what both projects and farmers are doing to control erosion, and how project interventions affect farmers' own investments. This in turn can help policymakers and watershed officials target their interventions resources to support the kinds of investments that farmers are less likely to make with their own funds.

The focus here is on soil and water conservation investments on rainfed plots, since the evidence suggests that irrigated plots receive plenty of investment with neither financial nor technical assistance. The types of soil conservation investments listed by respondents include land leveling, earthen, stone or vegetative barriers, grass strips, drains, and tree planting. The mean value of total investment between 1987 and 1997 on all rainfed plots was about Rs 4,475 per ha in real terms (Rs 35 = $1 in 1997). The corresponding value for irrigated plots was Rs 69,900, of which Rs 10,630 was for nonirrigation investments like leveling and bunding.

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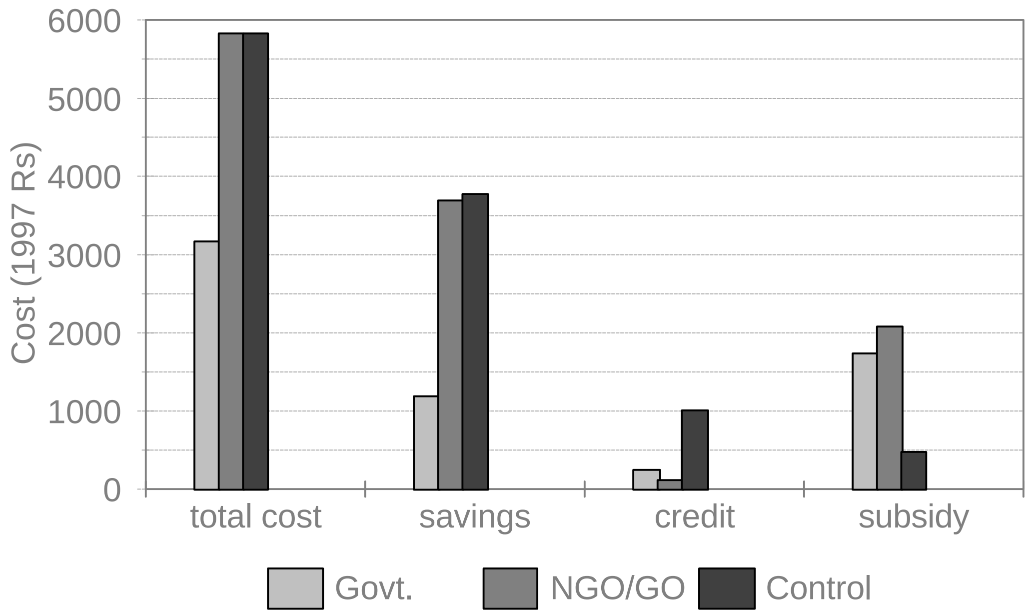
[26] This section draws on material previously published in Kerr et al. (1999).

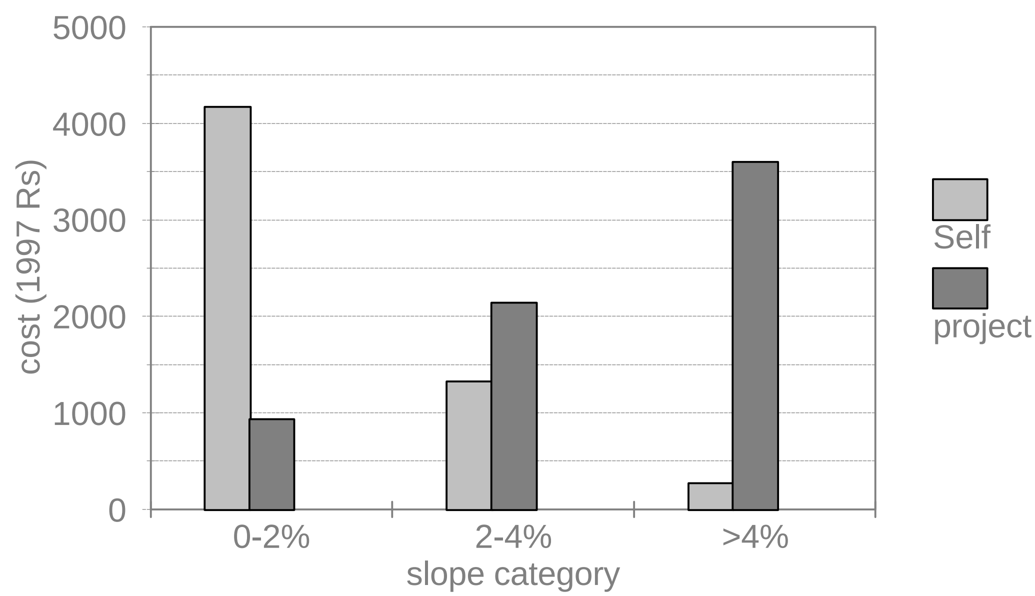
Figure 1 shows the variation in both total investment and source of finance across project categories; three main points arise from the figure. First, plots under NGO/GO projects and in nonproject villages have the highest levels of investment, followed by those in government projects. Second, while NGO/GO projects and government projects invested about the same level of subsidy, the NGO subsidies leveraged a much higher amount of funds contributed by the farmer. Third, farmers used very little credit to finance their investments, but this amount was much higher in nonproject villages that had little if any access to subsidies for SWC. (A few farmers in nonproject villages received subsidies from sources other than watershed projects.)

Figure 1: SWC investment by project category and source of finance



This initial picture of total investment suggests that watershed projects are not succeeding in stimulating soil and water conservation investments that farmers would not have made otherwise. However, the situation changes when one looks at how investment costs and sources of finance vary by the slope of the plot. As shown in Figure 2, while total investment cost varies somewhat by slope, the source of finance shows dramatic differences. Farmers invest their own savings mainly on plots with less than 2% slope. They use credit exclusively on these plots (not shown in the figure). Watershed agencies, meanwhile, devote their funds mainly to plots with more than 2% slope. The reason behind this finding is most likely that soil and water conservation investments have important productivity impacts in semi-arid rainfed agriculture, and efforts to conserve and concentrate soil and water may have greater productivity impacts on plots with more fertile, flatter soils. As a result, that is where farmers invest their own funds. This clearly suggests that funds from watershed projects complement farmers' own investments by investing on sloped plots that farmers would otherwise neglect.

Figure 2: SWC investment by plot slope and source of finance



The question remains why farmers in nonproject villages or those covered by the NGO or NGO-GO projects all invested more than farmers in the villages covered by the government projects. There are at least four reasons to consider. First, it may be that the government projects just selected villages where farmers were less able or interested in investing on rainfed plots, but the data provide no obvious indications that this should be so. A second possibility is that vegetative technologies under the NWDPRA and World Bank cost less than those introduced under the NGO and NGO/GO projects, but this would not explain the small proportion of total investment costs paid by farmers with their own funds. Third, it may be that farmers in government project villages invested less of their own funds while waiting for the project to pay for the investments instead, which would be reasonable given that government projects pay 100% subsidies in practice. A fourth possible reason is that some NGOs' higher cost sharing requirements leverage larger private sums. Some farmers covered by the Chaitanya project indicated that they could not afford to contribute 50% of the cost of investment, but other farmers did invest large sums of their own money. Perhaps Chaitanya's subsidy policy could have a stronger impact by helping farmers gain access to credit pay the matching cost.[27] Figure 1 shows that very few respondents in NGO villages used credit for land improvement investments on rainfed plots.

Use of Credit for Land Improvement Investments

The average amount of credit for soil conservation investments was only around Rs 360 out of an average total investment of nearly Rs 4500 per ha. An even more striking finding comes from examining the sources of the small amount of credit that is used. About 50% is borrowed from moneylenders, nearly another 50% is borrowed from relatives and friends, and a trace amount—Rs 14 per respondent—comes from informal credit groups. Not one farmer out of 239 in the survey borrowed even a single rupee from a bank for investments in land improvement on rainfed plots during the ten-year

[27] Regression analysis presented in table 32 below shows that land improvement investments on rainfed plots yielded low returns: Rs 1000 worth of pre-1987 SWC investments resulted in only Rs 14-70 average increase in annual net returns to cultivation. This might suggest that farmers would not take advantage of credit even if it were available. However, the reported low returns are based on the combination of self-financed and project-financed investments. Many of the project-financed investments were unwanted by farmers; returns might be higher for those that were not subsidized.

period under investigation. Irrigated plots, by contrast, received an average of over Rs 23,300 credit, with almost Rs 9,000 coming from banks. Of this amount, about Rs 4,400 was for nonirrigation investments like bunds and leveling, with an average of Rs 900 coming from banks. This is consistent with the findings of Kerr and Sanghi (1992) that formal credit was not even available for such investments. Sometimes bank credit may be tied to special watershed projects so that farmers can borrow to invest in certain approved technologies such as contour bunds. But typically such credit is useless since farmers are not interested in the approved approaches. Farmers have their own practices, but banks do not recognize them and thus do not make loans available.

It is difficult to infer from the data presented here whether making bank credit more available to farmers would help stimulate improvement of rainfed lands. The problem is that most farmers may not want to borrow funds for rainfed plots even if they are able to. This may be particularly so for sloped, erosion-prone lands. On the other hand, if credit were made available in combination with subsidies, farmers might respond favorably. In fact, the experience of MYRADA and Outreach, two NGOs in the southern Indian state of Karnataka, shows on a limited scale that this may be true (Kolavalli 1998; Fernandez 1998; Mascarenhas 1998). The key features of an approach that combines credit and subsidies would be, first, that credit must not be tied to specific technologies that farmers may not be interested in, and second, that subsidies must be low enough that farmers have to invest significantly from their own pockets or their time. As demonstrated in the next section, this is necessary in order to be sure they are serious about maintaining investments that are made.

Maintenance of Soil and Water Conservation Assets

If watershed agencies succeed in stimulating investment in soil conservation on sloping land prone to erosion, the next step is to encourage farmers to maintain the assets created by those investments. Table 30 shows the percentage of SWC measures that are well maintained on rainfed plots under different watershed projects, by the level of subsidy. (Investments on irrigated plots are almost always well-maintained regardless of the level of subsidy, so they are not discussed here.) Investments with no subsidy are almost uniformly well maintained, with only 2 out of 82 that are not. When subsidies of Rs 2500 or less are introduced, the overall maintenance level slips to 84%, and for subsidies over Rs 2500 it falls to 64%. The overall percentage of subsidized investments that are well-maintained is 74.

The pattern holds when the data are examined separately by project category (Table 30). One noticeable feature is that the NGO and NGO-government collaborative projects have higher maintenance rates than government projects. 100% maintenance is achieved for smaller subsidies and 79% on higher subsidies. The better performance in NGO and NGO-government collaborative projects compared to government projects suggests a payoff to their willingness to listen to what farmers actually want. On the other hand, it might also reflect the fact that some of the NGO investments are on flat plots and thus easier to maintain. However, examination of maintenance levels by both slope and project category (not shown), selecting only those plots with subsidized investments, showed that the good maintenance of NGO-supported investments is not limited to plots with no slope.

Table 30: Percentage of SWC investments that are well maintained, by project category and subsidy level, rainfed plots[a]

Project category	No subsidy		Less than Rs 2500 subsidy[b]		More than Rs 2500 subsidy[b]	
	Total number	% maintained	Total number	% maintained	total number	% maintained
Government[c]	31	97	35	77	26	58
NGO and NGO-GO[d]	25	96	14	100	14	79
No project	26	100	0	n.a.	4	50
Total (all categories)	82	98	49	84	44	64

[a] This covers investments made from 1987 to 1997
[b] Real value in 1997 rupees.
[c] This table combines all government projects into one category. These include the NWDPRA, World Bank, ICAR, Jal Sandharan and DPAP.
[d] NGO projects and NGO-government collaborative projects are combined into one category for this table.

As mentioned above, with subsidies exceeding Rs 2500 the maintenance rate under the NGO and NGO-GO projects is only 79%. NGOs invest in response to farmers' demands, and where subsidies are very high (100% for some NGOs), labor-intensive investments may provide employment for the farmer. In this case farmers may accept large investments that they do not intend to maintain.

An important question for policymakers is whether the high subsidy outlays are justified by the performance of the subsidized land improvements. This study is not able to address the effect of land improvement investments on production and conservation, but maintenance levels provide some information about performance. With overall maintenance levels of 74% (only 69% under government projects), subsidized investments covered in this study are not likely to be cost effective.[28] A stronger commitment to cost sharing will help ensure that farmers only accept land improvement measures that they truly want. More analysis is needed to assess the cost-effectiveness of project investments.

NET RETURNS TO CULTIVATION

Net returns to cultivation is an obvious plot-level indicator of agricultural productivity. Data are available for gross returns per hectare and both cash costs and imputed costs of household resources and labor. Investigators collected this information in interviews with farmers for the crops they grew in the year immediately prior to the interview. Unfortunately no baseline data are available for this indicator, so the analysis is purely cross-sectional.

The analysis covers only rainfed plots since irrigation dwarfs other factors in determining net returns. The mean annual net return was Rs 30,589 on irrigated plots but only Rs 2,989 on rainfed plots. Omitting irrigated plots leaves a sample of 246 plots, 140 in Andhra Pradesh and 106 in Maharashtra.

[28] Regresssion analysis in table 32 below indicates that a thousand rupees worth of pre-1987 soil and water conservation investments only resulted in Rs 14-70 average increase in annual net returns to cultivation.

Table 31 presents the mean net returns per hectare by state and project category. These figures show far higher returns in Andhra Pradesh than Maharashtra, and they show generally higher figures for plots under projects with an NGO component than for plots under government projects or nonproject villages. However, many other factors affect net returns per hectare, so it is important to analyze their determinants using multiple regression.

Table 31: Mean annual net returns to cultivation, rainfed plots (Rs/year)

	Average net returns per ha	
Project category[a]	Maharashtra	Andhra Pradesh
All plots	1762	3918
NWDPRA	712	4133
DPAP or JS	505	3849
NGO	2935	4542
AGY	2255	n.a.
World Bank clear or ICAR	n.a.	3662
No project	1565	3492

Note: [a] Differences across project categories are not statistically significant.
Maharashtra: $F = 1.35$, 4 df, $p < 0.26$; Andhra Pradesh: $F = 0.15$, 4df, $p < 0.97$.

Explanatory variables for the plot-level analysis of returns to hectare include plot, household, village and project characteristics. 1997 values are used for variables that change over time since cultivation took place in 1997. The plot characteristics include area, land capability classification (which incorporates both slope and soil fertility), the rank of the plot within the farmer's overall holding, the number of seasons the plot is cultivated each year, the present value of land improvement investment it received, both during the 1987-1997 period and prior to 1987. Household characteristics include the farmer's total land holding size, percentage of income that comes from off-farm sources, and the number of household workers. Village-level characteristics include the type of road connecting the village and the distance to the nearest market. Project characteristics include the predicted probability that the project operates in the village, and the project's expenditure per hectare. As in the village-level regressions, the model is specified with expenditure and project category expressed separately and interacted.

The model is estimated separately for each state, for two reasons. The first is that project activities and objectives vary by state, and the second is that conditions in the two states vary significantly. Government policies affecting agriculture do not differ greatly between the two states, but there may be other state-level differences that are not accounted for in this model.[29]

Table 32 displays the results of the econometric analysis for the two states.[30] The model's explanatory power is low, and for Maharashtra it is not even statistically significant. The only explanatory variable that is consistently significant in both states is the NGO project category, which has a positive sign. None of the other project categories have significant coefficients. In Andhra Pradesh, the number of household workers is significantly negative; this is because households with more workers probably use more labor, and in this exercise household labor was costed equally to hired labor. The number of seasons the plot is cultivated per year is significantly positive, as expected; it reflects favorable soil and rainfall conditions that permit multiple rainfed crops per year.[31]

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[29] When the analysis was conducted for both states together, a state-level dummy variable had to be dropped due to high correlation with other explanatory variables.

[30] The Andhra Pradesh model is limited by the need to combine the NWDPRA, World Bank and ICAR projects into a single category when predicted values are used. This is because these categories contain insufficient observations to include in the two-state multinomial logit analysis of determinants of project category.

[31] Watershed projects aim to enable multiple cropping on rainfed plots, but multiple cropping predated the projects in all cases observed.

Table 32: Determinants of farmers' net returns to cultivation[a]

OLS regressions

Variable	Andhra Pradesh[b] Model 1[c]	Andhra Pradesh[b] Model 2[d]	Maharashtra[b] Model 1[c]	Maharashtra[b] Model 2[d]
Plot area (ha)	898	920	-426	-411
	(606)	(589)	(395)	(372)
Land capability class II (dummy)	1198	1208	1561	1377
	(1086)	(1094)	(976)	(929)
Number of seasons cultivated per year	3405	3467	1434	1771
	(1334)**	(1366)**	(1162)	(1223)
Value of pre-1987 land improvements	70	63	14	22
('000 Rs/ha)	(49)	(49)	(13)	(10)*
Value of post-1987 land improvements	-39	-40	-9	-10
('000 Rs/ha)	(25)	(24)	(24)	(24)
Farmer's total landholding (ha)	-6	-6	-1	7
	(25)	(25)	(17)	(19)
% of farmer's income from off-farm	-44	-43	-39	-36
	(44)	(44)	(19)*	(17)*
Number of workers in farm household	-103	-102	32	-13
	(45)**	(45)**	(189)	(164)
Paved road in 1997 (dummy)	-843	-783	-497	-202
	(707)	(818)	(405)	(450)
Distance to nearest market (km)	-45	-47	-70	-126
	(30)	(35)	(22)**	(52)**
Mean project expenditure per ha ('000 Rs)	-206		35	
	(200)		(25)	
NWDPRA/World Bank/ICAR	649		-3161	
	(1400)		(2449)	
DPAP/Jal Sandharan	1310		-3665	
	(1195)		(2194)	
NGO	5834		1869	
	(1618)***		(1891)	
AGY/IGWDP			-2541	
	n.a.		(1905)	
Mean project expenditure/ha by		-237		80
NWDPRA/World Bank/ICAR ('000 Rs)		(179)		(144)
Mean project expenditure/ha by DPAP/JS		37		-66
('000 Rs)		(154)		(215)
Mean project expenditure/ha by NGO ('000 Rs)		1219		1047
		(373)***		(214)***
Mean project expenditure/ha by				95
AGY/IGWDP ('000 Rs)		n.a.		(326)

Notes: [a] Coefficients and standard errors are adjusted to account for sampling weights, clustering and stratification. *, **, and *** indicate statistical significance at the 1%, 5% and 10% level, respectively. Predicted values based on the multinomial logit regression in Table 14 are used for the four project category variables in Maharasthra. Predicted values for Andhra Pradesh project categories are based on a multinomial logit regression that uses 72 villages from both states. 14 villages from the AGY and IGWDP are omitted because these categories are not found in Andhra Pradesh. In this model the World Bank, ICAR and NWDPRA project categories must be combined into a single category due to insufficient observations on these projects in Andhra Pradesh. Standard errors are not adjusted for use of predicted values.

[b] Sample sizes: Andhra Pradesh 140, Maharashtra 106.

[c] Model 1: mean expenditure per hectare and project category are expressed as separate variables.
Andhra Pradesh: $F(10,2) = 35.07$, $p < .03$; $R^2 = 0.20$; Maharashtra: $F(7,2) = 1.2$, $p < 0.53$; $R^2 = 0.22$

[d] Model 2: mean expenditure per hectare is expressed separately for each project category.
Andhra Pradesh: $F(10,2) = 175$, $p < .01$; $R^2 = 0.20$; Maharashtra: $F(7,2) = 5.79$, $p < 0.16$; $R^2 = 0.20$

In Maharashtra, statistically significant variables include distance to market (negative), percentage of income from off-farm (negative), and the value of pre-1987 land improvement investments (positive). The negative effect of off-farm income may indicate that farmers with more off-farm income put less effort into rainfed agriculture.

The positive coefficient for the NGO project category in both states is somewhat surprising since most NGOs, the AGY and the IGWDP did not focus on technical assistance for rainfed agriculture. However, discussions with project staff revealed that these projects place a premium on helping villagers access government services and helping them identify marketing opportunities. These two activities could have a positive effect on crop income even if the project staff do not engage in technical assistance. The lack of a significantly positive effect of the NWDPRA, World Bank and ICAR projects is disappointing given the focus of these projects on introducing new technology for rainfed agriculture.

When the model was run with actual project dummy variables instead of predicted values, the results were roughly the same, with NGOs always being the only category with a positive, statistically significant coefficient.

9. CONCLUSION

This study began with three research questions: 1) What projects are most successful in promoting the objectives of raising agricultural productivity, improving natural resource management and reducing poverty? 2) What approaches enable them to succeed? 3) What nonproject factors also contribute to achieving these objectives? The major hypotheses were that participatory approaches yield superior project impact and that favorable economic conditions and good infrastructure also support better natural resource management and higher productivity. Findings of the empirical study in Maharashtra and Andhra Pradesh lend support to the hypothesis that more participatory projects perform better than their more technocratic, top-down counterparts, and that a combination of participation and sound technical input may perform the best of all.

Evidence about the role of economic conditions and infrastructure is more limited. This section summarizes these findings and offers suggestions to improve the impact of watershed projects and other development efforts in the future.

EVIDENCE OF PROJECT PERFORMANCE

Participatory Projects Perform the Best

The study examined the evidence regarding project performance in managing uncultivated common lands, expanding the area under irrigation, and raising the productivity of rainfed agriculture.

Concerning the management of common lands, projects in Maharashtra taking a more participatory approach—the AGY, IGWDP and NGOs—performed better according to several indicators. The AGY and IGWDP were much more successful in introducing social fencing institutions, whereas villages under other projects showed little difference from nonproject villages. All of the projects appear to have contributed to reducing erosion in the main drainage line, but again, the AGY and IGWDP projects performed the best in this regard, followed by the NGOs and finally by the government projects. On uncultivated common lands, most of the projects appear to have contributed to reducing soil erosion below what was found in nonproject villages. Villages under NGO projects had the least erosion, followed by the AGY and IGWDP and then the DPAP. Finally, the better condition of common lands on these projects appears to have come at the expense of access to products from the commons such as fuel and fodder. Respondents in the AGY and IGWDP villages indicated that they had suffered from reduced access to fuel and fodder from common lands more than respondents under other projects.

The quantitative analysis did not yield strong conclusions about projects' efforts to develop irrigation. Available data could not capture the complexity of the fractured rock aquifers in the study villages. Changes in irrigated area over the project period could be attributable to many factors for which data were unavailable. Nevertheless, in discussions with project beneficiaries those under the AGY and IGWDP were most likely to report that projects had contributed to raising the level of water in their wells. At the same time, none of the projects appear to have done much to help poor, landless people gain access to the additional water generated through project efforts. Project officials under the IGWDP report that wages and employment days for landless workers have risen in some villages due to expansion of irrigated area, but data in this study could not distinguish between short term employment under the project and a long term rise in labor demand.

On cultivated lands, the study focused on project efforts to raise productivity under rainfed plots since farmers already manage irrigated plots quite productively. Andhra Pradesh projects focused much more on developing rainfed agriculture whereas those in Maharashtra focused more on developing irrigation. Many projects in Andhra Pradesh aimed to introduce conservation-oriented agronomic practices, and all of them appear to have been successful in promoting cultivation across the slope. They also promoted investment in soil conservation structures such as bunds and terraces; farmers under the NGO, AGY and IGWDP projects invested more in soil conservation than those under other projects. Also, these projects were more effective than the purely government projects in using their own funds to leverage farmers' investment of private funds. Long-term maintenance of conservation structures was higher where farmers invested a higher proportion of their own funds; also, for a given level of project subsidy, maintenance of investments was higher under the AGY, IGWDP and NGOs than the government projects. Finally, rainfed plots under NGOs enjoyed higher net returns per hectare than those under government projects.

Factors that Enable Participatory Projects to Perform Better

What factors enabled the more participatory projects to perform better? In answering this question it may be worth reiterating some of the characteristics of these areas that distinguish them from irrigated lands and the most favorable rainfed areas. In irrigated areas, transferring green revolution technology was relatively simple because improved seeds and other inputs were well suited to millions of farms covering huge areas. The new technology was so profitable, with relatively little risk, that farmers were willing to abandon traditional farming systems in favor of new approaches. In less favorable rainfed areas, on the other hand, the success of technical interventions often depends on location-specific biophysical and socioeconomic conditions and requires collective action by local people. Farmers pursue complex strategies for producing food and earning their livelihoods. New agricultural technologies usually incur opportunity costs by competing with one or more of the many components of the farm household economy, effectively reducing the net benefits of project interventions (Walker and Ryan 1990). Early watershed projects introduced technologies for conservation and production without any input from farmers, all on the basis of trials in experiment stations far from the villages and devoid of socioeconomic constraints. The lack of sustained maintenance or adoption under these circumstances is not surprising given the difficult conditions prevailing in many rainfed areas.

This background helps explain why people's participation is the key feature of the best watershed projects. All projects claim to take a participatory approach, but clearly the term "participation" means different things to different people. In the most innovative and successful NGO projects, participation means that local people are full partners in the watershed development program, with both the authority to determine how the project proceeds and the responsibility to help plan, implement and pay for it. In most government programs, on the other hand, "participation" means convincing local people to go along with the predetermined project design. The findings of this study suggest that full participation is critical to project success, and this should not be surprising given the special characteristics of rainfed areas.

Some specific characteristics of participatory projects are as follows:

They devote time and resources to social organization: The best projects employ staff trained in social organization and devote substantial time to facilitate collective action prior to implementing watershed works.[32] As shown in Table 8, on average over 40 percent of the staff in the AGY, IGWDP and NGOs were trained in social

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[32] The need to employ staff with social skills is not unique to India or to developing countries. The Landcare movement in Australia found that recruiting staff members with social skills contributed to improved performance there as well (Campbell 1994).

organization compared to zero percent in the government projects. Also, the projects with an NGO component devote at least a year to organizing people prior to making watershed investments, whereas the government-implemented projects never devote more than a few weeks. They invest in watershed works only after villagers prove they can work collectively; otherwise social organization may be superficial and will not be sustained after project funds and staffs are withdrawn.

They build each group's interests into the project: The best NGO projects recognize that rural communities are heterogeneous, composed of social groups with diverse, sometimes competing interests. These groups may include people of different religion, caste, land holding status, occupation, gender, etc. Some groups are always more politically powerful than others, who may have little or no say in decisions that affect their well-being. Accordingly, some NGOs in Andhra Pradesh organize communities for watershed development by working separately with each interest group they can identify. They help each group become organized and then mediate negotiation between groups, ultimately brokering a watershed development approach in which every interest group stands to gain from overall project success. This approach, discussed in more detail in Section 2, is necessary since project benefits and costs may be distributed unevenly.

Some participatory projects, particularly some NGOs in Maharashtra, devote a great deal of effort to social organization but are less careful to address the interests of each social group. In particular, project plans are approved not on the basis of consensus among interest groups but by a simple vote requiring a majority of around 70 percent, depending on the project. This approach is easy to implement in Maharashtra with its relatively homogeneous social structure, but often it means that the landless minority has no say in designing the project. As discussed above in Section 6, typically shepherds have no say in project plans that remove their access to traditional grazing grounds. In some villages the shepherds ignore the grazing bans, undermining the project, while in other villages the grazing ban is enforced and the shepherds suffer. In this case equity and productivity objectives are in conflict.

They work with farmers to design interventions and select technologies: In participatory projects, project staff work closely with farmers to design project interventions and select technologies to be used. This is critically important to ensure that beneficiaries truly want what the project has to offer. This approach requires relaxing the strict orientation towards achieving physical targets that most government projects pursue, and also that local people help finance the costs of investment.

As shown in Section 8, greater flexibility in choosing technology results in superior performance in maintaining soil conservation investments under participatory projects. Rainfed plots under these projects also realize higher net returns to cultivation. Some projects like the NWDPRA and World Bank projects still place limits on farmers' role in choosing their own technologies, and maintenance of investments made under these projects remains low (Table 30). Most projects with an NGO component, on the other hand, have taken a much more flexible approach and have better results to show for it.

They choose the village, not the watershed, as the unit of implementation: Since successful watershed management depends on organizing communities to work together, the best projects use the village as the primary project unit rather than the watershed, which would be the logical unit in a purely technical program. They reconcile the village-based approach with the watershed orientation of the technical plan by breaking the watershed into sub-units that are treated separately within each village. In short, they manage a watershed by assembling a set of small-scale plans, each of which makes sense at the local level, and gradually building up to a larger scale. More technocratic projects, on the other hand, begin with a master plan for a larger watershed and try to make local units conform to it. Given the complexity of rainfed agriculture in the semi-arid tropics, the difficulties this approach faces should not be surprising.

They screen villages for enabling conditions: Before deciding where to implement watershed development, some of the best programs screen villages to ensure that they possess geographic and social conditions conducive to successful watershed development.

Favorable social conditions are particularly important given the extent to which participatory approaches rely on project participants to help manage projects and make them successful. Also, one might argue that how the NGOs and NGO-government collaborative projects screen villages for their work is one of the most important determinants of these projects' success. The best examples of screening villages for favorable social conditions are the Indo-German Project and the Adarsh Gaon Yojana in Maharashtra, which work only in villages willing to practice *shramdan*, or voluntary community labor. *Shramdan* is a good indicator of capability to undertake collective action, which can contribute to watershed project success. These same projects, as well as some NGO projects in Andhra Pradesh, make no investments until the villagers have demonstrated that they can successfully control grazing on common lands. Also, in Maharashtra NGOs and the Jal Sandharan project appear to favor villages that have no common land, thus eliminating an important source of conflict in designing and implementing a watershed plan. Details of these screening approaches are provided in Sections 2 and 5.

It is important to note, of course, that there is no single critical factor that should be used to screen villages for project participation. Critical social organization skills, and indicators of their presence, may vary by location. For example, projects in Maharashtra have selected *shramdan* as an important prerequisite, but projects in other places with different customs and traditions may find that other indicators are more important.

Regarding geographic conditions, two of the most important are the relationship between village and watershed boundaries and the opportunities for water harvesting. The latter is of course relevant in Maharashtra, where water harvesting is the major project objective. Relative uniformity between watershed and village boundaries facilitates planning and administration. Selecting watersheds that fall within village boundaries is a good idea given that watershed budgets are not unlimited.

They work in coordination: Two kinds of organizational coordination appear to be important in watershed development. First, NGOs and government agencies have complementary strengths and can benefit from collaboration. The success of the AGY and IGWDP, two projects in which government and NGOs collaborate at every step of the project, demonstrates that this is so. It is important to contrast this with the approach to NGO collaboration promoted by other projects, including the Jal Sandharan and NWDPRA. They invited NGOs to work for a few weeks on social organization efforts, but this was seen as distinct from other project efforts.

Second, government watershed development efforts in India are famous for bureaucratic delays and turf wars that arise because watershed activities fall under the domains of numerous departments. Overcoming this problem is critical to raising the quality of work. Farrington and Lobo (1997) discuss the intricate approaches taken by the Indo-German Project to iron out interdepartmental administrative complications. The Jal Sandharan project, on the other hand, appears to suffer from continued lack of coordination among departments (Pangare and Gondhalekar 1998). This difference may help explain the better performance of the AGY and IGWDP compared to the Jal Sandharan.

The Role of Infrastructure

Analysis presented in Sections 6-8 gives weak support to the notion that improvements in performance in agricultural production between the pre- and post-project period were greatest in villages with improvements in infrastructure. Erosion on common lands is lower in villages with higher population density, and net returns to cultivation fall as the distance to the nearest market increases. Stronger association might exist, but the econometric analysis suffers from the fact that changes in various types of infrastructure were found only a small number of villages, so the sample may be too small and the time frame too short to capture the effect. Also, analysis at the district level by Fan and Hazell (1998) clearly suggests that improved infrastructure raises agricultural productivity. This would suggest that the growing interest in India in an approach dubbed “watershed plus”, in which watershed and infrastructure investments are designed to complement each other, has merit.

Another reason to believe that infrastructure is important is that respondents consistently list various forms of infrastructural improvements as their top priority for developing their village. Many respondents made multiple suggestions; they are listed in Table 33.

As is the case with much of the data collected for this study, responses from the two states overlap but have some significant differences. In Maharashtra, the three most commonly listed priorities are improved medical facilities, better roads, and better drinking water supply, followed by increased irrigation and improved educational facilities. In Andhra Pradesh, improved medical facilities are mentioned most commonly by far, followed by better roads, latrines, irrigation and better bus service. Table 33 shows other priorities also listed, including several that were listed too infrequently to warrant inclusion in the main body of the table.

Table 33: Priorities for developing the village: percentage of respondents cited by[a]

Priority	Maharashtra	Andhra Pradesh
Improved medical facilities	38	64
Roads	37	37
Latrines	10	37
Drinking water	35	15
Irrigation	22	25
Improved bus service	8	26
Better electricity	10	20
Better educational facilities	18	9
Improved housing	4	17
Credit/bank	3	7
Watershed development	9	1
Veterinary service	8	2

Notes: [a] Respondents listed multiple priorities. Other priorities (listed in descending order of frequency): employment, dairy or milk collection center, telephone service, including STD, community hall and equipment for it, government shop, ban on alcohol, vocational training, land for landless, fruit trees, horticulture, tree plantation, improved seeds and fertilizer, ban on dowry, community tractor, grain storage facility, weekly market, petrol pump, post office. Large landholders are more interested in irrigation, watershed works and credit; landless are more interested in housing, electricity and latrines. No patterns were observed across project categories.

While there were no significant differences across project categories, there were differences across landholding categories; larger landowners tended to be more interested in irrigation, watershed development and credit, while landless people were more interested in improved housing, electricity and latrines (not shown in the table). Almost all the respondents who cite watershed development as a priority lived in Maharashtra, probably because they equate watershed development with irrigation development.

Infrastructure development is important regardless of the extent of people's participation, but there is also a role for participation in infrastructural improvement. In short, people should have a say in what kinds of infrastructure investments are made; this is part of the idea behind the Panchayat Raj legislation for decentralized government. A further distinction is that people should also be able to choose between watershed and infrastructure investments. In a truly participatory environment in which villagers are equal partners, they should be able to determine whether scarce investment funds should be devoted to watershed development, infrastructure development, or both. It is easy to imagine that some villages must be in greater need of improved infrastructure than watershed development, so there should be flexibility to make this judgment. This is especially so given the small impact of the large amount of funds devoted to watershed development in the past.

ADDITIONAL ISSUES FOR THE FUTURE

The previous section has suggested a number of project approaches that contribute to better project performance, and all projects should strive to pursue them. Two broader issues important for better allocation of resources to watershed development are the need for better monitoring and evaluation, and the question of how much and how fast watershed development can take place without sacrificing project performance.

Monitoring and Evaluation

This study suffered from a lack of good data on agricultural productivity and natural resource conditions, but this lack of information has other implications that are much more serious. In particular, it means that government planners lack sufficient data to draw firm conclusions about the returns to different kinds of watershed development investments. Given the vast size of the budget for watershed projects, better information about their performance would go a long way toward more cost-effective government planning. Currently too many funds are allocated on the basis of too little information and, as the findings from this study show, the potential for waste is great.

The data shortage takes two forms: 1) a lack of baseline data against which to compare current conditions, and 2) a lack of monitoring data for easy assessment of current conditions.

Baseline data: Most projects collect at least a small amount of baseline data while selecting project sites and preparing work plans. In NGO projects, background data cover both agroclimatic and socioeconomic issues, while in projects managed by state-level government departments, the data are skewed toward agroclimatic factors. This reflects the technical orientation of most government watershed agencies. Government projects typically conduct detailed soil surveys before commencing work and prepare detailed land use maps. Many NGOs may collect similar data through less formal but equally detailed participatory rural appraisal (PRA) exercises. In both cases, however, typically there is no systematic mechanism for storing the data and making it available for comparison at a later date. Inquiries with government offices revealed that such records are often discarded once the project work comes to a close. The reason is that for both government and nongovernment projects, baseline data are usually collected for the purpose of planning, not evaluation.

Monitoring: All government watershed projects keep detailed records of funds spent, structures built, and other physical targets, but such information reveals nothing about impact. It is purely a bureaucratic requirement to limit misuse of funds. Most NGOs also keep records of work done, and again, a small number of the better ones evaluate their own work. The World Bank’s Integrated Watershed Development Project (IWDP) provides a clear example of collection of detailed monitoring and evaluation data; this work is contracted to researchers at state agricultural universities who produce regular, detailed reports on the performance of technical interventions. The NWDPRA also has guidelines for monitoring and impact evaluation.

Three important problems remain, however. First, it is difficult to obtain the data that have been collected for monitoring. For example, efforts to obtain such data for the current, GOI-sponsored study were not successful. Second, the data are not organized in a common format across different types of projects, so they are not necessarily useful for comparison between project types. Third, the monitoring procedures under some projects, such as the IWDP and NWDPRA, fail to address socioeconomic issues or the implementation process. In the future, monitoring should address process in order to obtain a better understanding of the challenges and impacts of participatory approaches.

Common monitoring and evaluation guidelines are needed: There is a strong need to develop common guidelines for collecting baseline and monitoring data. The difficult question concerns what kind of information should be gathered and at what level. It is best to keep the data set small so collecting and maintaining it do not become a burden. It would be easy for the Ministry of Agriculture and Ministry of Rural Development to issue guidelines for evaluating all projects within their jurisdiction, but generating common guidelines acceptable to multiple ministries and even NGOs would be more difficult. Accordingly, a high level meeting to develop a common framework for data collection should be a high priority. Such a gathering should include not only ministry officials but also representatives of NGOs and researchers in order to make sure that all parties' priorities are addressed and that a workable, usable system is developed. A tiny proportion of the vast watershed budget in each ministry could then be set aside for collecting and maintaining such data in a representative sample of all kinds of watershed projects throughout the country. A common interministerial office could be responsible for monitoring watershed projects. Arrangements could be made to gather data from all kinds of projects, including those of NGOs.

A Call for Caution in Watershed Investments

This study has found that participatory watershed projects managed by NGOs have made a significant contribution to agricultural productivity and natural resource conservation in the study villages. More technocratic, top-down government projects, on the other hand, have fared less well. In fact, for many performance indicators the government projects did not perform any better than nonproject villages.

The AGY and IGWDP, two collaborative projects between NGOs and government agencies have performed particularly well, and this appears to bode well for the Ministry of Rural Development's efforts to expand participatory approaches to a large scale. However, it is important to acknowledge that the NGO-government collaborative projects analyzed in this study have benefited from favorable treatment that cannot be extended on large scale. For example, as mentioned above, all of their villages had been the site of previous watershed projects (as had almost all other projects in Maharashtra). In all of the IGWDP's sites covered under this study, an experienced NGO had already been active in the village for several years. The AGY, meanwhile, was a high profile project subject to relatively frequent visits from high-ranking government officials, so project staff may have worked particularly hard and development funds for all kinds of activities were allocated on a priority basis. Such special treatment will not be possible as these projects continue to expand, so it is premature to draw conclusions about the potential for scaling up based on the findings presented here. However, these comments are not meant to detract from the good performance of these projects; resources should be allocated to experiment further with government-NGO collaborative projects and any other efforts to introduce more participatory approaches to government-funded projects.

The major lesson to be learned from this study is that most government watershed development investments have yielded disappointing results given the vast resources allocated to date. Lessons learned from early projects have been put to good use in more participatory approaches on a relatively small scale, but expanding them to a large scale remains uncharted territory. The MORD has worked for the last few years to scale up participatory approaches, but progress has been slow and there have been many pitfalls. Its participatory guidelines represent a very favorable development, but it is unrealistic to think they can be successfully implemented on a nationwide scale very quickly.

A strong argument can be made that watershed investments should slow down, focusing on experimenting with innovative participatory approaches, until there is sufficient capacity among government staff to work in a more decentralized, participatory way. However, given that large watershed budgets have already been put in place, the focus should be to use project funds to encourage such government reform. This could be done by disbursing funds only when state and district governments show that they are making progress in adopting more participatory approaches. The MORD is already taking this approach. If it can help encourage bureaucratic reform it will represent an important spillover benefit that will offset slow progress in the actual watershed development objectives.

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