Rule Compliance in Participatory Watershed Management: Is it a Sufficient Guarantee of Sustainable Rural Livelihoods?

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Abstract: *In recent years, decentralised development approaches have been promoted to realise the goal of poverty reduction. In the agriculture sector, declining budgetary support and deteriorating quality of service provision by state parastatals the world over has prompted an interest in Irrigation Management Transfer (IMT) and Joint Forest Management (JFM) policies. Donor-supported JFM and IMT projects have encouraged co-management between state parastatals and farmer groups or the private sector to undertake tasks of catchment protection, water allocation, collection of irrigation service fees (ISFs), and routine maintenance of irrigation infrastructure in a watershed context. Some evaluations of participatory watershed management projects assume that compliance with institutional rules would facilitate greater cost recovery, enhance agricultural productivity, and reduce dependence on government budgets, and may, therefore, be viewed as indicators of institutional success. But, based on an extensive survey and a detailed case study of participatory watershed management organisations in the Haryana Shiwaliks, we argue instead that institutional success may be evaluated on the basis of how much rule compliance has contributed towards an improvement in transparency of programme implementation, pro-poor benefit distribution, and condition of*

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environmental resources. We also examine the prospects for participatory watershed management in the context of changes in the wider regional and macro economy.

Keywords: rule compliance, participatory watershed management, sustainable rural livelihoods

INTRODUCTION

IN RECENT YEARS decentralised development approaches have been promoted to realise the goal of poverty reduction. In the agriculture sector, declining budgetary support and deteriorating quality of service provision by state parastatals the world over has prompted an interest in Irrigation Management Transfer (IMT) and Joint Forest Management (JFM) policies. IMT and JFM policies typically refer to devolving management of previously publicly-controlled forests or irrigation systems to farmer groups or other private-sector entities (International Water Management Institute [IWMI] 1995). Donor-supported JFM and IMT projects have encouraged co-management between state parastatals and farmer groups or the private sector to undertake tasks of catchment protection, water allocation, collection of irrigation service fees (ISFs) and routine maintenance of irrigation infrastructure in a watershed context[1] (Svendsen and Nott 2000; ADB 2001).

Rule compliance in the case of participatory watershed management may be reflected in factors like the degree of farmer compliance with water allocation rules, payment of irrigation service fees or contribution of money or time towards routine maintenance of catchment areas of irrigation systems. Some evaluations of participatory watershed management projects assume that compliance with institutional rules would facilitate greater cost recovery, enhance agricultural productivity, and reduce dependence on government budgets, and may, therefore, be viewed as an indicator of institutional success (IWMI 1997; Samad and Vermillion 1999). However, we argue that when viewed from the point of view of beneficiary groups, rule compliance may be a necessary, though insufficient, condition for achievement of sustainable rural livelihoods. Our pessimism arises from the fact that sustainability of programme interventions may be compromised by (a) lack of transparency in programme implementation, (b) benefit distribution that bypasses the poor, (c) degradation of environmental resources, and (d) adverse changes in the policy and legal environment (Ashley and Carney 1999; Reddy et al. 2004).

The issue of transparency of programme implementation in the South Asian context is highlighted by a study on irrigation and statecraft in Tamil Nadu (Mosse 2000). The study describes the prevalence of "incentive payments" for awarding of public contracts for construction and maintenance of public works. It also refers to the process by which private gains from public works are shared among functionaries within the local bureaucracy and "upwards" with politicians. An evaluation of the Yanesha Forestry Cooperative project in Peru notes that "the financial clout of USAID was critical in forcing the government to officially recognise and legally title all Yanesha communities in the area to help protect them from colonist invasion." (Morrow and Hull 1996: 1652). The importance of transparent policy processes are also beginning to be reflected in donor policies in the agriculture sector (ADB 2001).

Pro-poor issues are highlighted by recent evaluations of watershed projects that have documented how powerful landholders may collude to appropriate benefits of watershed management at the expense of poorer peasants[2] (Platteau and Gaspart 2003). Second, studies point out that landless households that depend on public lands to meet a considerable portion of their subsistence needs for fuelwood, fodder, or timber may suffer as a result of JFM-style conservation measures that regulate their access to such lands (Agarwal 2000; Beck and Nesmith 2001). Third, studies of watershed management in South Asia highlight the fact that women may have to bear an increased workload from an improvement in access to irrigation due to doubling of agricultural yields (Arya et al. 1998; Sarin 1999).

Issues relating to the nature of environmental change are evident in the literature on watershed management (Dixon 1997; Bebbington 1999). For instance, intensive cropping using chemical fertilisers that may be facilitated by compliance with irrigation management rules may adversely affect water quality in downstream areas with implications for agricultural productivity or health of human populations in the medium to long term. Further, construction of roads and expansion of markets for cash crops in upland areas may result in a degradation of forests with adverse implications both for extent of soil and nutrient erosion, and status of women and other disadvantaged social groups (Agarwal 1996; Vandergeest 2003). The intensity of environmental degradation that arises from accelerated resource use may be exacerbated by spatial differences in slope, elevation, or soil types (Leach et al. 1999).

External conditions like inter-sectoral policy change and changes in market structure or factor prices can affect rule compliance in watershed management (Lam 2001). For example, the coastal provinces of Turkey, where cash-crop production predominates, irrigation service fees represented only 3% of the variable cost of production. As long as public irrigation agencies did not increase irrigation fees further, farmers were able to comply with user charges (Svendsen and Nott 2000). On the other hand, farmers' ability to comply with ISFs may be influenced by the degree of government subsidisation of agriculture. For instance, in Bangladesh and Indonesia, when government subsidies were withdrawn in the wake of an irrigation management transfer programme, farmers were unable to pay irrigation service fees (IWMI 1997). On the other hand, external interventions that materialise through markets or national development programmes may erode social capital assets like trust and reciprocity with adverse consequences for rule compliance (Woolcock and Narayan 2000).

In this paper we undertake a case study of two micro-watershed groups known as Hill Resource Management Societies (HRMS) in Panchkula district of Haryana state. The first micro-watershed group—Thadion—has failed over a period of three years to elicit rule compliance in management of an earthen dam [1] built by the Haryana Forest Department (HFD).[3] In contrast, the second group—Bharauli—has succeeded in relative terms in eliciting rule compliance in water allocation, ISF collection, and routine maintenance of earthen dams. In this context, we examine the effect that three years of sustained rule compliance in dam management has had on rural livelihood indicators: transparency of programme implementation, pro-poor benefit distribution, and nature of environmental change.

OVERVIEW OF THE STUDY AREA AND PROJECT DESCRIPTION

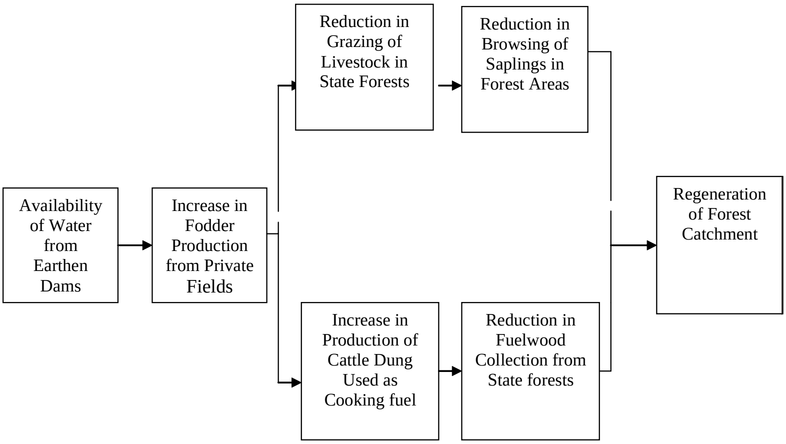
In recent years Haryana has emerged as one of the most prosperous states in India. Driven by irrigation expansion and large-scale adoption of high yielding varieties (HYV) of Green Revolution crops like paddy, cotton, and sunflower, Haryana has achieved impressive agricultural growth. Notable gains in farm wage rates have been partly responsible for increases in per-capita income (Narayanamoorthy 2001). However, on the flip side, Haryana has seen widening income disparities between those mainly dependent on casual agricultural work and those occupied in the rural non-farm sector (Bhalla 1999). Widening income disparities probably explain why poverty rates have increased in Haryana despite increases in per-capita income. To add to this, Haryana has a poor record of land reforms as a result of which land distribution is skewed (Narayanamoorthy 2001). Access to non-farm jobs—a potential way to escape poverty—is however curtailed for certain groups like women in rural communities (Agarwal 1997).

Panchkula district has the largest proportion of land under forests in Haryana (HCFP 2000). As a result, the district has been a particularly important focus of participatory forestry projects. Since the early 1980s, a spate of community forestry initiatives have been undertaken: social forestry, joint forest management, and the Haryana community forestry project. The Haryana Joint Forest Management (JFM) Project was responsible for developing an integrated model of watershed management based on experiments that were undertaken in the village of Sukhomajiri between 1975 and 1985 (Arya and Samra 1995). From the Haryana Forest Department's point of view, the Sukhomajiri watershed management intervention was crucial to reduce siltation of the Sukhna reservoir located further downstream in the state capital of Chandigarh.

The Sukhomajiri model was premised on the idea that a linear relationship exists between the condition of forests located in the Shiwalik hills and agricultural productivity in the low-lying plains (see Figure 1). As a result, fodder production on private fields was encouraged through provision of irrigation from earthen dams in the expectation that greater fodder and dung production from irrigated fields would obviate the need to use state-owned forests for fodder and fuelwood extraction (Sarin 1996).[4] Between 1984 and 1989, an attempt was made to scale up or replicate the Sukhomajiri watershed model in about 35 micro-watersheds located in the Morni-Pinjore Forest Division of Panchkula District in Haryana.[5] An important feature of the scaling-up phase of the project was the creation of institutional mechanisms for sharing revenue from state forests with local communities to promote conservation of watershed resources.

Figure 1

The Sukhomajiri watershed model



The Haryana Joint Forest Management Project - Pro-poor Features of the Joint Management Contract

In June of 1990, Haryana became one of the earliest states of the Indian Union to adopt the Central Government's circular on JFM. There was an explicit attempt to encourage the participation of rural communities in the rehabilitation of degraded public forests. Earthen dams that were constructed acknowledged the intricate relationship between access to irrigation in downstream agricultural fields and patterns of fuelwood collection from forests in upstream areas. There was also an acknowledgement that access of traditionally marginalised groups such as the landless and women needed to be safeguarded. Five features of the institutional contract with an explicit focus on pro-poor concerns may be outlined as follows (TERI 1998):

- *Tenure reform*: Water user associations were constituted as Hill Resource Management Societies (HRMS) under the Registration of Societies Act. 1900. HRMS were given the opportunity once a year to lease out rights to harvest fibre grass from state-owned forests located in the catchment area of earthen dams. The lease price was fixed at the average of the previous three years revenue of the HFD from the designated forest area. Previously only paper mills had the right to harvest fibre grass from such forests.
- *Tradable water rights*: Landless households were given a share of water from dams, provided they were members of HRMS. Attempts were made to institute a system of tradable water shares so that landless households could sell their share of water to other households. Tradable water rights, it was reasoned, would place an economic value on use of water and thereby increase effectiveness of water use.

- *Modalities for private sector participation in watershed management*: We pointed out earlier that HRMS could lease rights annually to harvest forest products on public forest lands from the forest department. In the case of water from earthen dams (built on public forest land), water allocation rights purchased by HRMS could be further sublet to private contractors at auctions held annually. In the case of fibre grass, private contractors were to ensure that every household in HRMS received two head-loads of fibre grass free to meet subsistence requirements before deciding on its sale. In the case of water, profits from the sale of water from earthen dams were to be shared on a 50-50 basis between the private contractor and HRMS.
- *Access of the poor to decision-making forums*: HFD was to facilitate the annual elections of the HRMS managing committee. At least a third of positions in the managing committee of HRMS were to be reserved for women, who form a traditionally marginalised group in the Shiwalik region. Every woman in a household was entitled to membership distinct from membership of the male head of the household in the general body of HRMS. Further, in cases where a HRMS comprised of two villages—one relatively small and powerless than the other—attention was to be paid to issues like how revenue raised from sale of water (and fibre and fodder grasses) could be spent in a manner that benefited both villages.
- *Management of community funds*: An important principle followed regarding use of HRMS funds was that a proportion of profits derived by the water contractor from the sale of water from dams (and fibre and fodder grasses) were to be deposited in the HRMS common fund. A proportion of these funds could then be used for community development activities such as construction of village roads, repair of school buildings, or construction of rest areas for labourers. Such a provision would enable the use of public funds for maintenance of economic and social infrastructure in the village.

DATA AND METHODS

Rapid Survey of Management of Earthen Dams in the Post-Project Phase

Thirty-five HRMS were established in the Morni-Pinjore Forest Division of Panchkula district in Haryana. These 35 HRMS were responsible for managing 54 earthen dams. The goal of the survey was to visit all HRMS with earthen dams in this forest division. However, due to logistical constraints (roads being washed away in the monsoon rains), we could visit only 28 HRMS. This reduced our sample to 28 HRMS responsible for managing 45 earthen dams. Our rapid survey of the 28 HRMS was undertaken over the period of a month in 2000 during which information was collected on variables like sources of fuel for domestic household purposes and participation in co-management of watershed resources.

The issue of co-management of earthen dams needs to be examined in the context of the number of dams that were functioning when this survey was undertaken. Our survey revealed that only 8 of the 45 earthen dams that were constructed were functioning in 2000 (Kurian et al. 2003; Kurian and Dietz 2004).[6] In cases where the catchment stabilisation principle was followed, earthen dams continued to function. The catchment stabilisation principle basically emphasises the need to form village forest management organisations prior to dam construction. Village-based organisations were to institute rules regulating access to state forests for fuelwood, fodder, and fibre grass. In response to regulated use of forest areas, earthen dams could be built. The assumption was that the regulated forest use would have stabilised rates of soil erosion and, as a result, increased the lifespan of the dams (Arya and Samra 1995).

We undertook an assessment of three aspects of the earthen dams: (a) physical condition of headworks, (b) physical condition of spillway, and (c) physical condition of distribution channels. Our assessment revealed that approximately 31% of all dams silted up within five years of construction and 33% within ten years of construction (Kurian et al. 2003; Kurian and Dietz 2004). Interestingly, 20% of the dams functioned for less than a year. There are two clear periods of dam construction in which it is possible to discern a relationship between watershed institutions and the lifespan of dams. The first period covering the Panchkula forest range extended from 1984 to 1989. This was a period in which scant attention was paid to institutional issues related to setting up water user groups. Instead, emphasis was purely on constructing earthen dams. As a result, half of the dams silted up within five years of construction.

During the second phase of dam construction, which extended from 1990 to 1998, we note a gradual movement towards the Raipur Rani forest range. During this phase, new dams were constructed and community-based organisations were also established. The various stakeholders—Ford Foundation, Tata Energy Research Institute (TERI), and the Haryana Forest Department—closely monitored the process. As a result of closer monitoring and greater transparency, the number of dams surviving beyond 5 years increased by 50%. Further, the proportion of dams silting up within five years of construction fell from 50% in the previous phase to 21.4%. Nevertheless, we must emphasise that when compared to the Sukhomajiri pilot phase, dam performance had undergone a marked decline in Raipur Rani. This is evident from figures on the numbers of dams surviving beyond 10 years from construction. This is because of the failure to ensure catchment stabilisation prior to dam construction.

Case Study

Two of the 8 HRMS with functioning dams—Bharauli and Thadion—were selected for a comparative case study. We used five criteria to arrive at the choice of Bharauli and Thadion for the detailed case study. First, water-harvesting dams must be operational. Second, HRMS must be functional. Third, one HRMS (heterogeneous in endowment distribution) must function relatively better than the other (homogeneous in endowment distribution) with regard to dam management. Fourth, HRMS must be situated in close proximity to each other to reduce differences in contextual factors like distance from markets, slope, elevation, and forest type. Fifth, HMRS must be situated in the Raipur Rani forest range, where it was clear—based on review of secondary data on non-farm employment—that rural livelihoods depend to a greater extent on agriculture and animal husbandry. Two rounds of household surveys were undertaken to cover all households in the study sites. Household surveys collected information on household demography, cropping patterns, asset ownership, and participation in co-management of earthen dams. Socio-economic data was collected using structured interviews, focused interviews, and group discussions.

Analysis of Land Use Change

One forest compartment each in the catchment areas of the earthen dams at Bharauli and Thadion were selected for forest vegetation studies. Both forest compartments were within one kilometre from village settlements and experienced the greatest pressure from open grazing and fuelwood collection. Eighteen circular plots, each of 10 m diameter, were laid in the compartment in Bharauli and 15 such plots were laid in the compartment in Thadion. All 33 plots were in the portion of the forest that lay in the catchment area of the dams. Within each 10 m plot, plots of 5 m and 1 m were nested (IFRI 1997). Within the 10 m plot, the local names of all trees and those with girth exceeding 10 cm were recorded. Within each 5 m plot, saplings with girth exceeding 2.5 cm but less than 10 cm were enumerated. Information was collected on sapling density, height, and girth. Within the 1 m plot, the density and girth of all shrubs and saplings with girth less than 2.5 cm were enumerated. In addition, qualitative information was collected from each plot on soil erosion, livestock use, presence of epiphytes, and slope. Satellite imagery of land use changes at the study sites was visually interpreted based on NRSA photographs of April 1999 (NRSA 1999). Land use changes that took place in the Bharauli watershed between 1965 and 1999 were examined by overlaying 1999 satellite imagery onto Survey of India topography sheets of 1965. Map Info computer software was used to arrive at quantitative estimates of changes in land use. Analysis of biophysical data on forest condition was undertaken using standard Microsoft Excel software.

Description of Case Study Sites: *Bharauli and Thadion HRMS*

Demographic Features

Bharauli HRMS is composed of two settlements: Bharauli, a relatively large village with 80 households, and Sher Gujran with about 25 households. Sher Gujran village is located in the catchment area of the earthen dam while Bharauli lies downstream of the dam. Thadion HRMS is composed of two villages: Thadion with 50 households and Rethi village with 25 households (Figure 2). Bharauli HRMS is composed of four different caste groups compared to Thadion HRMS, which has only one caste group. Given the greater diversity of castes in Bharauli, some occupational specialisation based on caste identity is evident. For instance, the Tarkhans or blacksmiths undertake iron work for other caste groups. They are usually paid in grain for their services. Likewise, the Harijans have traditionally worked as hired labour on other people's fields or as domestic helpers in the homes of large landholders. In recent years, Harijan households have provided labour for water contractors to undertake routine repairs of earthen dams. No such caste-based pattern of occupational specialisation exists in Thadion.

Figure 2

Watershed areas of HRMS Bharauli and Thadion

HRMS Designated Forest area

The Shiwalik forests in the vicinity of Bharauli and Thadion HRMS have been classified as 'open scrub' according to Survey of India topography maps (Survey of India 1965).[7] With the introduction of joint forest management in the Shiwalik hills, a total of 712 ha of forest area was allotted to Bharauli HRMS. This area comprises 5 forest compartments. Thadion HRMS was allotted a forest area of 354 ha which includes 3 forest compartments. Both Bharauli and Thadion have one forest guard who is appointed by the forest department and is responsible for monitoring forest use by local villagers.

Earthen Dams

There are two earthen dams in the study area, each constructed by the state forest department. The Shiwalik forests serve as catchment in both cases. The earthen dam at Bharauli was constructed in 1990 at a cost of Rs 5,78,000, while the dam at Thadion was constructed in 1993 at a cost of Rs 6,53,000. Although the dam in Bharauli was built in 1990 it became functional only in 1995-96 after repairs. The catchment area of the dam at Bharauli is 39 ha, while the area of the dam at Thadion is 15 ha. Further, the command area of the dam at Bharauli is 40 ha compared to 20 ha at Thadion. Thirty-five households benefit from irrigation from the dam in Bharauli while 15 households are helped by dam-assisted irrigation in Thadion.

Alternative Irrigation for Dam-Irrigated Land

None of the water-using households in Bharauli have access to private tubewells as an alternative source of irrigation for dam-irrigated land. In Thadion, by contrast, there are 7 tubewells and 53% of water users have access to them.[8] From Figure 2 it is possible to discern that there are four distinct ecological zones: Zone I, where groundwater can be tapped at a depth of between 200 to 300 feet compared to Zone II, where the depth is approximately 50 feet. In Zone III, groundwater depth is in the range of 150-200 feet, while in Zone IV groundwater can be struck in the range of between 25-30 feet. Drilling costs, which are a major factor in farmers' decisions to establish tubewells, vary between Rs 18,000 to reach a depth of 25 feet and Rs 50,000 to reach a depth of 100 feet. It is not surprising, therefore, that all 7 tubewells in Thadion are located in Zone IV.

Water Transport

Water is transported by plastic pipes from the earthen dams. The pipes are buried at a depth of about three feet. At strategic locations in the command area, vertical exit valves are placed. At the end of the plastic pipelines, farmers dig artificial water courses to transport water to their fields. Water transport is dependent on gravity flow and usually has to crisscross several fields. As a result, in some cases it involves negotiations between farmers to facilitate the digging of channels to divert water towards their fields. Here, locally embedded notions of a fair allocation are critical to avoiding conflicts. Large farmers with plots located at different points in the dam command area have to balance their interests for water with those of small landholders.

Water Use Rules

Water in earthen dams is harvested during the monsoon period (June to September). Harvested water is then used during the *rabi* season primarily for the wheat crop. Water users in Bharauli are charged Rs 20 per hour of water used from the dam compared to Rs 10 in Thadion.[9] Three to four rounds of watering are possible in both Bharauli and Thadion. Rules stipulate that water allocation should take place on a rotational (hourly) basis for the wheat crop. During each round, farmers whose lands are situated closer to the dam are supplied water first, after which water is released for use by farmers further down the distribution channel[10]

RESULTS AND DISCUSSION

Effectiveness of Water Management: A Comparison of Bharauli and Thadion HRMS

Collection of Irrigation Service Fees

Household surveys in Bharauli revealed that 91% of dam users received water for four to five months during the *rabi* season (winter season) compared to only 28% of water users in Thadion (Kurian et al. 2003). Therefore one may argue that due to the assured supply of water from the earthen dam and a sense of fairness associated with water distribution, water users in Bharauli adhered to rules of payment of water fees to the contractor. We observe that in 1995-96 HRMS monitored water distribution from the dams in Bharauli and Thadion. In Bharauli, water users complied with payment of hourly water charges of Rs 20 while in Thadion, compliance was nil although water user charges were lower at Rs 10 per hour. In 1996-97 too, both were under the HRMS management, and the trends of compliance with user charges were similar. In 1997-98, both Bharauli and Thadion adopted contractor-based water provisioning. In Bharauli, the contractor paid the lease amount of Rs 3000 to HRMS whereas in Thadion, the contractor failed to do so. However, due to poor rains that year the contractors could not net a profit from water sales in 1997.[11]

In 1998-99, both water-user groups adopted contractor-based provisioning once more. In Bharauli, the contractor paid up the lease amount, while in Thadion, 3 individuals who combined to bid for purchase of lease rights could only pay 22% of the lease amount pledged to the HRMS. That same year, higher levels of compliance with payment of water user fees enabled the contractor in Bharauli to net a profit of Rs 7500. The same trend was repeated for 1999-2000, but in Thadion a history of non-compliance with water user charges resulted in reversion to HRMS water provisioning. But, by 1999-2000, repeated failure of the institutional mechanism for managing the dam in Thadion led to its siltation.

Water Allocation Rules

We adapted Ostrom’s use of “water availability difference” to examine predictability in availability of water among peasants at the head-end and tail-end of the dam distribution network (Ostrom 1994: 552).[12] The difference in predictability of water supply between head-end and tail-end peasants was lower in Bharauli than in Thadion (Table 1). This finding indicates a higher level of effectiveness associated with lower level of conflict among farmers and greater clarity about water use rules.[13]

Table 1

Level of predictability in access to water from earthen dams

HRMS	Water predictability among users at head of distribution network	Water predictability among users at tail of distribution network	Difference in water predictability between head-end and tail-end users
Bharauli	1.8	1.3	0.5
Thadion	1.7	0.1	1.6

Another indication of the effectiveness of the water distribution system is the difference between average water requirement and water availability. Based on rule of thumb calculations of water requirements during the *rabi* season and mean land sizes we arrived at the difference between water requirements and water availability.[14] In Bharauli, relatively more effective water management rules guaranteed water access to a relatively large number of households. This is reflected in the fact that both head- and tail-end water users enjoyed more or less similar levels of confidence that they would receive their share of water from the dam. In Thadion, by contrast, because head-end households tended to monopolise use of water, the difference between water availability and requirement is double. Greater effectiveness of water use from the dam is also reflected in the expansion of the Bharauli distribution network. In response to higher profits from water sales, the water contractor expanded the distribution network in 1999/2000 to provide irrigation to 15 additional households. As a result, a total of 19.5 acres was brought under irrigation.

In Thadion, proliferation of tubewells lead farmers to utilise water from the earthen dam to cultivate paddy.[15] Farmers with access to tubewells tend to view earthen dams as a supplemental source of irrigation for rice cultivation. Households belonging to a single extended family (*gotra)* with farm plots located at the head-end of the irrigation system monopolise water use, thereby depriving other households of their share during the *rabi* season. Households without access to tubewells are adversely affected by conflicts at the head-end of the irrigation system because their ability to raise crops other than rice to meet household food requirements is curbed.[16]

Participation in Repair and Maintenance of Earthen Dams

We find that peasants in Bharauli cooperate with the contractor in undertaking routine maintenance activities. In Bharauli, between 1995 and 2000 the mean number of labour days contributed towards maintenance of the distribution network was 3.7 compared to 2.3 in Thadion. Further, the mean monetary contribution towards maintaining the distribution network was Rs 377 compared to Rs 156 in Thadion. Greater success with routine maintenance of dams may be explained by a historically-defined labour exchange system. We find that in many cases landless households who were recipients of credit and grain from the water contractor during periods of drought in earlier years offered their labour to undertake repairs of dams. Very often their services were not paid for in cash but adjusted towards credit or grain that they received during distress periods.[17]

Rule Compliance in Participatory Watershed Management: Implications for Pro-Poor Benefit Distribution, Social Capital, and Environmental Change?

We have observed that irrigation service provision was more effective in Bharauli when compared to Thadion. But, did relatively greater success with watershed management in Bharauli guarantee sufficient attention to pro-poor concerns? In other words did distribution of economy-wide benefits from watershed management favour traditionally marginalised groups like the landless, marginal land-holding households, and women? We attempt an answer to this question by stratifying the Bharauli water user group and examining the distribution of economy-wide benefits from watershed management.

Stratifying Water User Groups

Stratification of groups is one approach to understanding distribution of benefits from watershed management. We used scatter diagrams to examine how households are distributed based on their ownership of endowments. Based on the scatter diagram, we stratified groups into three endowment categories: low (0-9.9), medium (10-19.9), and high (20-40). In Bharauli, 3 households are located in the high endowment category, 23 in the medium endowment category, and 9 households in the low endowment category.[18] On the basis of stratification we examine the distribution of benefits by focussing on four aspects:

- agricultural production strategies
- access to non-farm income
- irrigation access and status of women
- access to forest resources in catchment areas

Agricultural Production Strategies

Cropping patterns

The main agricultural crops grown in the Bharauli watershed are wheat, paddy, corn, and radish. Corn and paddy are grown during the *kharif* season, which extends from mid- June to October. Wheat and radish are primarily grown during the *rabi* season, which extends from November to April. Paddy requires large quantities of standing water, in contrast to corn, wheat and radish, whose productivity depends on smaller doses of water at particular periods during the growth cycle. There are differences in cropping patterns across endowment clusters in Bharauli. For instance, households in the lower and middle categories raise corn, wheat, paddy, and radish. Households in the high category in Bharauli raise corn, wheat and radish, but do not cultivate paddy.

Labour hiring

Farmers' cropping preferences influence their patterns of labour hiring. For instance, peasants in the high endowment category in Bharauli hire labour during the winter season to harvest wheat and radish. This is probably explained by the fact that peasant households in Bharauli cultivate both wheat and radish, which must be harvested at the same time in the month of April. With relatively smaller families (average of four), family members alone would be unable to perform the harvesting operations.

There is also an interesting difference in the type of labour hired in Bharauli. There is a greater reliance on female labour, especially during the harvesting of paddy. Interestingly, though, most of the labour for on-farm operations comes from outside the village. Interviews reveal that workers from the state of Bihar arrive during the harvesting period and accept lower wages than village residents. Landless households in Bharauli, on the other hand, find it more remunerative to take daily wage jobs in nearby towns.

Crop productivity

Per acre productivity of wheat is highest among households in the high endowment category in Bharauli. In fact, households in the high endowment category had the largest area under irrigation. Large aggregate area under irrigation by dams was reflected in higher cropping intensity, per acre application of fertilisers, and use of hired labour (Table 2).

Table 2

Cropping intensity and use of inputs in Bharauli micro-watershed

Endowment category	Cropping intensity rate	Per acre fertilizer application (kg)	Percentage of households hiring labour	Area irrigated by earthen dam (acres)
High	196.0	216.6	100	3.0
Medium	175.4	211.1	66.6	2.1
Low	185.7	191.5	60.0	1.2

Agricultural returns

Total returns to agricultural activity are a function of price, per acre productivity, and acreage. In Panchkula district, farmers receive similar prices for most major agricultural crops. Therefore, returns are primarily a function of per acre productivity and acreage. In Bharauli, agricultural returns were consistently higher for peasants in the high endowment cluster for all crops with the exception of radish.[19]

In the case of radish, despite the fact that households in the high endowment cluster devoted a larger percentage of their land to its cultivation, their returns from this activity were lower. This is probably explained by lower per acre productivity. We may recall from our earlier discussion that households in the high endowment category resorted to hiring labour for farm operations during the busy month of April when both wheat and radish are harvested. One may speculate that lower labour productivity associated with the use of hired labour instead of family labour is responsible for the lower per acre productivity of radish on farms of peasants in the high endowment category.[20]

Farm-based income

Income from the sale of agricultural crops and from animal husbandry may be ncluded under farm-based income. In Bharauli, mean farm-based incomes are highest for households in the high endowment cluster. Livestock incomes constitute 7.1%, 15.8% and 27% of farm-based incomes, respectively, for households in high, middle and low endowment clusters. This suggests that diversification into livestock rearing is a strategy adopted by relatively poorer households to guard against climate-based risks associated with reliance on smallholder agriculture.

Do Non-Farm Incomes Favour the Rural Poor?

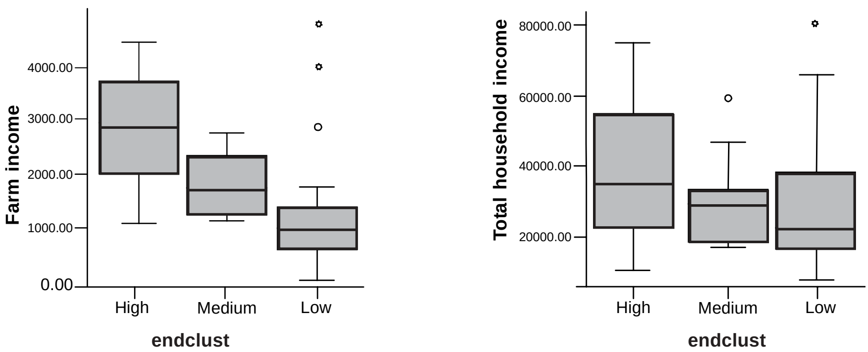
Our analysis indicates that farm-based incomes tend to favour wealthier landholding households. Do non-farm incomes discriminate in favour of poorer households to compensate for this bias? Our analysis indicates that non-farm employment exhibits great variety. The main types of non-farm jobs in the area are stone quarrying, truck driving, and employment in government departments like water supply, electricity, and public works. Other non-farm sources of income include family transport business and pensions for aged persons and retired army personnel. In Bharauli, 44% of non-farm jobs involved employment in government departments. Stone quarrying accounted for a further 33% of non-farm income in the village, while the rest was accounted for by government pensions, truck driving, and daily wage employment in nearby towns.

In Bharauli, 66% of government-sector jobs were captured by households in the low endowment category as also 88% of stone-quarrying jobs. The lone truck-driving job was held by a household in the high endowment category. Two of the daily wage jobs, involving work in house construction in nearby towns, were undertaken by households in the low category. It is important to note in this context that most of the non-farm jobs involved low-level skills and training and therefore posed few entry barriers for households. Our analysis indicates that non-farm incomes contribute immensely to household income, especially for low and medium category households in Bharauli. In fact, non-farm income constitutes 28.9% of income for high endowment category households, 44.4% for medium category households and 60% for low endowment category households.

Considering the importance of non-farm income in sustaining livelihoods of rural households it is pertinent to ask the question: To what extent does non-farm income influence patterns of rural income inequality? Our analysis indicates that non-agricultural incomes can potentially reduce inequalities in the distribution of household incomes. The inequality-reducing potential of non-agricultural income is reflected in the transformations shown in the box plot of farm-based income (Figure 3). The mean of the distribution moves up marginally while the number of outliers decreases from three to two. Also noticeable is that the range of incomes increases among the low category households, although the mean income level drops marginally. In the medium category, the mean level of income actually increases. In the high endowment category, the mean level of income drops when we consider non-farm incomes. However, we must concede that, despite the inequality-reducing impact of non-farm incomes, the overall distribution of total income still favours households in the high endowment category.

Figure 3

Non-Farm Income and rural inequality in Bharauli HRMS



The landless labourer and non-farm employment

Our analysis of non-farm incomes reveals that non-farm income definitely reduces the level of inequality in distribution of total household incomes. However, the overall distribution of total incomes still favours households in the high endowment category. In other words, non-farm incomes do not discriminate in favour of poorer households to the extent that they can compensate for the bias that farm incomes have towards wealthier households. There are two striking features of livelihoods of landless households. First, a larger proportion of landless households (about 45%) rely on daily wage jobs which are low paying when compared to jobs engaged in by low endowment category households (Table 3). We noted earlier on that 66% of government jobs and 88% of stone quarrying jobs that were relatively higher paying were undertaken by low endowment category households. By contrast, only 35% of landless households had access to stone quarrying jobs.

Table 3

Annual returns on non-farm jobs in the study area

Job Type	**Availability of Employment**	**Annual Returns**
Stone quarrying	8 months, for 20 days in a month, at a wage of Rs 75 per day	Rs 18,000
Government service	12 months at Rs 2,000 per month	Rs 24,000
State pension	12 months at Rs 200 per month	Rs 2,400
Daily wage	8 months, for 20 days in a month, at a wage of Rs 60 per day	Rs 9,600
Truck driving	12 months at Rs 100 per day for 30 days in a month	Rs 36,000

A second feature of landless households is the increasing competition they face from agricultural labourers. Two factors probably influence competition for farm jobs. First, employment is available for only a brief period during harvest. The number of days that employment is available throughout the year does not exceed 40. As a result, landless households prefer to work outside the village rather than take up agricultural jobs during the harvest season.

Second, migrant labour from Bihar are prepared to work for lower wages than local labour, thus making them a more attractive proposition for households hiring workers. Sheila Bhalla (1999), in reviewing changes in the workforce composition in rural Haryana, makes the following points:

- The latest rural labour inquiry suggests that in 1987/88, 67% of rural labour in Haryana cultivated land. Similar figures ranged between 7% and 8% in the preceding decade. What has happened is that members of households that had previously stuck mainly to cultivation accepted jobs as hired agricultural labourers in large numbers.
- In the decade ending in 1991, demographic pressure reduced the number of men who reported their main work as cultivation by some 6%. Simultaneously, the agricultural labour group grew by more than 4%.
- In Haryana, the rapid expansion of demand for hired labourers that characterised the early years of the Green Revolution attracted a surge of workers from small farm households who entered the hired labour market. By 1972/73, it had become a major source of grievance for the landless, who complained that landed households "were taking their jobs" (Bhalla 1999: 47-48).

Irrigation Access and Status of Women

Our analysis of livelihood strategies of relatively poorer landless households reveals increasing competition with landed households for non-farm jobs that have traditionally been the bastion of the landless. In other words, non-farm incomes do not discriminate in favour of poorer households to compensate for the bias that farm-based incomes have towards wealthier households. Women, another traditionally marginalised group—especially those drawn from poorer households—suffer from higher workloads as a result of higher agricultural productivity associated with improved access to irrigation from earthen dams. Focused group discussions indicate that women make more trips transporting fodder grass from fields to their homes than men. Second, when decisions are made to increase cattle herd sizes to maximise returns from the sale of milk, women end up spending more time feeding and bathing cattle. Third, unlike grass from forest areas, fodder grass from agricultural fields has to be threshed in a machine before it is fed to livestock. Women's involvement has increased in this task and will rise with an increase in fodder grass production from agricultural fields.[21]

Notwithstanding the increased workload of women, there are limited avenues open to them to negotiate a redistribution of benefits and costs arising from participatory watershed management. This is because women are effectively excluded from participation in decision-making forums relating to management of earthen dams. They are not invited to meetings of HRMS and remain unclear of their membership status in community organisations. Even if they do attend meetings organised by HRMS, cultural norms that prescribe that it is improper for women to speak up in front of men effectively relegate their views on natural resource management priorities to the back burner. This was shown in expenditure patterns of HRMS that predominantly reflected male priorities (construction of temples and meeting halls for elders from which women are excluded) as against women's priorities like repair of village schools and provision of drinking water taps.[22]

Access to Forest Resources in Catchment Areas

Irrigation and fodder grass production on private fields

One of the core assumptions guiding the Haryana Forest Department's decision to construct earthen dams was that it would facilitate increased fodder grass production on private fields. Increased fodder production could facilitate greater dung production by facilitating livestock rearing. Greater dung production presumably would reduce fuelwood collection from state forests for cooking purposes.

To understand whether irrigation provided by earthen dams induces peasants to grow fodder grass on their agricultural fields during the *rabi* period, we ran a linear regression. We found that the potential for fodder grass production was greater on fields with access to irrigation from the dam.[23] We followed up the regression with another to examine the relationship between fodder grass production on private fields and dung production in the winter season. The tables show a positive relationship that suggests that when dam-assisted irrigation is available during the winter period, dung production is also at its all-year high.

To conclude this line of examination, we ran one more regression to explore whether higher levels of dung production had any influence on intensity of fuelwood extraction during the winter. We found a negative relationship between the level of dung production and intensity of fuelwood extraction from state forests. This implies that households with better access to irrigation in the winter (*rabi* season) had higher production of dung, which is used as a substitute cooking fuel. This lowered fuelwood extraction from state forests.[24]

Irrigation intensity and fodder grass production on private fields

We pointed out earlier that households in the high endowment category had the largest acreage under dam-assisted irrigation. However, contrary to project assumption that greater access to irrigation would reduce levels of fuelwood extraction from state forests, we find that households in the high endowment group with largest acreage under dam-assisted irrigation were actually extracting greater amounts of fuelwood from state forests compared to households in the medium and low categories (Table 4).

Table 4

Irrigation intensity and use of state forests in Bharauli HRMS

Endowment category	Arable land irrigated by earthen dam (as a % of total land irrigated)	Fuelwood extraction from state forests by season (kg per month)			Annual fodder extraction from forests (kg per month)	Dung production by season (summer/monsoon/ winter, kg per month)		
		summer	monsoon	winter		summer	monsoon	winter
High	36	11.6	15.4	13.9	1450	8.6	10	21.3
Medium	45	26	3.1	12	1202	7.5	9.4	18
Low	70	14	6.5	12.9	1410	5.4	9	15.6

This finding is explained by three factors:

- Arable land irrigated by earthen dams as a percentage of total irrigated land was the lowest for households in the high endowment category. The percentage of land irrigated by earthen dams as a proportion of total irrigated land was 36%, 45% and 70%, respectively, for high, medium and low endowment category households.[25]
- Relatively larger areas irrigated by earthen dams as a percentage of total land irrigated among medium and low endowment households resulted in higher levels of fodder grass production on private fields compared to that on the fields of high endowment households (Table 5).
- Larger areas of land irrigated by earthen dams as a proportion of total irrigated land among low and medium categories of households led to comparable increases in dung production between the summer and winter months.[1]

Table 5
Fodder production on private fields relative to other sources

Endowment category	State forests (kg per month)	Private fields (kg per month)	Local markets (kg per month)
High	1450	3500	55
Medium	1202	3843	527
Low	1410	3671	173
Landless households	831	875	13

Replenishment of Social Capital Assets

A high level of cooperation is evident in the Bharauli water user group, as reflected in compliance with water user charges and payment of the full amount of the water lease. Co-operation in management of the earthen dam in Bharauli has replenished social capital such as norms of reciprocity and trust. At least three forms of social capital replenishment that have arisen from earthen dam management are identifiable in Bharauli.

First, a wealth of expertise in management of traditional water channels (*kuhl*s) exists in Bharauli. Some 60% of water users in Bharauli have evolved a common set of norms from participating in management of a *kuhl* (water distribution channel) that is over a hundred years old. Second, norms operating at the level of extended families (*gotras*) influence bidding at water auctions. For instance, Singh Ram, a nephew of Bant Ram, said that he abstained from bidding at water auctions since it went against ethics that specified he should not participate when a member of his family was already involved. Such norms may be predicated on the expectation of a family member receiving a favour in the future.

Third, an interesting facet of water user charges in Bharauli is the role of local-level processes in ensuring compliance with payment of irrigation service fees. Contrary to what most NGOs and donor agencies expect, compliance with water user charges is mediated by a complex web of exchange relations. Such inter-linked exchange relations also influence modes of payment of charges for use of water from earthen dams. For instance, Singh Ram, a marginal peasant in Bharauli, pays for use of water from the dam over a period of six months. Sometimes he even borrows money from the water contractor, Bant Ram. The contractor keeps an account of his dues. Sometimes Singh Ram can make no cash payment to clear his debt with the contractor. At such times he can be asked to work as hired labour on Bant Ram's land and his wages are adjusted in accordance with the debt he owes Bant Ram for a variety of services.

Environmental Change: Land Use and Catchment Regeneration

Visual interpretation of satellite imagery acquired in April 1999 and its comparison with Survey of India Maps of 1965 reveals some interesting changes in land use (*natural capital*) in Bharauli. Firstly, as a result of the expansion of the dam distribution network the area under perennial agriculture has increased. Approximately 60 acres of agricultural land has been brought under perennial agriculture as a result of supply of water from the dam in Bharauli. Household surveys in Bharauli indicate that crops like radish, onion and chilly are sown during the *rabi* period, between December and April. Secondly, expansion of the dam distribution network has resulted in reclamation of riverbed areas for cultivation purposes. Satellite imagery indicates that approximately 30 acres of land were reclaimed and brought under cultivation.

An assumption behind the Haryana Forest Department's decision to construct earthen dams was that increased fodder grass production following from improved access to irrigation from dams can potentially reduce livestock browsing and lead to regeneration of saplings in forest areas. Further, use of dung as an alternative cooking fuel can potentially reduce local residents' felling of saplings in the forest areas for use as fuelwood. Catchment regeneration arising from behavioural changes may be captured in differences in rates of sapling regeneration. Vegetation studies conducted in catchments of dams indicate that in fact forest condition was relatively better at Bharauli when compared to Thadion (Table 6). Such positive changes in land use may be attributed to relatively greater success, compliance with rules regulating access to catchment areas for fuelwood and fodder collection, and conflict-free water distribution from the earthen dam in Bharauli.

Table 6

Forest regeneration in the catchments of earthen dams

Parameter	Bharauli forest catchment	Thadion forest catchment
No. of saplings	11	8
Basal area[1] of trees	1.81	0.35
Basal area of saplings	6.42[4]	2.78
Diversity of saplings[2]	2.08	1.54
Density of saplings[3]	7.72	3.53

Notes:
1. Basal area is a measure of the woody biomass in a given area (Becker and Leon 2000).
2. Diversity refers to the number of species as a proportion of the total number of species per acre.
3. Density refers to the number of trees in a given area.
4. Statistically significant result.

Can Participatory Watershed Management be Sustained? Influence of External Conditions: Fiscal Regime and Declining Markets for Fibre Grass

An important principle followed by the forest department in determining the lease amount to be paid by HRMS is that of the total forest area. For example, Bharauli with its larger forest area of approximately 700 ha, pays a lease amount of Rs 8,100 for fibre grass harvesting rights. Thadion, with its smaller forest area of some 350 ha, pays Rs 725 as lease amount. But what is overlooked in this calculation is the net area under fibre grass within the forest area of a HRMS. For instance, although no studies have been done, it is clear from discussions with field staff and fibre grass contractors that the net area under fibre grass in Bharauli is much smaller than that in Thadion.

The regressive fiscal regime of the forest department has been accompanied by declining markets for fibre grass. Since 1993 private paper mills, an important source of demand for fibre grass from forests managed by HRMS, have declined. This has been a consequence of the Central government's decision to liberalise import of raw materials, leading to the import of cheaper raw materials from abroad. The decline in demand for fibre grass by paper mills lead to a decline in profits of HRMS. Since fibre grass profits have been an important source of funds for HRMS to undertake routine repairs of earthen dams, the sustainability of earthen dam management has been threatened (Table 7). More importantly, Thadion HRMS that has been less successful in the management of communal resources such as earthen dams is being rewarded while Bharauli HRMS is more hard pressed to undertake maintenance of irrigation infrastructure.

Table 7

HRMS net profits from leasing fibre grass from state forests

HRMS	1997/98	1998/99	1999/2000	2000/01
Bharauli	18,033	12,390	Did not lease	8,335
Thadion	12,387	8,922	11,397	13,760

CONCLUSIONS

Rule compliance in the case of participatory watershed management may be reflected in factors like degree of farmer compliance with water allocation rules, payment of irrigation service fees, or contribution of money or time towards routine maintenance of catchment areas of irrigation systems. Some evaluations of participatory watershed management projects assume that compliance with institutional rules would facilitate greater cost recovery, enhance agricultural productivity, and reduce dependence on government budgets and may, therefore, be viewed as an indicator of institutional success. However, we argue that when seen from the point of view of beneficiary groups, rule compliance may be a necessary though insufficient condition for achievement of sustainable rural livelihoods.

Rule compliance is a necessary condition for achievement of sustainable rural livelihoods because it has the potential to ensure attention to equity concerns and enhance environmental management. Attention to equity issues was reflected in our analysis of water allocation, collection of water user fees, and routine maintenance of the earthen dam in Bharauli. Enhanced environmental management arising from rule compliance was reflected in favourable land use changes such as reclamation of agricultural land and regeneration of catchment areas. However, our analysis indicates that success with ensuring rule compliance is crucially dependent on external conditions. We highlighted how rainfall patterns, absence of alternative irrigation from private tubewells, favourable agricultural terms of trade for wheat, and social capital influenced compliance with institutional rules relating to dam management. Similarly, we pointed out how changes in import policies of the Central government made it cheaper for paper mills to import raw materials from other countries. The resultant reduction in demand by paper mills for fibre grass supplied by HRMS affected the gross profits of community organisations. As a result, proceeds of fibre grass sales that constituted an important source of funds to undertake repair of earthen dams were no longer forthcoming.

Our analysis indicates that participatory watershed management projects may fare poorly in terms of ensuring focus on pro-poor concerns. This was reflected in our survey of agricultural production strategies pursued by farmers from different endowment categories that benefited from irrigation from the dam. We observed that large endowment category households had relatively larger land area under dam-assisted irrigation and achieved relatively higher cropping intensity rates and farm incomes when compared to farmers from medium and low endowment categories. Further, we noted that as a result of a failure of the system of tradable water shares, landless households were completely excluded from the benefits of irrigation from earthen dams. On the other hand, landless households were facing increasing competition for relatively low paying non-farm jobs from small landholding households. Further, women as a sub-group were burdened with increased workload resulting from increases in agricultural productivity on private fields. Despite the relatively greater costs that women were bearing when compared to men as a result of an increase in access to irrigation, there were few avenues for them to negotiate a distribution of costs and benefits arising from watershed management. This was because they were effectively excluded from decision-making forums related to management of watershed resources.

The important policy implications of this study are threefold. First, the focus of institutional analysis of watershed projects must shift from "project" to "post-project phase". This would enable the design of institutional mechanisms to undertake inter-sectoral policy co-ordination that would dovetail over-time changes in state policies as well as access to non-farm labour markets, management capacities, state parastatals, and the stock of physical, natural, produced, social, and cultural capitals both at the community and household level. Secondly, assessment of watershed management projects must be based on innovative methodologies that would indicate how increases in cropping intensity or farm incomes are distributed across different categories of households based on their wealth or endowment status. Third, watershed assessments must evolve approaches that highlight how power dynamics operate both within household and community groups as a way of guaranteeing access of marginalised groups like women and asset-less households to decision-making forums. Attention to the concerns listed above may induce institutional change that has the potential to bring about sustainable rural livelihoods.

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Notes

1. A watershed refers to a geo-hydrological unit that drains at a common point (Brooks et. al 1992).
2. Most discussions of equity issues in participatory irrigation management assume that large landholders would have their plots located at the head-end of an irrigation system while poor farmers would have their plots located at the tail-end of a system. Similarly, discussions of watershed or river basin management also assume that downstream users would bear the externalities caused by land and water management practices of upstream resource users. While these assumptions may be true in specific instances, it may be futile to generalise. This is because as a result of land scattering practised in large parts of northwest India, large landholders may have their farm plots distributed across different locations in an irrigation command. Similarly, it is not uncommon for upstream resource users to either rent or purchase arable land in the lower reaches of a watershed and thereby incur the costs imposed by upstream resource use practices (see Kaul 1997).
3. Earthen dams are made of compacted soil from the Shiwalik foothills. Shiwalik hill forests serve as catchment of earthen dams. The catchment areas are usually bowl shaped; water from the hills collects in them during the monsoon period. Water collected during the monsoon period is used during the winter period for supplementary irrigation primarily for wheat cultivation. Institutional arrangements that regulate opening and closing the sluice valves are critical; if the sluice valve is left open beyond a certain point the dead storage of the dam silts up. Water is transported to agricultural fields on the basis of gravity flow. The dams are also fitted with spillways to ensure that excess water flows away without damaging the main body of the dam.
4. Cattle dung is used extensively as a cooking fuel in the Shiwalik region (Saxena 1996). It was assumed that increased production of cattle dung would reduce pressure on state forests for supply of fuelwood for cooking purposes.
5. For administrative purposes Morni-Pinjore Forest Division is further sub-divided into three forest ranges: Pinjore, Panchkula, and Raipur Rani.

6. The eight functioning dams were under the management of 8 HRMS.
7. Open scrub refers to degraded land in need of rehabilitation through soil and water conservation measures (Survey of India 1965).
8. Tubewell density in Thadion is 2.8, i.e., 7 tubewells in a command area of 20 ha.
9. In another paper we argue that a higher water rate in Bharauli reflects a higher economic value that farmers place on supply of water from earthen dams in the absence of private alternatives like tubewells (Kurian and Dietz 2004).
10. We may recall from earlier in the discussion that a system of tradable water shares was introduced by the JFM project. This meant that landless households in particular who did not have a need for irrigation water could sell their share of water to other households. But our study indicates that the system of tradable water shares was not being implemented in Bharauli.
11. Mean annual rainfall in the study area declined to 1188.5 mm in 1997 compared to 1395.8 mm and 1372.7 mm in 1995 and 1996 respectively (CSWCRTI 2000).
12. We allotted weights to qualitative assessments of how predictable farmers' access to water from earthen dams was in Bharauli and Thadion. By 'predictable' we refer to how confident a farmer was that the dam water user with a plot adjacent to his would release water to him for his use. Accordingly, we allocated weights depending on whether a farmer's access to water was high (2), medium (1) or low (0). The values that we arrived at for Bharauli and Thadion HRMS represent an aggregation of individual farmer responses to our query on level of predictability in access to water from earthen dams.
13. Discussions in Thadion revealed that two households removed distribution pipes to level their fields and never replaced them. In response, Somnath, a large land holder, installed a siphon and pumped water out from the dam to his field using a circuitous route. Pumping water using a siphon can silt the dam, and so other farmers resented this idea. As a result, Amarjeet, Somnath's uncle pledged to siphon water and desilt the dam regularly using his own funds. Amarjeet began charging farmers a fee to siphon water to their fields on the pretext of recovering his investment for the dam de-silting works that he planned to undertake. However, in reality he did not undertake de-silting work on the dam as he had promised. Somnath began a parallel scheme of water siphoning and pledged that he would stop this scheme of water siphoning only if his uncle began de-silting work on the dam. The continuing conflict between these two individuals led to eventual silting of the dam in March 2001. As a result, access of the other 13 households to water from the dam was compromised.
14. During a period of normal rainfall, three waterings are required for a wheat crop. Four hours are required to water 1 acre of wheat crop from the dam. Mean land size among water users in Bharauli is 4.7 acres. Therefore, mean per-capita water requirement for wheat for water users in Bharauli is 18.8 hours (4.7 x 4). But in 1999-2000, a total of 555 hours of water was supplied in Bharauli at a mean per-capita rate of 16.1 hours. In Thadion mean land size is 5.8 acres. Therefore, mean per-capita water requirement for water users is 23.2 hours (5.8 x 4). But in 1999-2000 a total of 479 hours of water was supplied in

Thadion at a mean per capita rate of 32 hours. This leads us to conclude: 1) that per-capita use of water from the dam in Thadion was higher largely due to greater demand for irrigation to augment supply from private tubewells for paddy cultivation in the wet season and 2) that a larger number of farmers in Thadion could potentially benefit from dam-assisted irrigation for wheat cultivation in the dry season if water is not used to irrigate paddy during the wet season.

15. It must be noted that farmers who did not own a tubewell purchased water from those who owned tubewells, thereby effectively spreading the influence of tubewell irrigation to all households with farm plots located at the head-end of the irrigation command of the earthen dam. Expansion of tubewell irrigation in Thadion was reflected in a higher percentage of households (46.6%) cultivating paddy compared to only (9%) of households in Bharauli.
16. In addition to equity aspects, studies in India have also highlighted the adverse environmental effects of unbridled tubewell expansion that has taken place in the context of state subsidies for purchase of inputs like diesel and hardware like pumpsets (Shah 1993). The negative equity and environmental effects of tubewell proliferation has the potential to undermine collective action in watershed management.
17. For a discussion on inter-locking factor markets in Haryana, see Bardhan, 1984:61.
18. In this context it is important to note that sharecropping does not exist among any of the water users in Bharauli and Thadion.
19. Higher agricultural returns have been aided by secular increases in agricultural terms of trade for wheat and maize, two principal crops grown in the region (Government of Haryana 2000).
20. We acknowledge this to be a weakness of the study design, as a result of which it is difficult to assert that family labour has potential to increase per acre productivity in contrast to hired labour.
21. In the case of fodder grass collection from forest areas as well we found a clear relationship between gender and class. For instance, in the high and medium category of households, fuelwood collection is primarily undertaken by male members of the household. However, low and landless categories of households rely on women and young girls to a greater extent to undertake fuelwood collection. This is primarily because male members from approximately 80% of landless category households were engaged in low paying non-farm jobs in nearby towns.
22. We acknowledge from the point of view of watershed management that attention by community organisations towards routine maintenance activity may be considered favourably. However, our intention here is to highlight the fact that when women are not adequately involved in decision making, watershed management interventions may offer them limited benefits. From the perspective of empowering traditionally marginalised groups like women, therefore, such interventions may fare less favourably.
23. Fodder production refers to both fodder raised as a crop as well as fodder as agricultural residue. In the case of the latter, we acknowledge that higher

levels of agricultural productivity may result in higher fodder production. Implicit in this assumption is the fact that households in the high endowment category (with demonstrated levels of agricultural productivity) had the potential to achieve higher rates of fodder production on a per acre basis.

24. Discussions revealed that fuelwood collection from state forests is highest during winter.
25. One must remember that in the case of high endowment households, relatively lower percentage of land irrigated (as a percentage of total land irrigated) by earthen dams were not being compensated by higher area under irrigation from alternative sources like seasonal *kuhl*s. Our analysis indicates that percentage of land irrigated by *kuhl*s as a percentage of total land irrigated was highest for households in the low endowment category. The percentage of land irrigated by *kuhl*s as a percentage of total area irrigated was 63%, 60% and 88.2% for high, medium and low endowment categories of households.

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