Benchmark Survey for Impact Assessment of Participatory Watershed Development Projects in India

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With the beginning of the new millennium, Watershed Development Programme in India has embarked on a new phase of consolidation of experiences so that the programme could effectively perform its role as the key strategy for rural development in large parts of the country. One of the important conditions for launching onto the new phase is to get a reasonably realistic picture of what has been achieved over the past 10 years. Unfortunately, assessing this is difficult despite the existence of a large number of studies examining the impact of watershed development. The difficulties arise mainly due to certain methodological issues involved in impact assessment. One such issue pertains to absence of benchmark studies prior to implementation of watershed projects.

While a number of studies have gone into identification of parameters and development of protocols for impact assessment, operationalising them on the field is often cumbersome if not impossible. Also, operationalisation of the benchmark surveys needs to be adapted to the context specific situations. The present exercise is an attempt in the direction of evolving a methodology which is comprehensive as well as technically sound, and at the same time, feasible to be operationalised by a large number of agencies involved in implementation and/or monitoring evaluation especially in three different agro-ecological regions in India viz; dryland, forest-based and hills. The study, is by and large, exploratory in nature.

We are grateful to the Planning Commission for giving us an opportunity to conduct the field experiment and in the process evolve a practical methodology for a benchmark survey for watershed projects in these three different systems. Especially, we are thankful to Dr. Rohini Nayyar and Dr. Nagesh Kumar for taking keen interest and extending financial support for the study. Mr. P.K. Aggarwal also facilitated the process for extending the support.

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At this juncture we would also like to put on record the fact that conducting a benchmark survey in the relatively remote areas in three states involved a huge task not only in terms of logistics but also in terms of time specificity, compilation of maps as well as secondary data, and the requisite skills. No doubt, the task could not have been accomplished without the support of a large number of researchers, officials and professional organizations. We would specifically like to mention the help provided by various officials of Watershed Management Directorate (WMD) at Dehradun, Prof. Dinesh Marothia at the Agricultural University at Raipur, and IFFCO in Kalol (Gujarat). We are thankful to the PIAs, the village communities and a number of other individuals and agencies that lent valuable support during our field work in the three states. Finally, the hard work put-in by the field investigators has been the most critical feature of the exercise. We express our appreciation and gratitude for their efforts.

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We wish this modest effort will contribute towards the setting-up of appropriate monitoring and evaluation system, essential for improving the outcomes of watershed development in different parts of the country.

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Chapter 1
Introduction

1.1 The Context

With completion of the first set of Watershed Development Projects (WDPs) initiated by the Ministry of Rural Areas and Employment (MoRAE), and with significant experiences gained through implementation of the National Watershed Development Project for Rainfed Areas (NWDPRA) supported by the Ministry of Agriculture, the country is poised for major leap towards watershed based development especially in the dryland/semi-arid regions in India. The initial feedbacks from both these projects are somewhat mixed. Notwithstanding certain limitations in project design and/or implementation, these projects have led to at least two positive outcomes: (i) creation of a large number of structures for soil water conservation; and (b) setting up of participatory institutions for management of the local resources. Both these may have significant pay–offs in terms of resource regeneration and capacity building in the long run. Capturing these is difficult since participatory processes take a rather long time before showing up tangible results.

Meanwhile a number of efforts have been made especially, as part of monitoring and evaluation exercise, to ascertain the outcome of various watershed projects in the short or medium term. But the studies, by and large, provide only a partial view of the actual outcome. To a large extent this information gap exists because of the two major limitations. First, there are number of methodological difficulties in gauging the actual impact of WDPs (Dar, 2003 in ICRISAT). And second is absence of a proper base-line data, which is essential for a fairly robust, if not scientifically most accurate, assessment of the outcomes of watershed projects. There is of course, an additional difficulty arising from the fact that watershed development is continuous process, rather than a time bound project with well-defined set of activities and clearly earmarked funds.

While the criticality of getting the benchmark values is fairly well established in the vast and ever growing literature on project evaluation and impact assessment, the exercise is often resource intensive and at times, cumbersome. This is particularly true in the context of watershed project, which deals with multiple resources, through multiple activities and aims at multiple goals-environmental, economic, and social. This leads to a major problem of identification of measurable impact or performance indicators along the multi-faceted avenues through which changes are taking place (Shiferaw and Freeman, 2003; p. 31). Evolving a robust and yet rigorous methodology for assessing the impact of watershed projects is thus, a major challenge facing the, academicians, policy makers, and practioners. This exercise is an attempt in this direction.

1.2 Review of Existing Evidence

A number of studies have been conducted over the past the past decade, examining the impact of various watershed projects in the country. To a large extent these studies have been undertaken as a part of the monitoring/evaluation exercises mainly at the instance of the funding agencies both in the government as well as non-government sectors. There are however, a number of independent studies, trying to capture the impact cutting across watershed projects funded by different agencies and linking up with the larger issues of productivity and livelihood, equity and decentralization, and resource as well as institutional sustainability (Shah, 1998; Kerr, et.al 2002; Joy and Paranjpye, 2003). As a result, the studies despite being rich in terms of analytical approach and content, do not help create a larger picture of what has been actually achieved from the large mosaic of watershed projects being implemented in different parts of the country. In what follows we try to highlight some of the important findings from the existing studies focusing on impact of watershed projects in the country.

A comprehensive study by Deshpande and Reddy (1994) seeks to examine the impact of National Watershed Development Project for Rainfed Areas (NWDPRA) in Maharasthra. It tries to capture the impact of watershed project using `with-without' comparison across different agro-climatic conditions in the state. Among the major findings, it is observed that crop- yields were higher among non-beneficiaries vis-à-vis beneficiary households though, the authors note that the latter may have better allocative efficiency vis-à-vis the former. Similar findings have also emerged from a recent study in semi-arid regions, which observed that the plot level productivity effect of the watershed project was not significant in a pooled analysis of all crops and all villages (Shiferaw et. al; 2003; Reddy and Soussan, 2003; Shah, 1997).

Based on a large survey of about 100 villages and 350 plots, the study by Kerr (et.al) observed only a limited impact of most of the projects especially, the Government sponsored projects like (NWDPRA) vis-à-vis some of the participatory projects like Indo-German Watershed Development Project (IGWDP). It was also observed that scaling of the participatory projects especially, through Non-Government Organisation (NGOs), was difficult. These kinds of observations have been echoed from a number of projects implemented by NGOs with exceptions of the few `successful' projects, implemented through NGOs, and having reasonably large coverage of villages (say, >200). Some of these NGOs are: Aga Khan Rural Support Programme (AKRSP) in Gujarat, Mysore Rural Development Agency (MYRADA) in Karnataka, Gram Vikas Trust (GVT) in Madhya Pradesh and Rajasthan, Seva Mandir in Rajasthan, Karnatakea Watershed Development Project (KAWAD), Western India Rainfed Farming Project, and Doon Valley Project (DVP) in Uttarakhand. Barring these, and some of the major success stories Ralegaon Siddi, Sukhmajari and Rajiv Gandhi Watershed Mission in Madhya Pradesh, a large number of studies on watershed projects in different parts of the country have indicated mixed results especially on economic impact (Chopra, 1999). Similarly, doubts have been raised about the long-term sustainability and/or replicability of some of the flagship projects listed above. Also, it is noted that the economic impact, often reflected in a favourable benefit: cost ratio is often influenced by availability of additional irrigation among only a handful of farms and farmers as observed through a review of 35 studies on watershed projects in different parts of the country (Shah, 1999a).

It is however, pertinent to note that more than the direct impact on yield, watershed projects seem to have exerted positive influence in terms of reduced run-off or erosion (Kerr, 2002), and stability of yield especially under rain-fed conditions. Similarly, positive impacts on drought mitigation and reduced distress migration have been observed from a number of studies especially, in dry land regions (Shah, Anil, 2000). Of course, these observations are often based on perception-based information rather than on quantitative estimates of some of the critical bio-physical indicators (Joy and Paranjape, 2003). Against these there a few studies, mainly from agricultural universities or other scientific-research institutions, which tried to measure the impact in terms of bio-physical measures. For instance, a study by Karanth and Abbi (2001) on the PIDOW project in Gulbarga, found that under similar rainfall conditions, the run-off had reduced by 30 per cent over a period of 10 years. Similarly, studies by Central Soil Water Conservation Research and Training Institute (CSWCRTI) have demonstrated positive impact on reducing runoff and improving crop yields in different parts of the country. Scientific studies have also gone into examining the changes in hydrological features as a result of watershed projects. Based on the studies in Karnataka and Andhra Pradesh (Batchelor et al. (2002)), notes that watershed projects often bring certain unintended changes in hydrology. They observe that: (a) water harvesting measures, unless backed up by proper institutional arrangements for regulating the use, may lead to inequitable access and shortage of drinking water; and (b) water harvesting programmes exert significant impact on the pattern of water use, and that this can create distinct situations of winners and losers. These situations often lead to a scenario where watershed projects end up with further depletion of ground water than what was before. Of course, this is not because of the project intervention; rather the situation arises despite such interventions. It may however, be noted that in absence of a proper water balance study, it is difficult to gauge whether the increased water use refers to the annual flow or digging into the stock. To a large extent limitations of the studies emerge from the fact that the benchmark or the pre-project values were not available.

Notwithstanding these limitations, it may however, be useful to get some kind of a broad idea of the outcome of the watershed projects. Following observations emerging from the existing body of literature could be sum up the overall experience with respect to watershed projects in the country:

(i) Despite the integrated approach to natural resources development, water harvesting structures and irrigation assume the central stage of watershed programmes especially dryland regions.

(ii) While the impact on productivity is mixed, increased irrigation facility, irrespective of the water use efficiency, is the single most important factor resulting in favourable benefit-cost ratio.

(iii) Although irrigation is an important intervention, its availability across households and natural resources within a watershed is fairly uneven.

(iv) Participatory processes do not generally address the issue of inter-household equity as well as environmental sustainability.

(v) The sustenance of watershed treatments, as well as institutions hinges a lot on people's stakes in the project. Cost sharing, as an important indicator of people's stake, is found to be fairly limited except for a few cases of the often talked about successful projects/ agencies.

The above observations highlight the fact that apart from irrigation-induced improvement in productivity and net-returns, there is limited impact in terms of environmental regeneration and sustainable livelihood among the poor. As a result, watershed projects as of now, are characterized by certain critical missing links such as: regeneration of CPRs and degraded forest in a large number of watershed projects (Shah, 1999b). What is more concerning is that in most cases the environmental impact are captured only through indirect measures (Chopra, 1999). Even if environmental regeneration takes place, the requisite mechanism for ensuring that the additional resource, e.g. water for irrigation is distributed evenly and used efficiently, is seldom present. Since the conventional impact assessment focusing mainly on benefit: cost ratio at a village or micro watershed level, it does not reflect adequately on these issues. This is despite the fact that recent approaches for participatory watershed development, now adopted by – the Ministry of Rural Areas and Employment (MoRAE) as well as Ministry of Agriculture (MoA) make these issues particularly relevant for impact assessment.

Overall, it appears that whereas the existing studies do bring out some positive impacts of the various watershed projects, the findings are not conclusive. Based on a brief review of evidence from the first batch of watershed projects under the MoRAE, Rao (2000) noted that "from all these evaluations, one does not get a direct indication of soil conserved through watershed development --- and that it would be useful to develop indicator and methodologies to capture separately the improvement in soil status" (p. 3945). Similar observations could also be made about the impacts in terms of sustainability of (a) productivity gains and their distribution across regions and households; and (b) participatory institutions for addressing the missing links.

Attempts have been made to assess the impact of participatory approaches. A recent study of project implementation under MoRAE suggested that lack of implementation capacity is the major reason for poor performance of the project. And that training alone will not be adequate as the incentives to participate in training itself may be weak (Farrington et.al, 1999). What is concerning is that such limitations arise even in the cases where the project implementation has been fairly participatory. The need therefore is to understand the dynamics of the three inter-related aspects which eventually determine the impact (or outcome) of watershed projects. These are: (i) technology, physical treatments and economic returns; (ii) institutions that ensure equity and efficiency in resource-use; and (iii) market linkages essential for enabling the project to sustain beyond the initial funding, and for spreading out to larger number of beneficiaries as well as areas.

1.3 Emerging Issues

The existing literature thus, raises certain important issues that need careful probing. First, the composition of watershed treatments covering both public as well as private land, needs a closer look before assessing the economic as well as environmental impact of the projects. To the extent the choice of treatments is governed by the structure of economic incentives, a large part of the common property resources (CPRs), are likely to receive a lower priority in the people centered participatory projects. Ensuring better coverage of treatments like pasture development, plantation on degraded lands, drainage line treatment, renovation of village tanks, community based drinking water facilities etc. may perhaps, need a carefully worked out incentive structure besides sorting out certain administrative difficulties in improving the effective access to the CPRs.

Second aspect relates to sharing of benefits not only across villages and communities but also among the landed households within a micro watershed. It is quite likely that the successful projects with an overall favourable benefit-cost ratio might reflect significant economic returns accruing only to a handful of landed households within a watershed community. Similarly, the impact in terms of reduced uncertainty of yield across a large number of farms and households operating under unirrigated conditions also need further probing.

Third, benefit-sharing, especially in terms of irrigation water, is closely related to the technology of water conservation as well as its utilisation. While harvesting rain water is essential, both for economic as well as environmental objectives, the water harvesting structures have to be planned systematically in the light of the geo-hydrological factors in a somewhat wider level i.e. at the level of river or sub-river basin. At present, some these vital watershed treatments are being planned and executed mainly at the micro watershed level without looking into the larger systems of which they form an integral part. If carried out in a haphazard manner, measure like check dams and other treatments on the drainage line, might create distortions in the geo-hydrological systems in the down stream. These issues often remain overlooked in the planned implementation as well as monitoring of the watershed projects.

Further, apart from water and irrigation, some of the agronomic practices like mulching, manuring, inter-cropping, trenching and other vegetative measures need a significant emphasis in watershed projects. For, these agronomic practices in combination with efficient use of water, can lead to a new farming system which could be economically as well as environmentally sustainable, and socially equitable. The need is to look at the technological potential and the commensurate incentive structures so to promote simultaneous adoption of these measures. This may warrant a fresh thinking in terms of cross-subsidisation both across watershed treatments as well as households.

This leads to the final issue of initiating a process of negotiation within and across micro watersheds. At present the issues of effective participation, sharing of costs and future management continue to remain elusive even in some of the better performing projects. While a part of this problem arises due to the `project mode' and the given time frame within which the intervention takes place and also evaluated, not much has been learnt about the mechanism that can work beyond the `project mode' in terms of funding, organizational support and monitoring.

Together the above observations though, tentative suggest that participatory processes and institutions alone may not do the trick of an effective implementation, which also has to stand test of economic viability and environmental sustainability. Given this context the pertinent questions in the context of impact assessment are:

(i) What are crucial factors influencing the impact of watershed projects in terms of (a) economic returns and their distribution; (b) participatory processes and institutions to ensure resource-use efficiency and environmental sustainability; and (c) market linkages for expanding the reach of the project beyond the immediate benefits and beneficiaries?

(ii) What is the interface between the three sets of outcomes viz; economic, institutional and environmental.

(iii) What are the major indicators capturing the above outcomes and how to assess them?

It is time that the academic community along with policy makers and practioners of watershed development, responds to the challenge of generating a broad based, comprehensive, and scientific data base to assess the outcomes of watershed projects- both in the short as well as medium and long terms. The fact that such a database does not exist, is mainly due to certain methodological difficulties in assessing the impact of natural resource management (NRM) in general and watershed in projects in particular (Dar, 2003). These aspects have been discussed as follows.

1.4 Methodological Issues

As noted earlier, the methodological difficulties in impact assessment emanate primarily because of the multiplicity of goals that include improvement of productivity, reduction of risk and conservation of the productive resource base (p.17). Equity and decentralization are other two important objectives of watershed projects in India. The expected benefits therefore are multi-dimensional and vary across time and scale. Similarly, external benefits often accrue to agents who may not be willing and/or able to pay for such benefits (p.29). On the other hand, many of the benefits may take place over a longer period time during which the initial operating environment might also change. The last feature is particularly important as it calls for a complex scheme of impact assessment combining both `before-after' and `with-without' comparison. Ideally, the approach should be to have a two sets of panels –with and without the project intervention, to be tracked over a period of 5-7 years. This obviously is a challenging task, involving a lot of time as well as financial resources. Recognising these difficulties, most of the studies in the Indian context have resorted to undertaking economic benefit-cost analysis, excluding the environmental impacts, by adopting `with-without' comparison. The other limitations observed in most of the studies pertain to: (a) selecting a proper control in an analysis using with - without comparison; (b) absence of adequate base line information on vital parameters like access to irrigation, fertiliser use, seed variety, soil type and topography etc.; (c) lack of adjustment for rainfall related uncertainties; (d) capturing only one-time employment gains; and (e) cursory approach for assessing changes in physical parameters like soil moisture, ground water table, survival of plantation etc.

The MoRAE has made provision for setting up a fairly elaborate system of monitoring and evaluation. One round of evaluation exercise was already undertaken during 2001; the results are yet to come out in public domain. The evaluation exercise however, had certain inherent limitations pertaining to the timing, coverage, and sampling. Besides these, the time-frame for completing the exercise was also very limited (AKF, undated). The most serious limitation of course, was absence of the bench-mark values for comparing scenario over time. This as we have noted earlier, has been a common problem faced by most of the impact assessment exercises pertaining to the NRM sector.

Another limitation, found in the case of a large number of studies on watershed projects relates to the timing of evaluation. Most of the studies are carried out either during or almost immediately after the completion of the project implementation. This reduces the scope for assessing the impact in the long term. Even in the studies undertaken immediately after the project completion, there is a problem of getting critical information for the intermittent points during the project period. This may pertain to some initiatives/responses to the drought/flood situations, which eventually may have exerted significant impact on the outcomes as they obtained at the end of the project implementation. While qualitative information are of immense value in the context of these participatory, equity and gender sensitive projects, it is essential to develop methods for eliminating subjective elements in these kind of feed back.

Environmental impact assessment in watershed projects also needs special attention. So far, the impact studies capture mainly physical aspect of the impact on natural resources like soil erosion, ground water table, soil-moisture content, vegetative cover and bio-diversity. Often, these impacts have been identified in the specific context of micro-watersheds under the study. This leaves out capturing the impact at meso and macro levels of a watershed. This is important in the event of expected changes in topography, land use, and hydrology. Ideally geographical information system (GIS), despite certain limitations, could help in ascertaining these changes taking place at different scales of a watershed. Nevertheless, they also need to be supplemented by additional information collected from the study sites. This approach, subsequently, should be complemented by a proper valuation of environmental regeneration. This is a relatively new field hence, needs detailed exploration.

Finally, the existing studies on watershed projects indicate plurality of approaches as well as methods adopted for collecting primary data. These include Participant Observation, Participatory Rural Appraisal, Process Documentation, One Time Household Surveys, and Longitudinal Studies. Ideally, all these are very useful tools. Evidentally, some of them might become more effective if used in combination of other methods. In fact, the need is to get both quantitative as well as qualitative information, collected by applying necessary cross checks and at times, physical verification. The existing studies, as noted earlier, depend heavily on perception-based information, at times provided by the implementers themselves. What is thus, crucial for impact assessment is a special probing skill to question some of the commonly shared perceptions and ability to grasp the cause-effect relationships in a context specific situation. This would require a fair amount of familiarity and prior information before undertaking a participatory data collection exercise. In absence of this it is likely that some of the apparent observations, especially those in the desired direction, might get established as empirically founded reality.

This kind of sensitisation is all the more important when a variety of agencies with different approaches and expertise get involved in monitoring and evaluation of watershed projects. While this is a welcome development in so far as it adds up to the variety of rich experiences among the researchers, technocrats, development activists, and at times, people themselves, one cannot undermine the importance of methodological rigor in such efforts. For, in the absence of it, one may easily get driven to the conclusions that at best are tentative, or may miss out some important lessons that could have been learnt if right kind of questions had been asked in right manner.

To a large extent these limitations emanate from resource constraints- time, skill, and finance. Hence the need is to workout a methodology, which could overcome many of these limitations, and at the same time, feasible to replicate by not-so-specialised scientific personnel. The present exercise tries to evolve such a methodology by carrying out a benchmark, which would provide the foundation for a comprehensive impact assessment to be carried out at later stages.

1.5 Objectives and Approach

The proposed study will focus on the three main objectives:

(i) To evolve a framework for impact assessment in the light of the existing studies on the impact of watershed projects in selected states.

(ii) To identify important indicators for assessing the impact in terms of economic benefits and their distribution, institutional mechanism and capacity building, and environmental regeneration.

(iii) To conduct a benchmark survey covering the aspects mentioned in (ii) above, and undertakes initial analysis in the framework evolved.

The study is mainly focused on the Integrated Watershed Development Projects (IWDP) supported by the Ministry of Rural Areas and Employment in three states with different agro-climatic conditions and topography. These include (i) Gujarat (dryland); (ii) Chattisgadh (forest); and (iii) Uttaranchal (Hills) (see Map 1). The analysis is divided into seven chapters including this introduction. The next chapter provides a brief overview of the major methodological approaches evolved by different agencies and discusses the strengths and weaknesses. Chapter 3 describes the details of the methodology adopted for the present study and rationale for that. Chapters 4 thru 6 present estimates of selected indicators based on the primary survey in three agro-ecological situations. The last chapter 7 identifies limitations of the present exercise and highlights need for further improvement.

Chapter 2

Indicators and Approaches for Impact Assessment: An Overview

Recognising the complexities involved in assessing the impact of watershed projects, attempts have been made to identify appropriate indicators, especially environmental indicators, and evolve methodologies for ascertaining the changes due project interventions. These include scientific measures for soil-loss, ground water recharge, and increased vegetation to socio-economic measure such as: productivity enhancement, income, employment on the one hand equity and gender empowerment on the other. Obviously the methodologies range from mainly survey based focusing on quantitative data to using participatory tools and obtaining qualitative information. The actual approaches, in most cases, try to blend both- primary surveys and participatory tools in order to arrive at a fairly robust understanding of the impact on the three major aspects viz; environmental, economic, and social. Choice of the specific approach however, would depend largely on factors like: scale and stage of project implementation, specific emphasis of the project, and of course, access to skill, time and financial resources at the dispense of the researchers. This chapter aims at discussing five major approaches developed by the Government Departments, NGOs, and researchers. The idea is to get broad canvass of the indicators as well as research methodologies and discuss the constraints faced in operationalising these approaches.

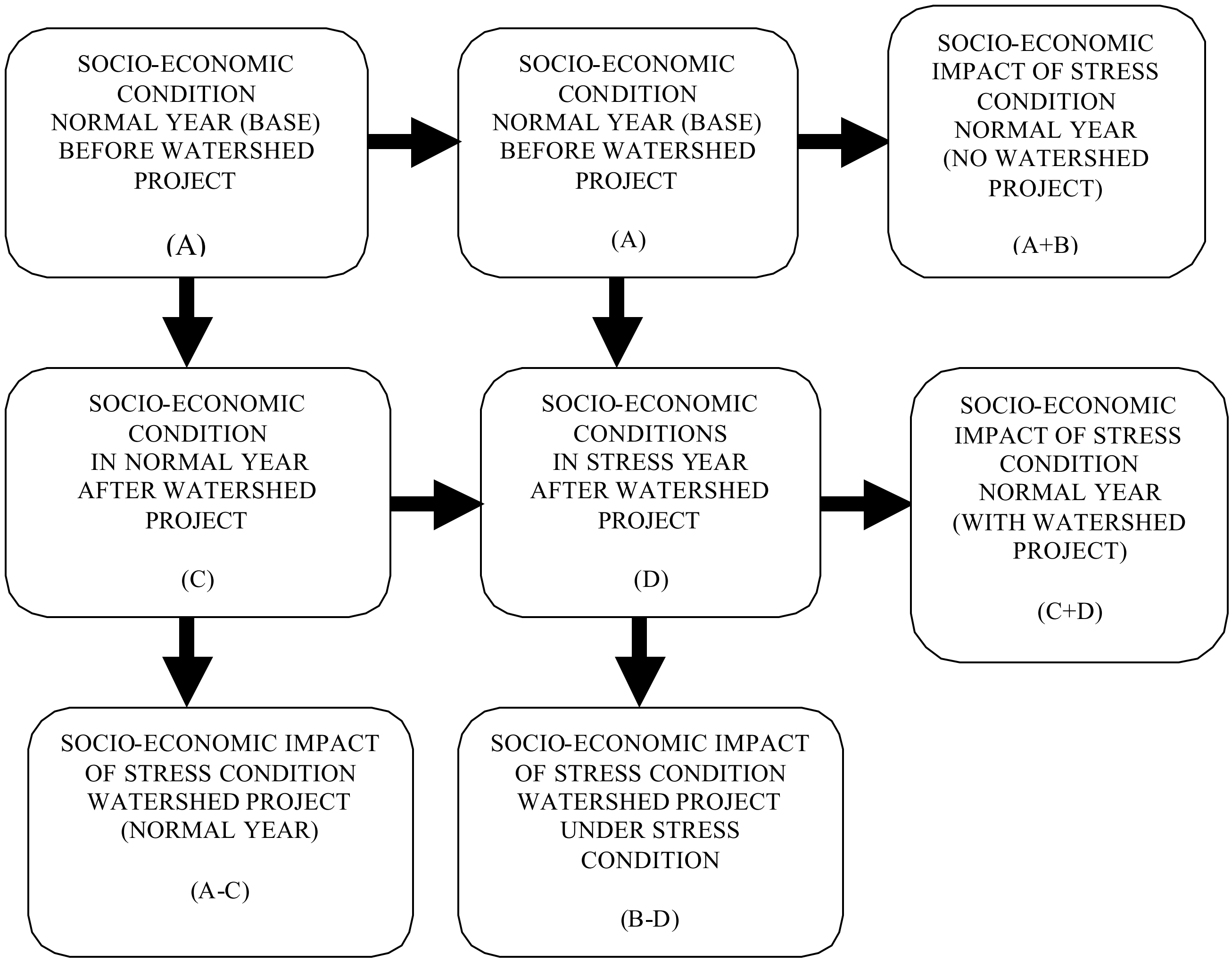
2.1 Various Approaches

(a) The Official Approaches

(i) NWDPRA:

The ministry of Agriculture, way back in the early nineties, had developed guidelines for project implementation and also for monitoring and evaluation (GOI, 1994). These provided a fairly rigorous methodology for impact assessment (or evaluation) to be carried out at the end of the project tenure. Chart 1 depicts broad schematic of the methodology. It is interesting to note that the methodology involves a `before-after' comparison, which essentially involves a bench mark in order to ascertain the changes over time. Since the central thrust of the project is `maximizing production during normal year and minimizing loss during stress year, the methodology also takes due cognisance of the critical importance of rainfall in determining the impact. Keeping this in view, a four-way comparison has been envisaged, which facilitates separating the impact of the project on one the hand and that of rainfall on the other.

Chart 1: A Framework for Watershed Impact Analysis



The guidelines also provide a detailed list of indicators for the three major sets of impacts noted above. While this is a fairly exhaustive list of indicators, measuring them might be difficult unless, a proper system of periodical monitoring and data systems are in place. Since the project guidelines have made extensive provision for such systems to take place, the approach may work fairly well for impact assessment. Two aspects may need attention. First, methodology does not involve `with-without' comparison so as to be able to take care of the problem of attribution. Second, it essentially requires a bench-mark, which covers two scenarios i.e. normal rainfall and stress period prior to the launching of the project. Spreading the benchmark survey over two or more years before and after the project period may not be feasible. One of the possible ways of overcoming this situation is to capture one as actual status and another by asking a hypothetical question. This of course, will bring-in some element of inaccuracy in the bench mark itself.

(ii) MoRAE:

As noted earlier, the Ministry of Rural Areas and Employment had initiated an evaluation exercise during 2001 in order to assess the outcome of the project's implementation during the first phase i.e. during 1995-2000. The exercise was to being carried out in 330 districts covered by the project. The main aim of the impact study was to find out, inter alia, how far the project has contributed to the improvement of socio-economic condition of the resource poor. The study was to focus on three objectives:

a. To assess the economic development of community, which is directly or indirectly dependent on watershed project.

b. To assess impact on ecological restoration through sustained community action and affordable technologies

c. To assess the impact in terms of more equitable distribution of benefits and increased opportunities for women.

Prima facie, it appears that the approach therefore, lays special emphasis on socio-economic-institutional aspects as compared to environmental aspect of the project. This in turn, also gets reflected in terms of the indicators selected and methods used for data collection. For instance, environmental indicators like soil loss etc. has been examined at the watershed level, using perception based question such as: Whether the project had a positive impact on control of soil erosion, arrest of run-off water, improvement in soil-moisture etc.' The answers sought were `yes' or `no'. Similarly, the approach does not envisage any bench-mark survey. The exercise envisages collection of information for only one point of time. Also the data collection exercise had limited time frame of only four months because of the `time constraint'. This apparently is a difficult proposition especially, when some of the bio-physical indicators need physical verification and triangulation. Finally, assessment of household income from various sources is an extremely difficult and time-consuming task to be accomplished in a quick survey such as this. Also these estimates need to be verified against certain important indicators like changes in asset base, consumption pattern, and human resources etc. In absence of this information it is difficult to ascertain changes in income of the households; attributing these changes to watershed projects might be even more difficult.

Given the methodological limitations in the impact assessment exercise initiated by the MoRAE, what at best can emerge is some kind of a crude indication of the changes and their association with the watershed project, as perceived by the village community. This kind of a quick assessment could however, be strengthened by supplementing the quantitative surveys with participatory tools, which ideally help gauging the cause effect relationship, irrespective of the magnitude. In what follows we discuss two major approaches that draw heavily upon qualitative data and participatory tools in conjunction with survey methods.

(b) Participatory Approaches

(i) Indo-German Watershed Project:

Driven by the considerations of developing a rigorous and yet practical approach fro impact assessment the Indo-German Bilateral Project has brought a manual Impact Indicators- An Alternative Tool for the Evaluation of Watershed Management. The approach is based on five major attributes of evaluation methodology viz; fast to execute; easy to use; cheap; responsive; and universally applicable (Basu, 2001). Nine major parameters were identified in order to capture impact of the project. These are:

1. Soil Loss
2. Ground Water Level
3. Height for Age of the Children
4. School Attendance and Enrolment Rates
5. Ownership of Select Consumer Durables
6. Social Capital
7. Use and maintenance
8. Outsiders (Dependence on)
9. Replication

Of these the first six indicators have to be estimated through a benchmark at the beginning of the project. The above set of indicators is being supplemented by participatory indicators, which could help understanding changes and the priorities thereof in terms of people's perception. Also these can help understand the intra-community dynamics and conflicts among different sets of stake-holders within the village. The next approach helps elaborating more on the participatory tools.

(ii) WASAN

Taking a holistic view of monitoring and evaluation the approach envisages process evaluation and impact assessment as essential components of the exercise. Whereas the former may look into the relevance, performance and missing links of the process indicators, the later may focus on assessment of impact against the stated objectives and also on revisiting of the initial objectives or hypotheses set up at the time of launching the project.

The impact assessment should look at the following attributes:

d. Gestation period
e. Strength of Impact (intensity and sustainability)
f. Resolution
g. Stake holder focus

Assessing these attributes would require detailed understanding of the processes that have gone into producing the actual impacts. The approach therefore, provides detailed guidelines for evaluating the processes at different stages of project implementation (Ravindra, 2001). .

(c) Combining Bio-Physical and Socio-Economic Indicators:

Despite various efforts for evolving a robust approach, which synthesizes scientific and socio-economic indicators in order to capture the impact of watershed project, the issue of striking a proper balance is yet to be resolved. The recent debate at an international workshop organised by ICRISAT (2003) deliberated these on the issue. Recognising the importance of the bio-physical indicators such as land quality, soil quality, hydrology, and agronomic indicators currently in practice, it was noted that the actual approach need to appreciate following aspects of the bio-physical indicators (Pathak, et.al, 2003). These are:

Tentative List of M & E Indicators

Item	Indicators	Frequency	Method of data collection
1. Employment	i. Total ii. Per unit of activity iii. Employment/Rs. 1000 spent iv. Migration	A/M/E	On-going evaluation NICNET format Sumangal Diary/Beneficiary index card Impact evaluation
2. Balance (Surplus)			
a. Food grains b. Fodder c. Milk d. Fuelwood	i. Fine cereal production ii. Coarse cereal iii. Pulses iv. Oilseeds	A/M/E	NICNET format Sumangal Diary Impact evaluation - do -
3. Changes in Ownership Pattern	i. Number of agricultural labourers ii. Landless labourers iii. Families by land-holding size	E	Ex-post evaluation
4. Water Levels a. Drinking water (adequate/inadequate/ scarce	Human Cattle Distance Increase in number of wells Increased in dry season cropped area	Season wise A/E M/E	On-going evaluation Ex-post evaluation - do -
5. Productivity	Yield differentials in major crops between irrigated and unirrigated area	M/E	- do-
6. Income	Total (By sources – incremental)	M/E	- do -
7. Subsidiary Activities	% families by different activities % families by proportion of income from subsidiary activities	M/E	- do -
8. Impact on Women	i. Employment ii. Wage rates iii. Supply of equipments/ implements iv. Other activities	M/E	On-going/ex-post evaluation
9. Peoples' Participation	i. Awareness ii. Repayment iii. Collective actions iv. Management of common property resources	M/E	On-going/ex-post evaluation
10. Improvement in Extension	Demonstration performance (good/medium/poor) Adoption of practices (good/medium/poor) Farmers training (good/medium/poor)	A/M/E	Inspection report NICNET Format

Features of Various Monitoring and Evaluation Activities under NWDPRA

Report (what)	Periodicity and Agency (by whom and when)	Submitted to (for whom)	Contents	Coverage (Sample)
I. Monitoring				
1. Regular administrative progress report	Monthly by WDT workers/PG Apprentice	WDT leader	Physical and financial progress by type of CFs identified	Entire micro-water-shed
2. MIS format (NICNET)	Quarterly – by PG apprentice	WDT leader NICNET (state and national authorities)	As prescribed MIS format	Entire micro-watershed
3. Sumangal Diary (Farmer's passbook) Beneficiary Index Card	WDT workers – project executing staff as and when work progresses -collated quarterly for MIS format	Discussed with farmers checked by WDT leader	As prescribed in the format	All farmers and land-less in the micro-watershed
4. Village ledger of Sumangal Diaries	WDT workers – 2st year of project updated annually	WDT leader and inspecting officials	As prescribed in the format	All farmers and landless in the micro-watershed
5. Inspection reports	National, state, district level officials, scientists etc.	District-state and national level authorities	As prescribed in the check list	Random sample of work sites in the micro-watershed
II. On-going Evaluation – Indepth Montioring Surveys:				
(a) Interviews (i) Farmers (ii) Key informant (b) Group discussion	NGOs wherever available or WDT team (internal) done annually – 1st survey being done at the beginning of 2nd year of the project. People's monitoring and evaluation	WDT team leader District/state level authorities	As in monitoring plus rainfall-monthwise, cropping pattern. Introduction of new crop varieties, cropping intensity. No. of Mitrakisan/ Gopal identified	Through a sample survey of 100 farmers for each watershed. While 50 of sample will be retained as constant. 50 will be selected anew every year
c. Participant observation (in group meeting) plus information obtained through monitoring			Farmers groups – Employment (on and off farm). Inspection follow-up. Extent of coverage under other activities. E.g. Social forestry, input supply, etc. present condition of assets created. Access to common property, resources etc.	Proportionate representation will be given to different land size groups and 10% for landless (5% constant)

(i) There is no universal set of bio-physical indicators. The selection of relevant indicators therefore, has to be based on a good understanding of various processes in a context specific situation.

(ii) Most of the currently available bio-physical indicators may need modification or refinement before they can be used for assessing impacts of watershed technologies.

(iii) Perceptions of the people needs to be taken into account in order to understand the processes taking place in the natural resource base in a contextualised setting.

The authors therefore, re-emphasised the importance of time series data on crop productivity in assessing the impact of watershed projects. It is noted that cropping diversity, intensity, pest infestation, and diseases, and deleterious weeds are the main attributes often used for capturing the impact of watershed development.

The above discussion on impact assessment could be summed up in the light of the framework presented in Chart II by Izac (1998).

Chart II: Multi-faceted Indicators of Impact at Different Spatial Scales – The Case of Soil Conserving Technologies

Indicator	Level		
	Farm	Household	Watershed
Biophysical	• Rate of erosion • Soil fertility status • Vegetation cover • Crop yields • Areas abandoned due to high erosion	• Food produced • Access to water and fuel • Quality of drinking water • Quantity of drinking water	• Slopes stabilized • Rate of siltation • Quantity of water in reservoir • Area under tree cover
Social	•	Awareness of environmental degradation	• Rate of immigration • Conflict for access to land and water • Income redistribution • Access to natural resources
Economic	• Fertilizer use • Rate of profits • Level of risk • Level of diversification	• Income level • Level of food security • Level of assets	• Infrastructure network • Biodiversity level • Dam siltation cost

Source: Izac (1998)

SOPPECOM Approach: Arriving at a Synthesis

Considering the major bio-physical indicators and the field experience in terms of operationalising the actual measurement of these indicators, SOPPECOM has come out with a fairly comprehensive approach that combines both bio-physical and socio-economic indictors by evolving simpler devices, using participatory tools, and seeking people's co-operation in recording the actual observations on a periodical basis. The approach recognizes that watershed development brings about significant modification in the immediate physical environment within a watershed. And that, this takes place at many different levels and affects the physical environment at many different levels. Measuring these changes at different levels thus, is crucial. A brief manual for measurement of selected physical indicators is presented in Appendix 1.

Soil Profile

The most direct and significant effect that the watershed treatments have is on the soil in the watershed. Soil erosion may be checked in situ or deposition sites may be created within the watershed so that eroded soil is deposited within the watershed rather than being carried outside it. There will thus be a change in soil erosion, accumulation and formation profile. Mapped on to the socio-economic status of the landholders, this may result in modification of productive resource and their potential for the different socio-economic groups.

Apart from soil erosion, transport and accumulation which are bulk transport processes, there are also expected to be changes in soil quality resulting in soil amelioration. This is expected to affect soil moisture retention and soil moisture availability for biomass. In turn different types of treatment may result in a change in biomass stands, and both, their relative proportions (the proportion between forest land, waste land, crop land, pasture land, silvicultural and horticultural stands) as well as their internal composition (which crops, trees or species occupy what area) is also expected to change.

These soil treatments (including the changes in biomass composition in the area) also affect the water balance within the system, one way or the other. For example, soil amelioration would lead to increase in the moisture holding capacity of the soil. This may result in an increase in base flows if more of the water percolates beyond the root zone and adds to groundwater. On the other hand, if rainfall is steadier, of lower intensity and there are biomass stands to take advantage of the soil moisture, it may result in a reduction in base flows, but an increase in biomass production within the watershed. This is simply to illustrate that though the direction of treatment (soil amelioration) may be the same, the results may by no means be in the same direction.

Water Balance

Besides the soil treatment measures, the drainage line treatments in a watershed will affect the water balance within a watershed even more directly. Detention measures that cause pooling of water can again have both kinds of effects. For example, excessive pooling could lead to a significant increase in evaporation even while there is some increase in groundwater recharge, and the net effect on the water balance may be a reduction in water availability that does not turn up as such within the watershed. This is because what was lost to evaporation would have contributed to run off into a downstream area and will appear as a reduction in water availability there instead of within the watershed. Within the watershed, an assessment would probably come out as positive on the basis of the increased groundwater recharge.

Scale of Observation

This brings us to the point of the meso and macro scale effects of watershed development. The basic unit of the watershed development programme is a micro-watershed and is treated as a micro-watershed programme in which each micro-watershed in seen as an independent entity. However, the water within a basin is clearly linked together and in principle, *all* intra-basin changes affect the nature of the basin-wide water balance and its components. Put in another way, every watershed programme has basin-wide effects, and though their significance may vary, for example, some of the effects may be important at meso-level but not significant at the basin level, in principle, the proposition is true.

These physical changes interact with the socio-economic situation within a watershed in many complex ways, and the net socio-economic effect of watershed development may also turn out to be complex and non-linear and multi-directional. The spatial distribution of physical factor and their changes may result in asymmetries that need to be uncovered precisely because of their unintended and unanticipated nature. One such asymmetry is that between water available as surface flow or storage and that available as groundwater flow and storage. While the latter is generally considered to be public property the latter is considered more or less to be private property and the spontaneous, unproblematised nature of watershed development may often tend to suppress the public resources and convert them to private resources.

Similarly, the change brought about by watershed development on livelihood patterns will not be unidirectional and unproblematic. The impact of watershed development is often implicitly assumed to be a matter of simply how much benefit, and the underlying assumption, mostly implicit, is that the direction of impact is unidirectional and the only problem is to quantify it. The examples above have served to point out that the impact is much more complex and multi directional and there is an urgent need to take it much more seriously than has been done so far and devise proper benchmarking and monitoring procedures that will allow us to learn what complex changes in the physical and environmental as well the social and economic situation are being brought about by the watershed development programme.

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The need for the benchmarking process has thus to be placed in the perspective of the need pointed out above. Unfortunately, in the case of the physical factors, this lack of benchmarking is crucial, and we have virtually no information on what impact watershed development programmes, individually as well as together, have had on the physical environment. For all we know, the aggregate impact may be beneficial and there may have been considerable improvement. All of it however, is conjecture and the impact is complex and problematic. There are already signs that the watershed development programmes are causing significant redistribution of water balance components between components, as well as across and between regions that need to be seriously studied and tackled.

Participatory Monitoring Processes

Broadly speaking there could be two type of purposes: (a) to build up a data base with regard to the situation prior to the interventions and to keep account of the changes that are taking place so that supra-local agencies like the funding agencies and government departments know what is happening with the investments; (b) create a data base of the type mentioned in (a) but going beyond this by providing space for the local communities to intervene and make corrections so that the programme goes in line with the wider developmental goals of sustainability, productivity, equity and livelihoods. If the objective of the benchmarking and monitoring exercise is of the first type alone then probably the exercise can be done in a non-participative, top-down mode as often done by the scientific establishments using some of the latest techniques like remote sensing, etc. However, if the objective is of the second type then the exercise needs to be done in a participative mode taking into account the local knowledge and also in the process build up the capability of the local communities.

Over the last decade or so, many participative tools have been developed for data collection, which can be useful for the benchmarking and monitoring. Participatory Rural Appraisal (PRA) methods have become very popular especially in the context of watershed development. Very often the funding agencies make this a condition for sanctioning projects and treat it as a proxy for participation. Experience shows that these participative methods and processes can be cost effective, time saving, can capture qualitative dimensions and processes more accurately and generate a sense of involvement and ownership in the local communities. However, when it comes to quantification, especially in relation to bio-physical aspects the PRA data often show wide divergence from true values. One example of this is that PRA methods use maps drawn by the village communities which do not have a scale. Thus the information captured on such maps cannot be accurately quantified. Also, proponents of PRA methods often show scant respect for other conventional, scientific methods and insist on using PRA methods as `stand alone' techniques.

All of these processes depend crucially on the capability of people to organise their own efforts and their own lives as well as on their understanding of what constitutes regenerative use and equitable access. And the question of how this capability is to be built up is perhaps the most difficult question to be answered by any strategy. Though the strategy proposed here also depends on participatory processes to bring this about, given the nebulousness of the term participation it would be necessary to discuss what kind of participation is implied. Considerations of space only allow at best a sketchy discussion.

PRA techniques also have limitations that are related to the limitations of traditional knowledge systems as a whole. For example, groundwater is a resource that is extremely poorly understood in many traditional systems. This does not, and should not be taken to, reflect on the richness of that knowledge, but reflecting rather on those approaches which tend to treat that knowledge as final, superior and complete. This is all the more pronounced once we begin to consider quantitative information.

Recently, the need to integrate PRA and other kinds of knowledge is being taken seriously. There is a wealth of information that is now becoming increasingly easily available from the state and the scientific establishment about land, water, land use and water use and about local resources generally from a variety of sources including area studies and mapping to satellite imagery. This information and PRA information continue to sit in separate parallel universes sealed off from each other. There is a need to synthesise, which in turn, needs some common ground, a bridge to be established between them.

In this context the Participative Resource Mapping (PRM) developed by the Bharat Gyan Vigyan Samithi (BGVS) with the help of scientists from the Centre for Earth Science Studies (CESS), Trivandrum are relevant. These methods are not rapid methods like the PRA methods. In fact, PRA often forms a prelude to PRM. The PRM is an extensive exercise that is completed by village volunteers who collect plot-wise and household-wise information from every plot and household in the village. Plot-wise information is collected plot-wise on the basis of the plots marked on revenue or cadastral maps. These cadastral maps used by the revenue department are familiar to the villagers and they often know their piece of land and its plot number and location. This map creates both the necessary bridge between participatory data and the data with the government, and is capable of incorporating quantitative information. PRM exercises have been conducted all over India as an instrument of participative planning, but especially in Kerala as part of the Panchayat planning programme. Efforts are now on to extend PRM to resource evaluation and monitoring and linking up with the extensive information becoming available from the government and the scientific establishment

The BGVS which pioneered PRM has also been a pioneering organisation in the literacy movement. In the present context of discussion, one may add, a pioneering organisation in bringing a participatory approach to the literacy movement, but with some important differences. Set up by the All-India Peoples Science Network, a network wedded to the slogan `science for social change', for them the need for participation has not been a new discovery; it has always been a founding principle of their activity. Nor has the value of people's knowledge been a new discovery for them. They started their literacy campaign by expressly emphasising that illiteracy is not ignorance. But for them, the task has never been only to express this knowledge. They have always considered literacy as a tool for something more, as something that has the potential to open new doors of knowledge for the people.

This opening of new doors of knowledge and capabilities for the people is the positive aspect that is most often lacking in the prevalent participatory approaches, which have been too occupied with their own new discovery of the value of participation itself. Unless participation is wedded to clearly defined objectives relating to the content of social action, it tends to remain a formal instrument, lacking direction and coherence. The rapid and widespread adoption of its terms and discourse has only served to worsen the situation. In the context of the strategy, this is very clear -- participatory methods are an instrument of capability building with a clear direction, of regenerative use and equitable access as founding principles.

This involves a wide array of participatory activities. It involves first of all, planning, monitoring and evaluation and regulation of resources and resource use. The PRM initiates this process of capability building. Participatory methods are now being developed for periodic monitoring of resource use and status through records maintained and observations taken by a group from the village. This also makes demands on the scientific community of developing sufficiently robust and simple models for assessment of resource status and use as demanded by local communities so that they may later on be strengthened and refined by limited periodic information gathering and observations. Some of the issues involved in this are separately discussed in another paper.
Secondly, it involves the capability of making best use of limited resources in a regenerative manner in order to maximise livelihood opportunities. This is a much more arduous long-term task. The Prayog Parivar experience is particularly relevant here, as is the experience accumulating through the LEISA network, the AME group and other networks and organisations devoted to various options of regenerative use. It would be of help here to organise modular farmers' groups like the crop groups of the Prayog Parivar, which were primarily farmer experimenters groups who met together to exchange and seek information and knowledge and to develop and propagate regenerative practices. The scientific establishment has also to face a challenge here in evolving mechanisms and institutions which can facilitate this process of learning through experimentation which is very different from the formal training and extension activity carried out by them. A similar kind of challenge is involved in facilitating groups from the disadvantaged sections who would take up non-farm biomass production and processing activity.

Chapter 3

Selection and Profile of the Sample Micro-Watershed

In order to capture different agro-ecological situations the study has been undertaken in three different systems viz; dry land, forest, and hills represented by one district each in Gujarat, Chhatisgadh, and Uttaranchal respectively. This chapter describes the procedure adopted for selection, and the presents main features of the micro watersheds covered under the study.

3.1 Selection of the Sample

The study consists of 12 micro watersheds, four each in the three districts representing the core feature of the three agro-ecological systems mentioned above. These are Amreli in Gujarat, Rajanandgaon in Chhatisgadh, and Dehradun in Uttaranchal. Some of the important features of the districts have been presented in Chart I (Also see Map 2).

Chart I: Profile of the Districts

District	Location		Area (sq km)	Agro-Climatic Characteristics		
	Latitude	Latitude		Rainfall (mm)	% of Area Under the Core Feature*	Main Crops and Soil Type
Amreli	20°45'N to 22°15'N	70°15'E to 71°45'E	7381	537	84.2	Groundnut, Cotton, Til Sandy, Shallow Soil
Rajnandgaon	20°07'N to 22° 29'N	80°2'E to 81°24'E	6396.28	1274	42.1	Paddy Clayey-Black
Dehradun	29°58'N to 31°2'30" N	77°34'45"E to 78°18'30" E	3088	2051	640 meters above mean sea level	Paddy, Wheat and small Millets Hill Alluvial

* **This pertains to proportion of are under dry land cultivation in Amreli; proportion of forest to reporting area in Rajanandgaon; and Altitude in the case Dehradun.**

Having selected the districts the major task was to select sample watersheds – 3 having watershed projects, and one without any project so as to serve as a control for comparison. Initially, the idea was to follow same procedure for selecting micro watersheds in the three locations. This however, was not possible because of the location specific conditions and constraints in obtaining some of the basic information such as topo- sheets in the three sites. Nevertheless three common criteria were used for making initial selection. According to these only those micro-watersheds were considered for selection:

(a) Which have started between last 1 and 2 yrs of our study.
(b) Where no major treatments has been implemented so far
(c) Which are present on the upper, middle & lower reaches of a single watershed.

Given the fact that planning for micro-watersheds does not necessarily follow any specific watershed, meeting the last criteria was rather difficult. Alternatively we tried to identify an area or block within the district where a cluster of watershed projects existed. The actual procedure followed in each of the three districts has been described as follows.

i) Amreli (Gujarat): While making selection of micro-watersheds for this district, not a single watershed area was found which could fulfill all the aforesaid common selection criteria. As most of the part of this district is plain dry land, with no prominent ridgelines (major area falls in slope range of less than 1%), so the selection was really hard. Not a single watershed area was found where we could find three micro-watersheds on its different reaches. This problem was faced as micro-watersheds (of about 500 ha) were sanctioned randomly in the district, without any concern about the treatment of a watershed from top to bottom, as long as the project proposals fulfills all other criteria as stated in the guidelines. So finally we made selection of on the basis of the order of the stream in which the drainage of micro-watershed culminates. Reason for this criterion is the size of catchment area associated with different order of streams, up and above the confluence point of the stream & the micro-watershed drainage. The district-planning map was used as the basis for identifying micro watersheds on different order of streams. This in turn gives different degree of accessibility to these associated streams and in-situ harvesting of rainwater. It may however, be noted that it was not feasible to obtain top sheets for the selected micro watersheds as the area constitutes a part of the restricted zone due to proximity to the coastal boundary. Thus, we had to resort to using the cadastral maps obtained from the revenue department. The selected watershed is being funded under the Drought Prone Area Programme (DPAP) of the Ministry of Rural areas and Employment, Government of India. Given these limitations four micro watersheds were selected for the study. These are:

a) Antaliya of Liliya taluka for first order stream.

b) Dhangla of liliya taluka for second order stream.

c) Bhiladi of Babra taluka for third order stream.

d) One control micro-watershed i.e. Sajantimba was also chosen, where there is no watershed project is currently planned or implemented. This micro-watershed has the similar type of socio-economic & agro-climatic condition, in comparison to the Antaliya micro-watershed. It is present on the same first order stream, on which Antaliya is located.

ii) Rajnandgaon (Chhatisgadh): It is situated on the westernmost side of Chhattisgarh. Of the total reported area, 36 per cent is under forest, which is mainly concentrated in its Aundhi, manpur, Chauki, Mohla & Dongargarh blocks. Keeping the concentration of forest in these blocks, two mili watersheds located in Chauki and Mohla blocks were identified for selecting micro watersheds for the study. This was based on the list of different watershed projects being implemented by the Zilla Parishad under Rajiv Gandhi Gandhi Watershed Mission.

Selection of micro watershed was based on the following criteria:

a) Percentage of forest area was used for classifying micro watersheds in three categories representing high, medium and low level of forest coverage.

b) Only those micro watersheds were selected which have been started in last one or two years.

The selected micro watersheds are:

1. Kodewara: This micro watershed represents high level of forest area. It is situated in the Tikadoranala part-2 mili-watershed of Mohla block. There is only one village inside this micro-wsd, called Kodewara. About 417.258 ha area of the village is taken for watershed treatments.

2. Harekhapayali: This micro-wsd is selected under mid level of forest area. It is situated in Bandokanala part-2 mili-watershed of Ambagad Chauki block. There are two villages in this micro-wsd i.e. Harekhapayali & Sansargarh. About 525.707 ha area of the combined area of two villages has been taken for watershed treatment.

3. Kaudikasa: This micro watershed is selected under low level of forest area. It is situated in Bandokanala part-2 mili-watershed of Ambagad Chauki block. There is only one village in this micro-wsd i.e. Kaudikasa. About 395.110 ha of its village area is taken under watershed for treatment.

4. Control micro-watershed - Tatoda: This micro watershed, located in the proximity to Kodewara in the high forest area. It consists of one village i.e. Tatoda.

In fact it was difficult to locate micro watersheds with different levels of forest since we did not have access to toposheets (even from the office of the Survey of India, Dehradun). We could however, get photocopy of the toposheets for the region, which had some indications of the level of forest area. But the black & white photocopy of toposheets do not give much idea about the contours and the ridgelines. Since delineation of the first three micro watersheds was already done at the time of sanctioning the project, we adopted the same area for our study as in the case of Amreli. For the control micro watershed there was an additional problem since watershed area has not been earmarked for any specific project under implementation. In this case we identified a major stream and the associated streams passing through the village and observed the flow pattern. Based on these observations along with the information obtained through the informed persons in the area, we tried to mark an area of about 6-700 ha. to be considered as a micro watershed with approximate delineation of the ridge.

iii) Dehradun (Uttaranchal):

Hills being the focal point for study in this region, selections of micro watersheds was based on certain location -specific criteria besides the two common criteria viz; year of inception of the project, area of approximately 5-700 ha; and location at different reaches of a watershed. The location-specific criteria primarily consisted of difference in the general slope of the micro-watersheds. Here general slope is defined as the ratio of the altitude difference between the highest and lowest point of the micro watersheds and the distance between the two along the drain. Since in the general slope of the micro-watershed in the study region does not vary significantly, we have selected three watershed areas taking into consideration the following additional criteria:

a) Position on the watershed i.e. on the upper, middle and lower reach.

b) Elevation difference between the selected micro watersheds

c) Difference in the presence of low slope areas, within the micro-watersheds.

The selection of micro watersheds is based on year wise information about the spread of watershed projects being implemented in different blocks of Dehradun district. Going by the criteria of the year of inception, Amlawagad watershed in Kalsi block was identified for selection of micro watersheds in the region. Amlawa is a small perennial river, fed throughout the year by numerous smaller drains, formed by natural springs. It start forming near Chakrata city & merges into river Yamuna, near Kalsi village. Around 5617.70 ha of area in the upper catchment of this river is sanctioned to the state government's soil conservation unit (Dakpathar) in the year of 2001-2002, for watershed treatment under Integrated Wasteland Development Programme. This area is divided into 10 micro-watersheds of about 500 hectares. From these 10 micro-watersheds, we have selected three where only entry point work and some small SWC structures were constructed in all the selected micro watersheds. Selection of micro watersheds is based on the toposheets, which were fortunately available for the region. Thee micro-watersheds selected for the study are:

1. **Amlawagad-2:** This micro watershed is located on the upper reaches of the watershed area taken for treatment. There are three villages, which fall under the natural boundaries of this micro watershed; these are **Hoda, Magroli & Kwarna**. But the official demarcated area of the micro watershed also includes Dakiyarna village. Inclusion of this village however, would lead to a problem of multi exit points within the given micro watershed. We have therefore, excluded this village from the area of Amalwagad –2 micro watershed selected for the study. The total area of the micro-wsd is 462.67 ha, this includes the area of all the four villages excluding area under forests, roads & settlements. The top reach of this micro watershed contains fairly dense mixed forest of banj (*Quercus leucotrichophora*) and burans (*Rhododendron arborium*). While the forest area is excluded from the official demarcation of micro watershed, we have considered this area as part of the natural watershed.

2. **Amlawagad-5:** This micro-watershed officially is demarcated from the middle reaches of the watershed and stretches up to the lower reaches. There are four villages in the

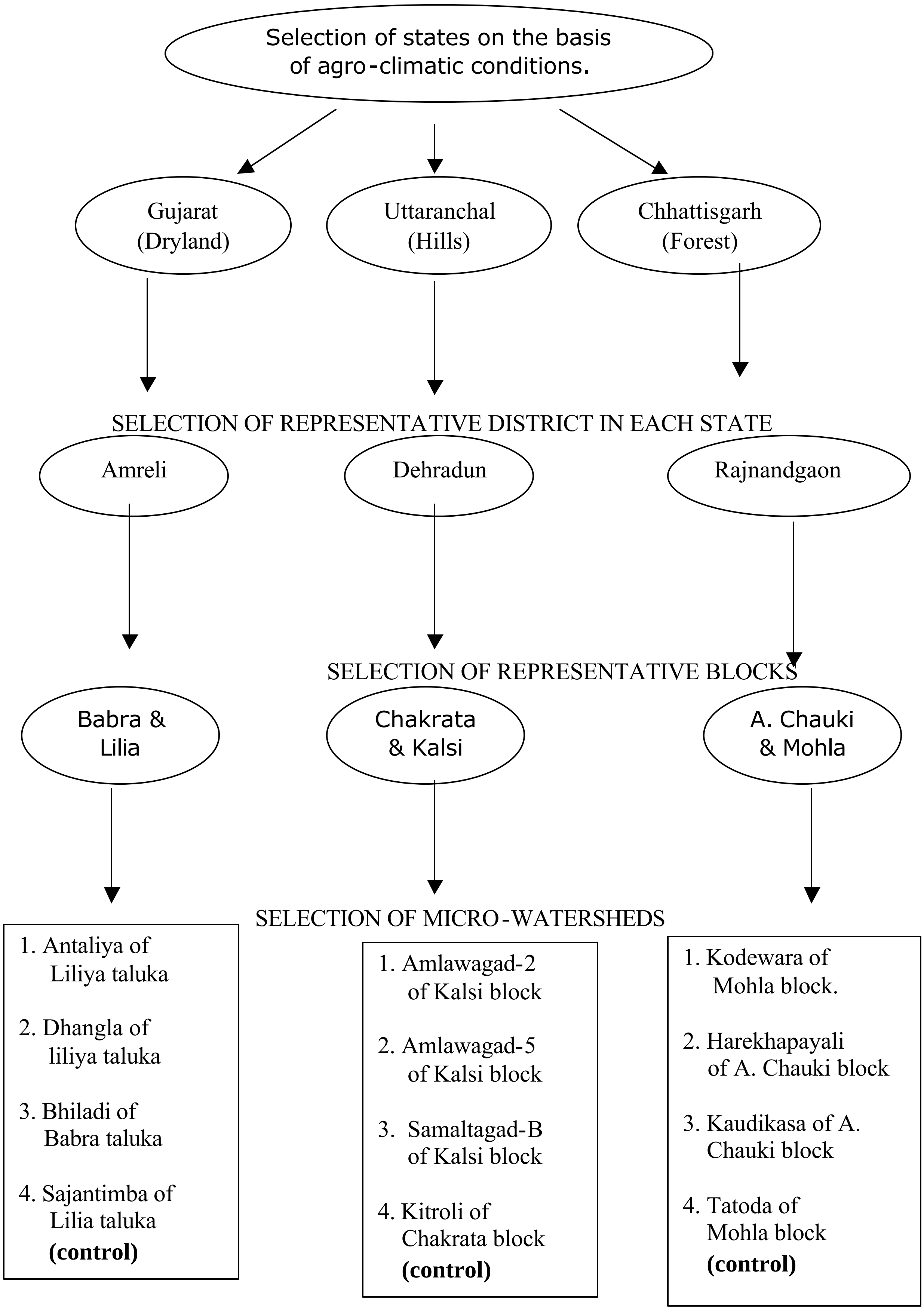
officially demarcated micro-watershed viz; Kota, Tarli, Kakadi and Kanbua. Together these villages have an area of 726.94 ha. The official demarcation however, has the same problem of multi exit points. In order to avoid this we have demarcated a micro-watershed, within the officially demarcated area. This refers to its confined catchment area with a single exit point. It also falls in the mid reaches of the watershed. This consists of two villages viz; **Kota and Tarli**. The upper reach of this micro-wsd is inhabited by reserved forest, containing dense banj (*Quercus leucotrichophora*). The canopy density is fairly high, about 65%-75%.

3. **Samaltagad-B:** This micro-watershed is located in the lower reach of the watershed. There are five villages in this micro-watershed viz; Udpalta, Kurauli, Khatasa, Bori and Newi. Together these villages cover an area of 598.70 ha. Of course, a part of this area covered by the administrative boundary of the villages, fall outside the natural micro watershed and thereby has multi exit points. We have therefore demarcated a catchment area within the officially defined boundary of the micro watershed, consisting of two villages of Samaltagad-B viz;. Udpalta and Kurauli, and also some area of Uproli and Rani village of Bantalgad-C. For the purpose of our study we have confined the selection of households and plots to Samaltagad-B.

Control Micro Watershed-Amtiargad: The control micro watershed has been selected from the upper reach, adjacent to Amlawagad- 2. This consists of area from four villages in the upper catchment of Amtiargad river. The selection is based on the considerations such as: similarity with the sample micro watershed in terms of type of vegetation, general slope of the area, agricultural practices, human & cattle population etc.

Chart III presents a graphic description of the sample micro-watersheds selected for the study.

Chart III :SELECTION OF MICRO-WATERSHEDS



3.2 Selection of Important Indicators:

The discussion in chapter 2 gives a fairly good idea of multiplicity of indicators and complexity of measurement thereof. Keeping these in view, we have identified three of indicators that were feasible to mange through a short-term study such as this. The indicators pertain to socio-economic, environmental, and institutional aspects as shown in Chart IV below.

Chart IV: Major Indicators and Methods of Data Collection

Details of Indicators
I. Socio- Economic (i) Literacy (by age and sex) (ii) Infant Mortality (iii) Outmigration (adjusted for level of Income) (iv) Asset Base: Land, Irrigation, House (type), other consumer durables and productive assets and livestock (v) Extent of irrigation and cropping intensity (vi) Use of purchased inputs (vii) Cropping Pattern (viii) Crop Yield (ix) Household income by sources (x) Productivity of Milch Animals **II Institutional** i) Awareness about participation in watershed committee and/or self help group ii) Expectations from watershed project iii) Borrowing from various sources other than SHGs **III Environmental:** i) Number of Wells ii) Level and Quality of Ground Water iii) Extent of Use of Pastures/Forests/Other Commons iv) Time Spent for Collection of Drinking Water v) Vegetation Mapping on Forest Plots vi) Soil –nutrients and salinity viii) Extent of crop failure

3.3 Coverage and Data Collection:

In order to collect information for the above indicators and the related variables, we have used a combination of methods and data collection-instruments blending quantitative and qualitative information as shown in Chart above. The information has been collected at three levels viz; micro watershed, households, and plots- private as well as public. This involved a number of visits during different seasons since certain information need to be collected only after the monsoon is over or winter crop is harvested.

Initially, a house-listing was conducted covering all the households in the villages covered by the micro watersheds. This was followed by a transact for mapping the status of major natural resources in the village. These exercises were conducted adopting participatory methods. Moreover secondary data were collected for supplementing the information collected through the participatory exercises for house listing and resource mapping.

The next stage was to conduct a detailed survey of households on a sample basis, and selected plots cultivated by the landed households thereof. The households were selected on the basis of stratified quota sampling method. This consisted of 20 households with land and 5 landless. The landed households were divided into two categories- with and without irrigation. Whereas the household survey collected information on a large number of variables pertaining to socio-economic, environmental, and institutional aspects, detailed information was collected from a two plots cultivated by each of the sample households having land. These plots were selected on the basis of their location with respect to the main stream. We tried, to the extent possible one plot on the upper reach and another on the lower reach of the stream. Subsequently, we collected information for about 40 plots in each micro watershed, totalling up to 480 plots from 12 micro watersheds. The information consisted of all inputs, outputs, and net return from the crops grown during all seasons in a year. The reference year for the survey is July, 2002 to June 2003.

For environmental indicators, we focused on four variables viz; ground water table and extent of irrigation in winter and summer seasons, soil profile, and vegetation mapping. Besides these we tried to put monitoring devices for rainfall and stream flow; this however did not succeed in the even of heavy rainfall during the monsoon of 2004, and also because of the absence of any institutional mechanism to record the observations at frequent periodicity. We of course collected information about the rainfall for the reference year from the nearest block offices. Given this backdrop, we now present the main findings from the field study in the subsequent three chapters dealing with Gujarat (Chapter 4); Chhatisgadh (Chapter 5); and Uttaranchal (Chapter 6). It may be noted at the outset that the results are mainly in terms of presenting bench mark values, hence provide a snap shot of the situation prevailing at the time when a large part of the watershed activities is yet to commence.

Chapter 4
Gujarat: Main Results

This chapter presents the results from the primary survey along with other exercises conducted in the four micro watersheds in Amreli district of Gujarat. The district, as noted earlier, is one of the most drought prone areas in the state. The two blocks from which the sample micro watershed have been selected namely Babara and Kunkavav, can be taken as fairly representative situation so far the geo-climatic conditions are concerned. The area is generally plain, with thin and degraded top soil. Rainfall is scanty i.e. < 600 mm per year. Rains are received only during monsoon with less than 15 rainy days spread over early July to end of August. Droughts are very frequent. The reference year i.e. 2002-03 was also marked by an extreme drought situation. Ground water is the only source of irrigation, which generally fails under drought conditions. Livestock is traditional occupation, supplementing income from the crop cultivation. However, frequent droughts, in absence of any institutional arrangement for management of the pastures have been over used, hence severely depleted. The livelihood base therefore, is highly unstable, with migration of varying duration is the main source sustaining the rural households. Given the highly fragile natural resource base, households especially those with somewhat better economic and social background choose to divert their resources by investing in alternative occupations outside the village economy. Finally, the village community is divided on caste lines, which make setting up of any community-based institutions fairly difficult.

4.1 Profile of the Micro Watersheds

The sample micro watersheds represent more or less similar scenario with respect to the natural resource endowment, economic well being and social fabric as described above. Table 4.1 presents some important features of the micro watersheds (coterminous with village in this case) under the study. Following observations are important to note:

i. While the villages have fairly large area under cultivation, most of it is un-irrigated except for Bhiladi where the proportion of irrigated to gross cropped area is 25.4 per cent.

ii. Wells/ tube wells are the main sources of irrigation though; a large number of them are defunct to depletion of ground water.

iii. There are a few water harvesting structures such as village ponds and check dams already in the villages except in Antaliya.

iv. All the villages have more than 100 acres of area under pastures. This is fairly substantial. The pastures however, serve limited purpose because of their degraded status as we will see later in this chapter.

v. Degradation of pastures, in turn, get reflected in relatively limited livestock population especially cow, buffalo, and bullock. It may be noted that the number of bullock pairs is less than the number of households owning land. The ratio of bullock to landed households would be even worse as the actual number of landed households is generally higher than what is reflected on the official records.

vi. Most of the villages are provided with supply of drinking water brought from outside.

vii. Only one village has a co-operative society for credit and input supply.

viii. The entry point programmes taken up in the three micro-watersheds include plantation on community land.

ix. Watershed committee and self help groups (SHGs) have already been formulated in all the three project villages.

4.2 Socio-Economic Profile of the Sample Households

Population, Literacy and Migration:

The household profile presented in Table 4.2 highlights some important features. These are:

i. The average size of the households is 5.2 to 7.1 across the sample villages.

ii. Whereas the sex ratio is favourable in Bhiladi and Antaliya, the same is very low in the case of the other two villages thus, indicating higher incidence of out migration from these villages.

iii. The literacy rate among the household population is 67.5 per cent; 75.7 % among male and 59 % among female. However if we look at the children in the age group of 6-14, the literacy level is as high as 86.8 per cent, notwithstanding the gender differential. It may however, be noted that our sample is tilted in favour of landed households, which constitute a relatively more privileged section of the village community.

iv. As large as 30 per cent of the sample households reported out migration during the reference year. Similarly 23 households reported that some members of their family has moved out of the village on a long term basis. The number of migrants during the reference year however, is higher in Dhangla and S. Timba as noted earlier.

Land and Irrigation:

Table 4.3(a and b) provides information about access to land and irrigation among the sample households. As noted earlier, 20 out of the 25 sample households in each village are landed. Of the total 80 households in the four villages having land, 29 (i.e. 36.2%) have access to irrigation. The proportion is relatively high in Bhiladi and Antaliya whereas Dhangla and S. Timba have only 4 and 2 households having irrigation.

The average size of land holding is 14.2 acres per landed household, which varies from 9.9 acres in Bhiladi to 22.2 acres in Antaliya. Of the total 1134.5 acres of land owned by the landed households, about 109 acres are irrigated; this constitutes 9.6 per cent of the total owned land.

Besides the owned land, 12 landed households have leased-in land from other households. Apparently, the incidence of leasing-in is higher among those with larger land holding size. Those with a relatively weaker land base thus seem to have limited stakes in the land base activities.

Ownership of Livestock and Other Assets

As noted earlier, ownership of livestock especially, more productive animals such as cow, buffalo and bullocks is limited. The total number of livestock owned by the sample households is 302 (Table 4.4). Of these 101 are bullocks. If we consider pairs of bullocks the number works out to be about 50. This is fairly lower than the number of landed households in the sample. Of course, increasing use of tractors, to an extent, may have replaced bullocks. Similarly, markets for hired draught power may be responsible for lower number of bullock pairs than the number of landed households. Nevertheless it is plausible that a part of the farming community especially, small and marginal farmers, may not be able to manage proper tillage and other agronomic practices requiring draught power. It is pertinent that pre-sowing tillage practices form a very crucial part of the dry land farming in the region.

Traditionally, animal husbandry and dairying has been an important coping mechanism in a drought prone region such as this. The status with respect to ownership of cows and buffalo however, presents a dismal picture with a population of 99 and 57 respectively. Clearly, many of the sample households do not own any milch animal. While a part of the dismal situation could be attributed to drought during the reference year, the shrinking livestock base needs special attention from the view point of watershed management.

The observed skewed ness in ownership of livestock is further reflected by the pattern of ownership of other assets (See Table 4.5). Whereas a large proportion of the households owned pucca house (76%), and have access to electricity (94%), only 35 and 58 per cent of the households had toilet and bath facility at home. Nearly one third of the households own a television set and a two-wheeler. Five households own a tractor. Prima facie, it appears that there is small subset of households, perhaps those having irrigation and/or regular salaried income constitute a better off class of the community. While they constitute about 33 per cent in the sample, they may represent roughly 20 per cent of the entire population assuming that about 50 per cent of the households are landless or semi-landless as against 80 per cent in the case of the sample.

Income from Different Sources

We tried to estimate household's income from various sources. Generally the income estimates of course, are subject to limitations in reporting the income. In order to overcome these limitations, we have tried to compute net income from different activities such as agriculture, livestock, casual labour, trade/business, service etc. It may still be appropriate to use these estimates as `order of magnitude' rather than the actual numbers. Moreover, the estimates also help getting an idea of the multiple sources of income among different types of households. Table 4.6 (a, b, c, & d) provides source wise estimates of estimates of income among the sample households.

It is observed that, among landed households, mean income from various sources is Rs. 76,162 per annum (table 4.6a). This varies significantly from Antaliya (Rs. 96, 525) to Dhangla (Rs. 63, 730). The average household income from agriculture varies across land holding size (Table 4.6b). The ratio of agricultural income between marginal and large land holding size class is 1:4, which is almost in proportion to the difference in the land holding size in these two categories.

Average income among landless households is Rs.31, 397 per household (Table 4.6c). This works out to be about one half of the average income among landed households with irrigation. The estimated income however, varies significantly across village. Landless households in S.Timba have the highest mean income of Rs. 37, 200. This may be partly due to higher incidence of out-migration in this village. A large number of workers from this village seem to have been involved in diamond industry in Ahmedabad and Surat.

It may be noted that the total number of sources reported by the landed and landless households were 255 and 36.These work out to be 3.18 and 1.8 sources per household in the two categories respectively. Obviously, landed households have significantly more diversified income portfolio as compared to the landless. Among landless 15 out of 20 households reported agriculture labour as a source of income. What is however, important to note is that only 6 households (i.e. 30 per cent) of the landless households have reported income from animal husbandry, the proportion is 60 per cent among landed households.

We tried to estimate net returns from production of milk per household. This worked out to be Rs. 4-5000 from cow and Rs. 10-12,000 from buffalo (See Table 4.6d).

Cropping Pattern and Yield

The major crops grown by the sample farmers are: Cotton –Unirrigated; Groundnut- Unirrigated; Seasmum; and Jowar –Fodder. Together these crops account for 81.1 per cent of the total area under crop (Table 4.7). In fact, Cotton-Unirrigated constituted more than 50 percent of the gross cropped area (GCA) among three villages, except Bhiladi.

Of the total 1,222 acres of land under crop, only 4.8 acres of land under Rabi season. To a large extent this is due to a drought during the reference year. The rest is cultivated during Kharif. It may be noted that the area under crop is marginally higher than the land owned by the sample households, which is 1134 acres as shown in Table 4.3a. To a large extent the difference is due to leasing-in of land as we noted earlier, and also due to encroachment. Both are likely to be under reported because of the legal implications.

Table 4.8 presents yield for the crops grown by the sample farmers. These yields compare fairly well with the state average despite the fact that the reference year had experienced drought. What is also surprising is that the yield of un-irrigated groundnut is only marginally lower than the irrigated groundnut for all villages taken together. There is however, substantial difference in yield across villages. One of the possible reasons for this could be that, the area might have received limited but, timely rainfall, essential for the crop. On the other hand, the irrigated crops may not have received adequate irrigation because of the paucity of ground water during the year.

Input Use

Finally, we have tried to work out input use and production on the sample plots selected for comparision over time and space. Table 4.9 provides village wise information for the crops grown on the sample plots. It is observed that use of FYM as well as chemical fertiliser is limited to the main crops such as cotton and groundnut. This is mainly due to the fact that these are also commercial crops. It may however, be noted that number of farmers using chemical fertiliser in crop like cotton, is much higher than that using FYM. To an extent, low use of FYM is associated with low livestock population, owing to limited availability of bio-mass in the region.

4.2 Institutions and Participation:

We tried to enquire about the household's awareness as well as participation in village level institutions such as watershed committee and self help groups (SHGs) etc. It is observed that 25 out of the 75 sample households were aware of the watershed committee formulated in three villages except the control village (Table 10). Of these only 8 were members of the watershed committee. When asked whether they were present in the meeting organised by PIA for formulating the committee, 13 households responded positively. What is however, concerning is that only 4 respondent reported active participation during discussion in the meeting.

It is interesting to note that most of the households envisaged replenishment of ground water as the major benefit from the watershed project (Table 4.11). Construction of check dam therefore was the main expectation from the project. This would also provide employment to the local workers.

About 21.3 per cent i.e.16 out of the 75 sample households reported membership of the SHGs formulated under the project (Table 4.10). This is a very small proportion of the households who have borrowed from other sources of finance. It was noted that 50 per cent of all the sample households have currently borrowed money; most of them obtained loan from bank or co-operative society and that, they borrowed mainly for farming activities. Ideally, it is this gap that the SHG formed under the watershed project should try to fill-up.

We tried to probe further into the difficulties faced by the households for a more active participation in watershed committee. While most of the households reported that there do not face any problem, the general feeling is that of indifference to such institutions. Probably most of the households are yet to be convinced about potential role that such institutions could play in the long run.

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4.3 Environmental Indicators:

This has been a somewhat difficult exercise not only because of the difficulties in setting up a system for periodic monitoring and the associated costs thereof (for which the present study did not make adequate provision) but, also because of the unscientific manner in which most of the micro watersheds are delineated (the problems already discussed earlier in Chapter 2). Given these limitations we have tried to focus on three indicators representing the status of ground water, vegetation on the CPLRs, and soil-nutrients. This section deals with the estimates on these three indicators.

Ground Water Table

Table 4.12 provides information on the depth of ground water in the wells bore wells owned by the sample farmers. In all there were 77 well and 8 bore wells for which information has been collected from the sample farmers. It is observed that whereas depth of 12 out of the 77 wells was less than 30 feet, for 37 wells it was between 31-60, and for the rest 28 well as it was more than 60 feet. Bore wells are generally deeper than 100 feet except in the case of two. The water table was recorded during December, 2003.

More than depletion of ground water table, the problem faced by farmers in these villages is of salinity. Hence even if the farmers want to dig deeper the ground water they get is saline. This, in turn, sets a limit to the usuable ground water unless, ground water is effectively recharged. It may be noted that all the villages receive water from outside, due to problem of brackishness. As a result, most of the households source drinking water from the water supply schemes of the state. The average time spent for collection of water is less than 1 hour for majority (i.e. about 56 out of 80). However, 18 households spend more than 3 hours for collection of drinking water during summer season. The important issue that emerges thus, refers to improving the quality of water within the micro watersheds (Table 4.13).

Status of Village Pastures

Initially, we tried to carry out a detailed vegetation mapping on the village pastures. This, however, did not provide much information as most of the pastures in the post monsoon seasons had gone dry. Alternatively, we asked the respondents about availability of fodder and fuels during different seasons. This information has been used, for the time being, to get some idea of the existing status of vegetation in the village pastures. Table 4.14 provides information about the number of households obtaining these resources during different seasons. It is observed that only about 35 per cent of the households reported grazing of animal during monsoon and winter' the remaining households either do not have grazing animals and/or do not use the village pastures as source of fodder. Among those who use pastures for grazing the animals, nearly 40 per cent obtain more than 50 per cent of the fodder requirement from village pastures during monsoon and winter.

Compared to fodder, the pastures serve as an important source of fuel for a majority of households who obtain fuel from the CPLRs. This is very crucial. A detailed mapping of resources during and immediately after the monsoon therefore, should be carried out for quantifying the bio-mass available on the CPLRs.

Soil-Testing

Finally, we tried to get a benchmark on some of the important soil characteristics viz; soil nutrients, ph; and estimated carbon. Originally the idea was to get soil-profiling; this was not feasible as it requires access to more sophisticated soil-laboratories, which often have limited capacities and, also the costs of conducting these tests are significantly high.

The soil-samples have collected from the sample plots, for which we have also collected detailed information about input use as well as output. The results of soil testing are presented in Table 4.15. It is observed that whereas 29 out of the total of 72 soil samples collected from the study villages have ph. value > and < than the prescribed norm, only 4 samples had higher than the normal EC-value. With respect to soil nutrients, the samples were found to have medium level of nitrogen potash (except for 2 samples), the soils have significant deficiency in the case of phosphorous (p). All the soil samples were found to have low or very low p-content. This suggests need to apply balanced doses of chemical fertiliser, especially, phosphates fertiliser besides enhancing the use of organic manure.

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4.4 Summing Up

The results, based on the primary survey, provide rich set of information about the status of the households' well being, crops and farm economy, status of the CPLRs, as well as ground water table, and people's perceptions as well as participation in the local institutions created under watershed projects. Together, this information provide a fairly good idea about the situation prevailing before the major work under the project is initiated. There are however, a few critical data gaps, which ideally, should be filled up. Since there are constraints in filling up these data gaps, we will discuss these issues in the last Chapter.

Table 4.1: Main Features of the Selected Micro-Watersheds in Amreli

S. No.	Particulars	Micro-Watershed			
		Bhiladi	Antaliya	Dhangla	S. Timba
1	Total HHs	127	168	166	157
2	Population	752	479	499	417
3	Landed HHs	98	96	75	103
4	Landless HHs	29	72	91	54
5	Total land (acre)	1572.42	2367.42	3377.02	2739.99
	Non-cultivated	58.22	0	0	47.52
	Pasture	166.42	239.91	186.83	136.52
	Other non-cultivated	0.99	163.36	236.77	106.08
	Cultivated land	1346.79	1963.98	2187.42	2450.00
	Irrigated	342.09	200.00	56.60	N.A
	Unirrigated	1004.70	1763.98	2130.84	N.A
6	**Source of Irrigation**				
	Well	In use: 15 Total: 30	In use: 20 Total: 80	In use: 4 Total: 50	In use: 8 Total: 100
	Tubewell	In use: 2 Total: 10	In use: 5 Total: 20	In use: 3 Total: 12	In use: 0 Total: 0
7	**Main Crop**				
	Kharif	Groundnut, Cotton, Til	Cotton, Til, Bajari	Cotton, Bajari, Jowar	Cotton, Til, Bajari
	Rabi	Jeera, Wheat, Chana (Gram)	Jeera, Wheat	Wheat	Wheat, Jeera
	Summer	Nil	Nil	Nil	Nil
8	**Livestock**				
	Cow Buffalo Bullock Other Sheep/Goat	20 81 112 58 227	72 31 100 55 78	43 59 62 52 62	70 43 87 63 31
9	**Drinking Water**				
	Well Tubewell Pond Pipeline Schemes	0 2 1 Mahi pipeline	1 0 1 Kalubar pipeline	0 1 1 Kalubar pipeline	2 2 0 Kalubar pipeline
10	**Schools**				
	Primary Secondary Higher secondary College	Yes No No No	Yes No No No	Yes No No No	Yes No No No
11	**Hospitals**				
	PHC CHC Private	No No No	No No No	No No No	No No No
12	**Link Road**				
	All weather Seasonal	Yes -	Yes -	Yes -	Yes -
13	Cooperative Society	No	Yes	No	No

14	PIA	Saurashtra Gram Vikas Charitable Trust (NGO)	Gujarat State Rural Development Corpn. (Govt.)	Ahmedabad Jilla Khadi Gramudyog Sangh (NGO)	NA
15	WDP Batch	DPAP VIII	DPAP VIII	DPAP VIII	N.A.
16	WDP Committee	Yes	Yes	Yes	N.A
17	SHG	Yes	Yes	Yes	N.A
18	Entry point activities	Deepening of pond (1), plant-ation and gunny bags filled nala plugs (1)	Plantation (2.5 acre) and gunny bags filled nala plugs (3)	Gunny bags filled nala plugs (7), farm ponds (2), plantation and restoration of gaucher land	N.A
19	**WDP Structure**				
	Farm ponds	2	0	2	N.A
20	Other structures	Checkdams (2) and ponds (4)	Farm ponds (2), check-dams (2) and pond (1)	Nil	Pond (1) and checkdam (2)

Table 4.2: Characteristics of Sample Households: Population and Literacy

	HH Variables	Villages: (Micro-Watershed)				All
		Bhiladi	Antaliya	Dhangla	S. Timba	
1	Total population	155	177	156	130	618
1.1	Male	74	88	82	69	313
1.2	Female	81	89	74	61	305
1.3	Sex ratio	109	101	90	88	97
2	HHs size	6.20	7.08	6.24	5.20	6.18
3	Children 6-14					
	Male	4	19	17	12	60
	Female	13	19	10	12	54
	Total	27	38	27	24	114
4	Literacy Among Children					
	Total	85.2	86.8	96.3	70.8	86.8
	Male	92.8	89.5	82.3	50.0	83.3
	Female	76.9	84.2	120.0	58.3	90.7
5	Literacy					
	All Population					
	Total	66.5	67.8	70.5	64.6	67.5
	Male	68.9	76.1	86.6	69.6	75.7
	Female	64.2	59.6	52.7	59.0	59.0

Table 4.2 (a): Duration of Migration: Amreli

	Micro-Watershed				All
	Bhiladi	Antaliya	Dhangla	S. Timba	
Total migrant	6	7	9	8	30
Months					
1	-	-	1	-	1
3	-	-	1	-	1
6	-	1	1	-	2
8	4	3	2	2	11
9	-	1	-	1	2
10	-	2	2	4	8
11	2	-	2	-	4
12	-	-	-	1	1
All	6	7	9	8	30

Table 4.3(a) Land Under Crops and Irrigation

Type of Land	Micro-Watershed				All
	Bhiladi	Antaliya	Dhangla	Control S. Timba	
Own Land					
T	198.3	443.5	272.4	220.7	1134.5
PH	9.9	22.2	13.6	11.0	14.2
Land Irrigated					
T	29.5	45.7	15.4	18.2	108.9
PH	2.3	4.6	3.9	9.1	3.7

Note: T = Total., PH = Per Landed Household

Table 4.3(b): Distribution of Sample Households by Ownership of Land

	Ownership of Land	Villages: (Micro-Watershed)				All
		Bhiladi	Antaliya	Dhangla	Control S. Timba	
1	Landless	5	5	5	5	20
2	Landed	20	20	20	20	80
2.1	Landholding Size					
(a)	<2.5	0	1	0	2	3
(b)	2.5 – 5.0	3	2	3	4	12
©	5.01 – 7.5	5	0	2	0	7
(d)	> 7.5	12	17	15	14	58
2.2	Access to Irrigation					
(a)	With irrigation	13	10	4	02	29
(b)	Without irrigation	07	10	16	18	51

Table 4.4: Ownership of Livestock among Sample Households

Livestock (No)	Villages: (Micro-Watershed)								All	
	Bhiladi		Antaliya		Dhangla		Control S. Timba			
	Sum	No. per HH	Sum	No. per HH	Sum	No. per HH	Sum	No. per HH	Sum	No. per HH
Total livestock	75	3.0	92	3.68	65	2.6	70	2.8	302	3.02
Cow	18	0.72	37	1.48	29	1.16	15	0.60	99	0.99
Buffalo	18	0.72	22	0.88	13	0.52	4	0.16	57	0.57
Bullocks	34	1.70	29	1.45	22	1.1	16	0.80	101	1.26
Sheep/Goat	4	0.16	4	0.16	1	0.04	30	1.2	39	0.39
Other livestock	1	0.04	0	0	0	0	5	0.20	6	0.06

Note: Estimates of bullock per household refers to landed only

Table 4.5: Ownership of Assets among Sample Households

Assets	Micro-Watershed				All
	Bhiladi	Antaliya	Dhangla	S. Timba	
Own house	25	25	25	25	100
House type					
Kacha	8	7	7	2	24
Pucca	17	18	18	23	76
Toilet	4	10	9	12	35
Bathroom	12	16	14	16	58
Electricity	22	24	24	24	94
T.V	11	7	7	8	33
Refrigerator	7	9	5	3	24
Scooter	11	9	7	7	34
Cycle	14	5	8	5	32
Radio	5	8	7	8	28
V.C.D	2	1	-	-	3
Tractor	-	1	4	-	5
Domestic flour mill	1	4	2	4	11

Table 4.6(a): Income From Various Sources (Landed Households)(Rs per hhs/year)

	Micro-Watershed				All
	Bhiladi	Antaliya	Dhangla	S. Timba	
Agricultural income	51415 (20)	67850 (20)	35388 (20)	47125 (20)	50444 (80)
Animal husbandry	11173 (14)	13971 (17)	11797 (15)	10000 (7)	12092 (53)
Agricultural labour	11867 (3)	-	13667 (6)	5000 (1)	12260 (10)
Other labour	20000 (13)	25333 (9)	24400 (11)	47333 (9)	26737 (42)
Trade	12000 (2)	60000 (1)	16700 (2)	19000 (2)	22200 (7)
Service	-	48000 (1)	30000 (1)	10000 (1)	29333 (3)
Out income	-	-	-	12000 (2)	12000 (2)
All income	75216 (20)	96525 (20)	63730 (20)	69175 (20)	76162 (80)

Note: The estimated income from each source pertain to average household reporting income from a particular source. The estimates of income from all sources refer to the total number of landed households in the sample

Table 4.6 (b): Village-wise Agricultural Income by Landholding Size

Landholding size (acre)		Villages: (Micro-Watershed)				All
		Bhiladi	Antaliya	Dhangla	S. Timba	
< 2.5	Mean n	- -	9000 (1)	- -	17000 (2)	24333 (3)
2.51 – 5.0	Mean n	31333 (3)	65000 (2)	16667 (3)	38375 (4)	35625 (12)
5.01 – 7.5	Mean n	49400 (5)	- -	21000 (2)	- -	41286 (7)
7.50+	Mean n	57275 (12)	71647 (17)	41050 (15)	53928 (14)	56484 (58)
All HHs		51415	67850	35388	47125	50444

Table 4.6 (c) : Income from Various Sources: Landless Households

Micro – Watershed		Income from works outside	Animal husbandry	Agri. labour	Other labour	Service	Business/ Trade	All sources
Bhiladi	M -	-	10250	11712.50	24000	-	9000	20070
	n -	-	2	4	1	-	-	5
Antaliya	M -	-	1000	21750	17750	-	24000	36600
	n -	-	1	4	4	-	1	3
Dhangla	M -	6000	30000	10333.33	27333.33	-	3600	31720
	n -	2	1	3	3	-	1	5
S.Timba	M -	-	18000	21000	30000	36000	-	37200
	n -	-	2	4	1	1	-	5
All	M -	6000	14583.33	16590	23000	36000	12200	31397
	n -	2	6	15	9	1	3	20

Note: As in Table 4.6 (a)
M = Mean income per household Rs./annum
n = No. of households reporting income from a particular source

Table 4.6(d):Income From Milk

	Micro watershed	Income Rs./Annum	
		Cow	Buffalo
1	Bhiladi	6480	9224
2	Antaliya	7240	14104
3	Dhangla	2896	8216
4	Sajan Timba	4008	10216
	All	4000	10704

Table 4.7: Cropping Pattern Among Micro-Watershed Amreli Area Under Crops (Acres)

		Bhiladi		Antaliya		Dhangla		Control S. Timba		All	
		A	%	A	%	A	%	A	%	A	%
Groundnut	UI	140.2	59.6	26.8	5.9	-	-	0.80	0.4	167.8	13.7
Cotton	I	21.2	9.0	43.2	9.5	-	-	22.0	10.1	86.4	7.0
Till	UI	41.1	17.5	51.2	11.3	79.8	25.1	53.3	24.6	225.7	18.5
Jowar	UI	10.4	4.4	62.2	13.7	39.2	12.3	20.0	9.2	131.8	10.8
Bajri	UI	1.6	0.7	42.0	9.3	16.8	5.2	1.6	0.7	62.0	5.0
Bajri	I	-	-	4.8	1.0	-	-	-	-	4.8	0.4
Groundnut	I	4.8	2.0	4.0	0.8	-	-	-	-	8.8	0.7
Cotton	UI	11.6	4.9	163.2	36.0	169.4	53.4	115.4	53.3	459.6	37.6
Pulses	UI	1.2	0.5	1.2	0.26	-	-	1.8	0.8	4.2	0.34
Maize	UI	2.2	0.9	-	-	4.8	1.5	1.6	0.7	8.6	0.7
Yeg	I	0.6	0.25	-	-	-	-	-	-	0.6	0.04
Ajmo	UI	-	-	44.0	9.7	3.2	1.0	-	-	47.2	3.7
Wheat	I	-	-	0.8	0.17	4.0	1.3	-	-	4.8	0.4
Ajmo	I	-	-	2.0	0.4	-	-	-	-	2.0	0.16
Jowar	I	-	-	2.0	0.4	-	-	-	-	2.0	0.16
Rujko	I	-	-	2.0	0.4	-	-	-	-	2.0	0.16
Til	I	-	-	4.0	0.9	-	-	-	-	4.0	0.33
		235.2	100.00	453.4	100.00	317.2	100.00	216.5	100.00	1222.3	100.00

Table 4.8: Yield of Major Crops among Micro-Watersheds: Amreli (Kgs/Acre)

Crops		Micro-Watershed				All
		Bhiladi	Antaliya	Dhangla	Control S. Timba	
Groundnut	UI	604.0	465.0	-	525.0	581.0
Cotton	I	763.0	421.5	-	245.5	460.0
Til	UI	75.5	50.0	41.6	88.0	60.0
Jowar (Fodder)	UI	1696.0	1090.0	1540.5	1410.0	1320.0
Bajri	I	-	83.5	-	-	83.5
	UI	437.5	250.0	497.5	750.0	335.0
Groundnut	I	900.0	625.0	-	-	775.0
Cotton	UI	501.5	414.0	322.0	385.0	375.0
Pulses	UI	116.5	216.5	-	522.0	319.0
Maize	UI	545.5	-	1625.0	325.0	1651.0
Ajmo	UI	-	175.0	25.0	-	164.0
Wheat	I	-	1250.0	1050.0	-	1083.5
Ajmo	UI	-	500.0	-	-	500.0
Jowar (fodder)	I	-	500.0	-	-	500.0
Rajko (fodder)	I	-	1000.0	-	-	1000.0
Til (Crop failed)	I	-	-	-	-	-

Table 4.9 (a): Input Use and Production of Major Crops: Bhiladi Village

	G. nut (UI) Kharif	Cotton (I) Kharif	Til (UI) Kharif	Jowar (UI) Kharif	Bajri (UI) Kharif	G. nut (I) Kharif	Cotton (UI) Kharif
Area (Acre)	46.8 (13)	12.2 (7)	22.21 (10)	9.01 (6)	1.41 (2)	6.21 (3)	22.21 (10)
FYM (Q)	1000 (5)	598 (7)	170 (3)	150 (3)	60 (1)	312 (3)	290 (6)
DAP (Kg.)	1385 (12)	752.5 (7)	340 (6)	50 (1)	50 (1)	137.5 (3)	660 (7)
Urea (Kg.)	- -	300 (4)	190 (3)	50 (1)	150 (2)	- -	450 (6)
Irrigation (No)	- -	21 (7)	- -	- -	- -	2 (1)	- -
Main production (Kg.)	14300 (13)	3400 (7)	4500 (10)	40 (1)	480 (2)	2300 (3)	4740 (10)
Residue Prod. (Kg.)	23480 (13)	7660 (7)	3800 (3)	7000 (6)	1100 (2)	15400 (3)	12400 (10)
Prod. Sold (Kg.)	18420 (13)	3400 (7)	4500 (10)	- -	- -	1400 (2)	4340 (10)
Price (Rs./Kg.)	14.25	19.30	22.15	-	-	15.5	20.0

Note: Based on data collected from selected plots. This refers to July 2001 to June 2002

Table 4.9(b): Input Use and Production of Major Crops: Antaliya Village

	G.nut (UI) K	Cotton (I) K	Til (UI) K	Jowar (UI) K	Bajri (UI) K	Cotton (UI) K	Jowar (I) K	Jowar (I) R	Maize (UI) K	Vegi. (I) K	Rasko (I) R	Ajmo (UI) K	Til (I) K	Wheat (I) R	Ajmo (I) K
Area (Acre)	30.6 (6)	23.6 (4)	32 (8)	82 (14)	28.8 (10)	107.4 (18)	4.0 (1)	2.0 (1)	1.2 (1)	2.4 (1)	2.0 (1)	12.8 (4)	2.4 (1)	2.4 (1)	2.0 (1)
FYM(Q)	380 (3)	280 (4)	373 (4)	311 (4)	96 (3)	592 (9)	40 (1)	- -	- -	40 (1)	- -	19 (1)	72 (1)	- -	20 (1)
DAP (Kg.)	1070 (6)	350 (3)	715 (7)	615 (6)	563 (8)	2372 (16)	50 (1)	- -	50 (1)	100 (1)	100 (1)	200 (3)	120 (1)	300 (1)	25 (1)
Urea (Kg.)	400 (3)	300 (3)	460 (7)	440 (5)	410 (9)	1745 (12)	75 (1)	75 (1)	- -	- -	100 (1)	230 (3)	60 (1)	300 (1)	25 (1)
A.S (Kg.)	- -	- -	35 (1)	- -	35 (1)	90 (1)	- -	- -	- -	- -	- -	- -	- -	- -	- -
No. irri.	- -	9 (4)	- -	- -	- -	- -	4 (1)	5 (1)	- -	15 (1)	30 (1)	- -	1 (1)	10 (1)	1 (1)
Main prod. (Kg)	7820 (6)	5880 (4)	4580 (4)	2300 (14)	8440 (10)	24460 (17)	-	-	-	-	-	1440 (4)	720 (1)	2400 (1)	15 (1)
Resi. pord (Kg)	20200 (6)	17000 (4)	4160 (4)	51600 (14)	11500 (10)	68020 (17)	1500 (1)	1500 (1)	1200 (1)	-	2000 (1)	740 (20)	-	2400 (1)	600 (1)
Prod. Sold (Kg)	7220 (5)	5880 (4)	4300 (8)	2200 (3)	900 (2)	24660 (17)	-	-	-	-	-	6740 (4)	720 (1)	1900 (1)	300 (1)
Price (Rs/Kg)	13.0	17.60	21.25	6.50	5.0	20.60	-	-	-	-	-	40.0	25.0	15.0	40.0

Table 4.9(c): Input Use and Production of Major Crops: Dhangla Village

	Til (UI) K	Jowar (UI) K	Bajri (UI) K	Cotton (UI) K	Wheat (I) K
Area (Acre)	64.8 (17)	17.2 (8)	11.8 (6)	88.6 (21)	1.2 (1)
FYM (Q)	388 (6)	84 (3)	22 (2)	992 (12)	80 (1)
DAP (Kg.)	1149 (13)	130 (2)	316 (3)	2215 (16)	100 (1)
Urea (Kg.)	654 (7)	80 (1)	341 (5)	1075 (10)	100 (1)
Irrigation (No)	-	-	-	-	16 (1)
Main production (Kg.)	6180 (17)	-	5640 (6)	22760 (21)	1500 (1)
Resi. Prod. (Kg.)	6000 (4)	23600 (8)	8000 (6)	58980 (20)	1500 (1)
Prod. Sold (Kg.)	6080 (17)	-	1400 (2)	22760 (21)	1000 (1)
Price (Rs./Kg.)	23.60	-	6.0	20.40	12.5

Table 4.9(d): Input Use and Production of Major Crops: S. Timba Village

	G. nut (UI) Kharif	Cotton (I) Kharif	Til (UI) Kharif	Jowar (UI) Kharif	Bajri (UI) Kharif	Cotton (UI) Kharif	Maize (UI) Kharif
Area (Acre)	1.2 (1)	10.0 (1)	27.6 (6)	6.0 (2)	2.4 (2)	55.4 (13)	0.80 (1)
FYM (Q)	-	125 (1)	125 (2)	50 (1)	-	189 (6)	-
DAP (Kg.)	50 (1)	750 (1)	900 (6)	15 (1)	10 (1)	1185 (13)	10 (1)
Urea (Kg.)	25 (1)	1250 (1)	650 (5)	30 (1)	25 (1)	1395 (11)	10 (1)
Irrigation (No)	-	4	-	-	-	-	-
Main production (Kg.)	60 (1)	6000 (1)	4900 (6)	-	880 (2)	12260 (13)	-
Resi. Prod. (Kg)	120 (1)	10000 (1)	6000 (4)	5800 (2)	1800 (2)	29820 (13)	1200 (1)
Prod. Sold (Kg.)	-	6000 (1)	4860 (6)	-	-	12260 (13)	-
Price (Rs./Kg.)	-	22.5	28.0	-	-	20.30	-

Table 4.10:Awareness and Participation among Watershed Committee and Self Help Groups

	Micro watershed	Awareness about W. Committee	Membership of	
			W. Committee	SHG
1	Bhiladi	8	1	13
2	Antaliya	9	2	03
3	Dhangla	8	5	-
4	S. Timba	NA	NA	NA
	All	25	8	16

NA= Not Applicable as the village represents a control micro-watershed

Table 4.11: Expectations from Watershed Projects

	Recharge of ground water	Checkdam	Employment	Other	Don't know
All micro watershed	43.0	7.0	9.0	36.0	5.0

Table 4.12: Water Tables in Wells/Borewells Owned by Sample Farmers

Depth (feet)	Wells No.	Tubewell
< 30	12	-
31-60	37	01
61-100	28	01
101-300	-	04
> 301	-	02
All	77	8

Table 4.13: Time Spent in Collection of Water

Micro watershed	Hrs. Spent per Day			All
	< 1	1-2	> 3	
Bhiladi				
Winter	11	11	3	
Monsoon	11	11	3	25
Summer	9	11	5	
Antaliya				
Winter	20	5	-	
Monsoon	20	5	-	25
Summer	18	6	1	
Dhangla				
Winter	7	16	2	
Monsoon	7	16	2	25
Summer	7	12	6	
S. Timba				
Winter	18	6	1	
Monsoon	18	5	2	25
Summer	18	1	6	
All				
Winter	56	38	6	
Monsoon	56	37	7	100
Summer	52	30	18	

Table 4.14: Percentage of Grass and Fuel Collection from Village Pastures

	% of Grass collection (a)	Bhiladi	Antaliya	Dhangla	S. Timba	All
1	0	22	9	21	21	73
2	< 25	1	8	1	1	11
3	26-50	0	6	2	1	9
4	51+	2	2	1	2	7
5	All	25	25	25	25	100
% of Fuel Collection (b)						
1	0	3	8	0	2	13
2	< 25	5	4	4	4	17
3	26-50	9	9	14	14	46
4	51+	8	4	7	5	24
5	All	25	25	25	25	100

Table 4.15: Soil Test Report - Amreli

Shed. No.	Village	Name of the Respondent	Survey No.	Area(Vigha)	P.H.	E.C.	N	P	K
1	Bhiladi	Karad Babubhai Gokalbhai	40p.	2.50	7.90	0.80	1.04	4.60	77
2	Bhiladi	Karad Bhikhabhai Savjibhai	40p.	4.00	8.00	0.35	1.20	4.60	329
3	Bhiladi	Karad Damjibhai Gokalbhai	40/3	2.50	8.20	0.34	1.16	23.90	115
4	Bhiladi	Akbari Kanjibhai Mohanbhai	33p.	3.50	8.70	0.54	1.50	18.90	176
5	Bhiladi	Solanki Jagabhai Valabhai	196/2	7.50	8.40	1.26	0.90	4.60	252
6	Bhiladi	Karad Manubhai Zaverbhai	7/1	1.50	7.80	0.91	1.20	18.90	134
7	Bhiladi	Akbari Babubhai Jivabhai	33 Bhila	25.00	8.10	0.48	0.75	4.60	176
8	Bhiladi	Patel Navnitbhai Dhanjibhai	35p.	5.00	8.10	0.38	0.76	23.90	310
9	Bhiladi	Solanki Chhaganbhai Laxmanbhai	196	10.00	8.10	0.33	0.67	11.60	281
10	Bhiladi	Patel Nagjibhai Hansrajbhai	35	3.00	7.90	0.47	0.75	23.90	217
11	Bhiladi	Karad Jayrambhai Shambhubhai	18/1	6.00	8.10	1.07	1.24	18.90	145
12	Bhiladi	Karad Jagabhai Bhimjibhai	69p.	9.00	7.60	0.86	0.81	23.90	145
13	Bhiladi	Karad Meghajibhai Bhimjibhai	69p.	8.00	7.50	0.26	0.67	18.90	176
14	Bhiladi	Patel Damjibhai Bhimjibhai	69p.	8.50	7.70	0.72	0.75	4.60	409
15	Bhiladi	Akbari Babubhai Meghajibhai	42/1	3.00	7.60	0.50	0.98	11.60	115
16	Bhiladi	Desai Dhanjibhai Vallabhbhai	Bhila	9.50	7.90	0.44	0.81	11.60	134
17	Bhiladi	Karad Gordhanbhai Gokalbhai	44p.	9.00	8.00	0.81	0.90	23.90	310
18	Bhiladi	Akbari Bhagabhai Jivabhai	146/1	6.50	7.70	1.04	1.16	4.60	187
19	Bhiladi	Akbari Laljibhai Jivabhai	146/1	8.00	8.10	0.34	0.63	11.60	145
26	Antaliya	Khuman Manubhai Tapubhai	25/1	25.00	8.10	0.56	0.71	4.60	429
27	Antaliya	Vaghediya Shanabhai Rajabhai	33/7	6.00	8.80	0.57	0.69	23.90	409
28	Antaliya	Khuman Mahendrabhai Bapubhai	35	25.00	8.50	0.44	1.23	11.60	115
29	Antaliya	Khuman Kathubhai Suranbhai	36/7	15.00	8.30	0.77	1.16	18.90	217
31	Antaliya	Bhayani Kamlaben Babubhai	23/1	8.00	8.60	0.45	0.58	4.60	386
34	Antaliya	Lathiya Bhikhabhai Jadavbhai	8/1	35.00	8.10	0.80	0.87	11.60	187
35	Antaliya	Kikani Laljibhai Pragjibhai	105/1	10.50	7.80	0.34	1.51	4.60	134
36	Antaliya	Bodar Dharmshibhai Mavjibhai	107/4	13.00	8.60	1.76	0.75	18.90	375
37	Antaliya	Dobariya Bhikhabhai Mohanbhai	107/3	15.00	8.60	0.48	1.20	14.00	145
38	Antaliya	Kikani Ravjibhai Dahyabhai	107/2	3.00	8.70	0.50	0.62	23.90	409
39	Antaliya	Kikani Thakarshibhai Pragjibhai	104/2	10.00	8.20	0.62	1.50	4.60	187
40	Antaliya	Kikani Arvindbhai Jerambhai / Vallabhbhai	51/4	12.00	8.40	0.21	0.75	4.60	409
41	Antaliya	Nathani Kurjibhai Bhagwanbhai	82	60.00	8.30	0.34	0.67	21.40	176
42	Antaliya	Dobariya Ratilal Jagabhai	14/1	50.00	8.70	0.45	0.69	4.60	134
43	Antaliya	Dobariya Natubhai Karmshibhai	18/5	33.00	8.10	0.51	0.67	23.90	252
44	Antaliya	Kikani Jivrajbhai Jerambhai	11/1	12.00	8.40	0.58	1.39	23.90	86
45	Antaliya	Dobariya Parshotambhai Mavjibhai	88/1	60.00	8.10	0.34	1.74	18.90	217
51	Dhangla	Mangukiya Madhavjibhai Hirjibhai	60	55.00	8.20	0.41	1.02	4.60	145
52	Dhangla	Khuman Bhabhlubhai Bhimjibhai	67p.	8.00	8.00	0.28	0.78	11.60	217
53	Dhangla	Der Balabhai Mesurbhai	88p.	10.00	8.40	0.48	1.24	4.60	187
54	Dhangla	Dhakecha Ravjibhai Parshotambhai	81/2	16.00	8.80	0.44	0.69	18.90	145
55	Dhangla	Domadiya Bharatbhai Manharbhai	70/2	30.00	8.30	0.57	1.74	23.90	409
56	Dhangla	Kanala Devuben Shardulbhai	56/3	19.00	8.20	0.53	1.20	23.90	217
57	Dhangla	Mangukiya Bhikhabhai Narshibhai	14p.	15.00	8.00	0.58	1.50	23.90	187
58	Dhangla	Viradiya Parshotambhai Manilal	17p.	13.50	8.20	0.47	1.16	11.60	366

59	Dhangla	Amreliya Nagjibhai Madhabhai	44/1	10.00	7.90	0.88	1.39	11.60	217
60	Dhangla	Amreliya Manubhai Jivrajbhai / (Nanjibhai)	44/4	13.00	8.20	0.50	0.78	18.90	134
61	Dhangla	Khuman Madhubhai Bhabhlubhai	65/2	7.00	8.50	0.89	1.74	4.60	176
62	Dhangla	Domadiya Virjibhai Lavjibhai	65/1	10.00	8.00	0.70	1.16	21.40	145
63	Dhangla	Kanala Batukbhai Jethabhai	47p.	15.00	8.00	0.74	0.81	23.90	115
64	Dhangla	Ambaliya Ramjibhai Bhagwanbhai	42/1	10.00	8.40	0.46	0.67	4.60	187
65	Dhangla	Khunt Ravjibhai Haribhai	45p.	20.00	7.90	0.35	1.97	14.00	347
66	Dhangla	Godhani Shambhubhai Kalabhai	15/2	10.00	7.40	0.37	0.81	4.60	310
67	Dhangla	Godhani Bhikhabhai Haribhai	12/1-3	7.00	8.00	0.76	1.97	23.90	115
68	Dhangla	Godhani Dhirubhai Savjibhai	15/3-2	8.00	8.10	0.84	1.05	21.40	429
69	Dhangla	Domadiya Khodabhai Naranbhai	84p.	13.00	7.80	0.73	1.45	11.60	301
70	Dhangla	Dhakecha Mavjibhai Thakrshibhai	85/2	18.00	8.10	0.42	1.03	18.90	429

76	S.Timba	Togadiya Panchabhai Devshibhai	10A	12.00	7.60	0.80	0.98	4.60	145
78	S.Timba	Dhorajiya Jayantibhai Devrajbhai	84/1-3	12.00	8.00	0.50	1.03	18.90	176
79	S.Timba	Togadiya Bavchandbhai Vallabhbhai	102p.	10.00	7.70	0.33	0.75	23.90	375
80	S.Timba	Dhorajiya Kalubhai Shamjibhai	84p.	15.00	7.80	0.70	0.67	21.40	310
81	S.Timba	Ayar Bhupatbhai Ravatbhai	116	20.00	8.50	0.38	1.02	4.60	115
84	S.Timba	Dhorajiya Kantibhai Vaghjibhai	71p.	10.00	7.70	0.43	1.97	23.90	310
85	S.Timba	Togadiya Chhaganbhai Rambhai	12p.	3.00	8.20	0.26	1.03	18.90	523
86	S.Timba	Gadhiya Parshotambhai Popatbhai	82A	12.00	8.40	1.11	0.75	14.00	176
87	S.Timba	Togadiya Ranabhai Rambhai	12p.	3.00	8.20	0.25	0.69	11.60	310
88	S.Timba	Togadiya Parshotambhai Devjibhai	17p.	16.00	7.40	0.87	1.27	4.60	134
89	S.Timba	Togadiya Virjibhai Ranchhodbhai	18p.	25.00	8.10	0.52	0.81	18.90	217
90	S.Timba	Mer Bijalbhai Rambhai	117/4	10.00	7.90	0.45	0.98	23.90	134
91	S.Timba	Jinjariya Ramanbhai Ramjibhai	76p.	5.00	7.90	0.28	0.98	23.90	187
92	S.Timba	Dhorajiya Kanubhai Devrajbhai	105p.	6.00	7.90	0.72	0.71	23.90	187
93	S.Timba	Kabariya Vallabhbhai Devjibhai	120p.	12.00	7.90	0.53	1.02	4.60	145
94	S.Timba	Kikani Maganbhai Mohanbhai	87/3	15.00	7.60	0.52	1.20	4.60	187

P.H. = (1) Acidic - < 6.5
(2) Normal - 6.51 to 8.10
(3) Bhasmik - 8.10+

E.C. = (1) Normal - < 1
(2) Harm ful - 1.00 to 2.99
(3) More Harmful - 2.99+

	Very Low	**Low**	**Medium**
N.	< 0.25	0.26 - 0.50	0.51 - 0.75
P.	< 10	11 - 25	26 - 60
K.	< 75	76 - 150	151 - 300

Chapter 5

Main Results: Rajanandgaon

This chapter presents results of the field survey in Rajanandgaon, representing forest based agro-ecological system. Forest resources thus, exert a significant influence on people's livelihood in the region. At present, most of the households undertake crop cultivation as the main economic activity, agriculture remains at a subsistence level. The impact of watershed project therefore, will have to be seen in the context of declining dependence on the forest. Given the fact that, forest department has been entrusted with the responsibility of implementing watershed project in the study region, the main thrust is likely to be on regeneration of forest. This ideally, is a valid approach provided the protection and future management of forest resources take place in a participatory manner. Given this backdrop, we present a brief profile of the region and the households in micro watersheds selected for the study.

5.1 Micro Watersheds and Villages: A Profile

Table 5.1 provides main features of micro-watersheds and villages comprising them. The important observations are as follows:

i. Of the 5 villages covered under the micro watershed, four are relatively small in terms of area as well as population except for Kaudikasa, which has a population of about 1500 persons, and located on the road side.

ii. The proportion of forest to total area varies from 84 per cent in the case of Kodewara to 41 per cent in the case of Harekhapayali.

iii. Most of the households except in Kaudikasa are landed. However, irrigation is available mainly in Kaudikasa.

iv. All the villages have wells as well as hand pumps for getting drinking water. Similarly all the villages have a primary school.

v. Only Kaudikasa is linked through a pucca road. Access to health facilities is also poor.

vi. Only Kaudikasa has a co-operative society.

vii. All the villages except for the control village already have a watershed committee.

viii. The initial activities undertaken by watershed project are: percolation tanks and resting place for cattle-Gothan.

ix. Livestock population is fairly large. The average number of livestock per household varies from 6.0 in Sansargadh to 3.1 in Kaudikasa. Of course, there is significant variation in the composition of livestock. This, in turn, has special significance with regards to protection of forest etc.

5.2 Socio-Economic Profile: Sample Households

The primary survey consisted of a sample of 80 households from four villages. Table 5.2 depicts main features of the sample households. The total population covered by these households is 435, which work out to be 5.4 persons per household. The household size varies significantly across villages with Tatoda (the control village) having smallest size of only 3 persons per household. Prima facie, this suggests significant out migration of younger members of the households.

The above observation however, is not confirmed by the estimates of sex ratio, which is fairly low i.e. 80 in the case of Tatoda. We had tried to gauge the incidence of out migration among the study villages. It is observed that 24 out of 80 households i.e. 30 per cent of the sample households reported out migration of at least one person during the reference year (Table 5.3).

The sample belonged to two main communities viz; scheduled caste and scheduled tribe. The overall literacy rate is 57 per cent; 67% among male and 45.7% among female.

Ownership of Land and Irrigation

As noted earlier, the sample consisted of households from two categories viz; landed and landless (Table 5.4a). Since the proportion of landless is fairly small among study villages except Kaudikasa, the sample consists of 11 landless households from three villages, and 69 landed households from four villages. The sample size thus, varied across the micro watersheds. A sample of 25 households was selected from each Kaudikasa and Harekhpayali – relatively larger villages having substantial number of landless households, and 15 households each in the case of Kadewara and Tatoda where number of landless households was 0 and 1 respectively (see table 5.1).

It was noted that a large number of households, including those not having their owned land, had obtained land through encroachment. Unlike other places (e.g. Amreli), encroachment of land is often reported by the respondents, since that helps confirming their stake in the forest-land. As a result, many of our respondents had reported cultivation of crops on the land encroached by them. Besides encroachment, 4 households reported leasing-in of land whereas 7 reported leasing out of land. This suggests a fairly active lease market in the country.

Of those having land, about 75 per cent have a land holding larger than 5 acres. Among the rest, - only 4 per cent have land holding smaller than 2.5 acres. Access to irrigation however, is confined to only 19 households. This works out to be 28 per cent of the 69 landed households. The average land holding size is 5.48 acres (table 5.4b). The land holding size however varies across villages; it is 4.06 in the case of Tatoda and 6.71 in the case of Harekhspayeli. The average size of irrigated land is 3.9 acres, ranging from 0.1 acre in Kadewara to 4.9 acres in Kaudikasa. Given the fact that the area is rich natural resource endowment in terms of rainfall, and soil-quality, and ground water table, irrigation is not a major priority for sustaining their livelihood. Relatively favourable resource endowment seems to have resulted in sustenance subsistence farming as we will see later in this chapter. .

Livestock and Other Assets

Table 5.5 presents estimates of livestock owned by the sample households. It is observed that besides the more productive livestock such as bullock and cow, the number of other livestock such as pigs, ducks, cocks etc. is fairly large. It may however, be noted that the number of sheep and goat is only 44; this may be considered favourable for protection of forest in the region.

The number of bullock is 105, which could make only 52 pairs. This is fairly smaller than the number of landed households in the sample. It was however, observed that buffalos are also used for draught power. Those not having any draught animals seem to borrow from others in exchange of their labour. Given the critical importance of bullocks in a subsistence economy such as this, population of cow is found to be relatively better; there are 90 cows and only 8 buffalos among the sample households. Of course, ownership of cows and buffalos is restricted to only a sub set of the sample households. For instance 48 out of the 69 landed households own bullocks, whereas only 18 out of the 80 households reported ownership of cows. Besides these, there are 219 livestock in the miscellaneous category. They consist of he-buffalo, pigs, etc.

Table 5.6 provides information about ownership of other assets. It is observed that all the households have their own house; though, all these are kachha structures. It was observed that the houses were traditionally built, and were spacious. Only 5 households had toilet facility at home. What is surprising is that 71 per cent of the sample households had access to electricity, which raises the issue of legality since the power connections are often 'un-official' or un-paid for.

It is also a pleasant surprise that 64 out of 80 households in the sample had bicycle. Similarly 13 households had reported having a TV set. Ownership of other small assets is also fairly wide spread among these households. Three households in Kaudikasa owned tractor. Overall, it appears that with respect to asset base, the households are fairly close to those in Amreli, which belong to a relatively more commercialized agrarian society. The difference however, may be found in terms of average flow of income among the households.

Income from Different Sources

We tried to estimate income from different sources. Table 5.7a gives estimated annual income among landless households, which works out to be quite minimal i.e. Rs. 7,648 per household. It may however, be noted that the income reported in Table 5.7 does not include the entire value of various forest produce that are used not only for consumption but also for selling in the market. We have of course, obtained detailed information about quantity of produce collected from forest and/or other CPLRs as well as field bunds. There were however, difficulties in reporting the quantities; valuing these however is still more difficult.

Among landed households, the average income is about Rs. 23,000 per households per annum. This varies significantly from Rs. 15,149 in Harekhapayali to Rs. 39,151 in Kaudikasa (Table 5.7b. These estimates, as in the case of landless households, are likely to be on lower side since they do not include the entire value of products collected/obtained from forests and other CPLRs. These aspects have been examined separately.

Alternatively we tried to assess the proportion of household's income obtained through forest produce- cash and kind- through informal discussions with the village community. It was noted that about 20-25 per cent of the income among landless households is obtained from forest produce. The proportion could be 15-20 per cent in the case of landed households. We have of course, tried to get estimated value of the products obtained from own farm/homestead and from forest, these are obviously under reported, as noted earlier. Similarly, only 7 households had reported income from livestock since most of the income is in terms of self- consumption. We have therefore estimated quantity of milk and other production from different livestock as shown earlier in Table 5.5. The estimated income per household from production of milk of cow and buffalo worked out to be Rs. 4,000 (among 17 households) and Rs. 9, 6000 (among 3 households) respectively. This is of course, different from the income from livestock reported in Table 5.7a & b.

Collection of Forest Resources

In order to gauge the extent of dependence on forest resources, we carried out a detailed enquiry about collection of different products from forest, and the time spent. The estimates in Table 5.8a suggest that the households having livestock obtain about 30 per cent of the fodder requirement from own farms and/or homestead. For the remaining 70 per cent of the requirement, these households depend on grazing in forest and other community land. The dependence for fuel wood is relatively higher. Of the 80 households, 72 reported collection of fuel wood from forest; most of them obtained more than 70 per cent of the fuel wood requirement from forest and community land (table 5.8b).

Apart from fodder and fuel, a large number of sample households collect fruits and other products like tendu leaves from forest. The survey results suggest that 63 out of 80 households (i.e 79 %) collect fruits from the forest and, 37 households (i.e 46%) collect other products from the forest. This is fairly substantial. But, these benefits are not reflected in terms of income estimates in Table 5.7 where only 47 landed and 6 landless households (as against 63) have income from such collection.

Crops and Yield and Input Use

Table 5.9a presents information about cropping pattern among landed households in the sample. Together the area under cultivation during Kharif and Rabi seasons is 328 acres; 312 acres in Kharif and 16 acres in rabi. This of course, does not include crops grown on bunds, as it was difficult for the respondents to measure the area. The reported area under crops therefore, is lower than the total estimated area (owned plus encroached) of 378 acres given in Table 5.4b.

It is observed that the as large as 78 per cent of cropped area reported by the sample households was under paddy. This varies from about 64 per cent in Harekhpayli to 81 per cent in Tatoda. The major crops are pulses and local cereals like `Kodo'. There are of course, a number of crops grown on micro areas such as vegetables, small millets, etc. The cropping thus, reflects subsistence agriculture system where households tend to grow most of the crops for self-consumption.

The subsistence nature of farming is further reflected in terms of low levels of yield as shown in Table 5.10. It is observed that average yield of paddy, which is main crop of the area, is 664 kgs. per acre. If we work out yield of grain it would be about 465 kgs. per acre. Similarly yield of pulses like Udad and Arhar is fairly low. It was noted that Arhar is often grown on bunds. In any case most of the crops are grown on a fairly small piece of land, which is generally broadcasted, without much of tillage and other pre-sowing operations as well as input use. One of the reasons for such low yield of pulses is that, these are grown as mixed crops, where proper estimation of area is not possible.

Table 5.11 presents estimates of input use on the main crop/s grown on the selected plots. It is observed that whereas most of the farmers had grown paddy as the main crop on these lands, use of irrigation and chemical inputs are found mainly in Kaudikasa.

5.3 Institutions and Participation

The second part of the profile refers to households' awareness about village level institutions and their participation in the institutions formed under the watershed project. It is observed that almost all households in the study villages except for Tatoda, knew about the watershed committee. Of these 47 per cent had attended the meetings of the watershed committee. The proportion varies from 69 per cent in Kodewara to 30 per cent in the case of Kaudikasa. To a large extent, low level of participation could be attributed to larger size of the village. It may however, be noted that of the 28 respondents who attended the meetings, 35 per cent had did not have any active participation in the discussions. Of the remaining 18 respondents, 10 were office bearers of the watershed committee. Other six contributed I terms of watershed planning etc.

None of the respondent reported membership in a self help group, as the group is yet to be formulated. It is however, important to note that 48 out of 80 households i.e. (60 per cent) have currently borrowed from other sources. For instance, 11 households reported borrowing from bank; another 12 had taken loan from a cooperative society, and 16 had borrowed from money lenders.

The main purposes for borrowing are- for crops (18), household consumption (17), and livestock (7). Over 60 per cent of the households in three villages had taken loan from different sources except in Kaudikasa where the proportion is 48 per cent. This may be due to relatively higher farm productivity in this village. Overall it suggests substantial scope for providing credit support in the study-region.

5.4 Environmental Indicators

The section deals with three indicators capturing the status of natural resources. These are: level of the ground water table, density and diversity of vegetation on forest land, and soil-features.

Water Table

Table 5.12 provides information about depth of ground water table in wells owned by the sample farmers. In all there are 22 wells and 3 tube wells in study villages. The wells are owned by 20 households; one having three wells. There are 12 households in Kaudikas who receive irrigation from check dam. These form a subset of those who own wells/tube wells. As a result, only 19 households have reported using wells for irrigation (See Table 5.4b).

We have information on depth of water table in the case 19 wells and 1 tube well. It is observed that 17 out of 19 wells had water table up to 30 feet. For tube well the depth is 230 feet. These observations were obtained during the early part of 2004.

We also enquired about availability of drinking water in the villages. It is observed that most of the households obtain water from hand pump and stand post, and that the time spent for collection of drinking water is less than 1 hour per day in the case of majority of households. For the rest, the time spent was between 1and 2 hours. Of the total sample 20 households reported spending 1-2 hours for collection of water during summer, and 6 households reported more than 2 hours per day for getting drinking water (Table 5.13). Overall it was observed that supply of drinking water is not a major problem; though, maintenance of hand pump could be a major problem.

Vegetation in Forest Area

We tried to map out vegetation by selecting small areas in forest on a sample basis. The exercise has been carried out by adopting two different approaches. First, refers to phytosociological study conducted in Kodewara and Tatoda, which are comparable villages. The second refers to a participatory method, where an inventory of different species of vegetation has been prepared through transact, seeking help of the informed persons in the village. In what follows we present results of the exercises conducted in two sets of villages.

Methodology

The Phytosociological study gives mainly the description of vegetation of a particular geographical area and provides the detail information about composition of tree, shrub, & herb communities & also the functional aspect.

Phytosociological studies were carried out in March 2004. In Site I (Kodewara) & SiteII (Tatoda) total 20 quadrates each were studied (10 for trees and 10 for shrubs). For studying Trees and Shrubs layers, the quadrates each of 10m x10m, and 3m x 3m sizes were laid down respectively using nested quadrate method (Khan; 1961) for the estimation of vegetation composition of these sites.

Studies on herbs layer were not made due to time constraint and absence of competent person to identify the different local herbs**.**

Importance Value Index (IVI)

IVI of a species in the community gives the idea of its relative importance. In both stand, both absolute & relative values of Frequency, Density, & Basal area were determined by quadrate sampling method. These relative values were used to calculate the (IVI). The species were then graded in order of decreasing IVI.

The importance value Index (IVI) was enumerated by the summation of relative values of Frequency, Density, & Basal cover (Curtis& Mclntosh, 1950&1951;Misra 1968) by using the following formula.

$$\text{Relative Frequency} = \frac{\text{Frequency of the specie} \times 100}{\text{Total frequency of the species}}$$

$$\text{Relative Density} = \frac{\text{Density of the specie} \times 100}{\text{Total density of the species}}$$

$$\text{Relative Dominance} = \frac{\text{Basal cover of the specie} \times 100}{\text{Total Basal cover of the species}}$$

Importance Value Index (IVI) = Relative Frequency + Relative Density + Relative Dominance

Main results of the exercise have been presented in Appendix II to V. It is observed that in Kodewara micro watershed all the three strata Viz: Herb, Shrub & Tree were present. The tree layer was dominated by *Tectona grandis* (Teak) with highest IVI (44.8) and other major species like *Terminalia tomentosa* (Saja) and *Cleistanthus collinus* (Karra). In shrub layer *Diospyros melanoxylon* (Tendu) is dominant specie. It is mainly due to the fact that the specie is reared by the local population, for its economic use in bidi industry. Though it's a large tree by natural habit, but due to continuous lopping for its leaves, it looks like a shrub. Other co-dominants in the shrub layer are *Tectona grandis* (Teak) and *Cleistanthus collinus* (Karra). Presence of teak in the shrub layer in a large number is due to extensive plantation of this specie, done by the Forest Development Corporation of Chhattisgarh. It is preferred specie for plantation as the area is the natural habitat for its growth and also due to its high timber value. Karra is also severely lopped by the locals as its branches are used for making fences for wadies and homes. Apart from these *Madhuca indica* (Mahua) and *Buchanania latifolia* (Char) trees are also found in a much-scattered form. These trees are used by locals from time immemorial for collecting flower petals and fruits and that is why one can find even big trees with large basal areas.

In Tatoda micro watershed all three strata viz: Herb, Shrub, Tree were present. The tree layer was dominated, with highest IVI by *Tectona grandis* (Teak), Koriya, *Pterocarpus marsupium* (Bijja) and *Madhuca indica* (Mahua). In shrub layer also *Tectona grandis* (Teak) is the dominant specie followed by *Diospyros melanoxylon* (Tendu) and Koriya.

The study indicates that under the extensive influence of plantation activities the vegetation character tends to change considerably. Earlier the area was under dense mix forest which is now gradually replacing by monoculture of *Tectona grandis* (Teak). Though the quadrate study was not made on the herb layer but the ocular observation of the site showed the presence of seedlings of many naturally occurring tree species of the area viz. *Pterocarpus marsupium* (Bijja), *Diospyros melanoxylon* (Tendu) etc. Herb layer in the areas inhabited by teak plantation was almost absent.

Vegetation Cover of Harekhapayali and Koudikasa Micro Watersheds

We tried to adopt a participatory approach for mapping out vegetative cover and forest resources in the remaining two micro watersheds. This was carried out with the help of help of the local people and forest staff in the region. The information collected from th etwo micro watersheds are presented as follows:

(a) **Harekhapayali micro-watershed:** The village has relatively better forest cover with diverse tree cover. The tree species found in this micro watershed area are:

Tree Species

Tectona grandis(Teak)	Buchanania latifolia(Anwla)	Bael*
Pterocarpus marsupium(Bijja)	Embilica officinalis(Karra)	Haldu*
Terminalia tomentosa (Saja)	Cliestanthus collinus	Dhuda
Salai	Sainha*	Girchi*
Modeh	Dhorban *	Ghainta
Diospyros melanoxylon(Tendu)	Bhirra *	Suar baal
Buchanania latifolia(Char)	Schleichera oleosa(Kusum)	Bahera
Jamun*	Charpatti	

* Local name

Kaudikasa micro watershed: Forest area in this micro watershed is very small. Moreover, the the forest is facing severe degradation due to large human and livestock population and connectivity due to better road link. Canopy density according to ocular observation was around 5-10% only. Presence of fresh stumps of timber trees indicated ongoing illicit felling of trees. Overgrazing & over extraction of fuel wood in the area has affected negatively on the forest regeneration. The various plant species found in the area are:

Tree Species

Tectona grandis (Teak)	Schleichera latifolia (Char)
Diospyros melanoxylon	Bhirra*
Madhuca indica (Mahua)	Karra*
Ptercarpus marsupium	Sainha
Terminalia tomentosa	Dhawal *
Salia	Barjhari
Buchanania latifolia	

Soil Test: The Results

In order to get bench mark values for soil nutrients and other features viz; Ph and electro-conductivity we got soil samples from the main plots of 68 landed households. The results, presented in Table 5.14 suggest that whereas the ph values are within the normal range for all plots, nutrient deficiency appears to be significant. For instance 50 out of the 68 samples were found to have low content of nitrogen; for phosphorous the number is 21. All the plots have medium content of potash. The nitrogen deficiency could be an outcome of mono cropping of paddy, with very limited application of chemical fertiliser as seen earlier.

5.5 Summing Up

The results presented in the foregoing sections provide a fairly comprehensive profile of the natural resources and farming system as well as people's livelihood base in the study region. Two observations are important in this context. First, agriculture is still at a subsistence level, despite (or because of) the better endowment of natural resources. Forest resources seem to be providing a substantial proportion of people's livelihood base. But, these benefits are difficult to quantify in monetary terms. The bench mark should therefore, rest more on the estimates of quantities rather than of income from such resources. Second, watershed project need to focus more on developing forest rather than water resources especially, for irrigation. Regeneration of both-private as well as community forests should thus, constitute core of the watershed treatment in the region.

Table 5.1: Main Features of the Selected Micro Watersheds: Rajanandgaon

S.No.	Particulars	Micro-watershed				
		Kodewara	Harekhapayali		Kaudikasa	Tatoda (Control)
1.	**Villages under each micro-watershed**	Kodewara	Sansargarh	Harekhapayali	Kaudikasa	Tatoda
2.	**Total HHS**	36	21	69	280	41
3.	**Landed HHS**	35	19	64	197	40
4.	**Land less HHS**	1	2	5	83	1
5.	**Population**	199	99	352	1488	220
6.	**Total Land (acre)**	1362.23	692.55	2745.84	NA	1978.53
	Non-cultivated	0	20.54	621.75	NA	0
	Forest/Gaucher	1152.76	348.60	1124.35	NA	1834.44
	Other non-cultivated	15.12	22.50	56.52	NA	20.18
	Cultivated Land	194.34	300.92	943.21	667.76	123.90
	Irrigated	0	0	1.00	267.26	3.3
	Unirrigated	194.34	300.92	942.21	400.50	120.60
7	**Migration** (No. of HHS)					
	Temporary	4	1	17	60	2
	Permanent	0	1	3	16	3
8	**Main Crop**					
	Kharif	Paddy	Paddy	Paddy	Paddy	Paddy
	Rabi	Lakhdi	Lakhdi	Lakhdi	Lakhdi	Lakhdi
	Summer	Nil	Nil	Nil	Nil	Nil
9	**Livestock**					
	Per HHS	6.8	6.0	5.6	3.1	4.6
	Cow	45	19	37	136	46
	Buffalo	25	7	60	55	22
	Bullock	54	16	0	207	48
	Other	122	56	221	189	41
	Sheep/Goat	0	29	15	99	31
10.	**Drinking water**					
	Well	5	3	2	21	9
	Handpump	1	1	4	3	1
	Pond	2	1	1	3	3
	Tap at home	NO	NO	NO	Few houses have water connections at home (Data not available	NO
11.	**Schools**					
	Primary	YES	YES	YES	YES	YES
	Secondary	NO	NO	NO	NO	NO
	Higher secondary	NO	NO	NO	NO	NO
	College	NO	NO	NO	NO	NO

12	**Hospital**					
	PHC	NO	NO	NO	YES	NO
	CHC	NO	NO	NO	NO	NO
	Pvt.	NO	NO	NO	NO	NO
13.	**Link Road**					
	All weather	NO	NO	NO	YES	NO
	Seasonal	YES	YES	YES	YES	YES
14.	**Co-op'society**	NO	No	No	YES	No
15.	**PIA**	Director, Society For Social Services, Madhya Bharat Chapter (Bhilai)	SDO (Forest), Ambagad Chauki		SDO (Forest), Ambagad Chauki	
16.	**WDP Batch**	DPAP VIII	DPAP VII		DPAP VII	N.A.
17.	**WDP committee**	YES	YES	YES	YES	N.A.
19.	**SHG**	Yes	Yes	Yes	Yes	N.A.
20.	**Entry point activities**	Gothan*	Gothan	Gothan	Gothan	N.A.
21.	**WDP (SWC) structures**					
	Boulder checks	0	19	30	25	N.A.
	Percolation tanks	2	0	2	2	N.A.
22.	**Other (SWC) structures**	Dabri** (1)	Dabri (1)	Dabri (3)	Dabri (2)	Dabri (1)

* A raised patch of land made for sitting and resting for cattle.
** Percolation tanks constructed under other schemes.

Table 5.2: Characteristics of Sample Households Population and Literacy

	HH Variables	Villages: (Micro-Watershed)				All
		Kodewara	Harekhapayli	Kaudikasa	Tatoda	
1	Total population	93	125	143	74	435
1.1	Male	47	64	71	41	223
1.2	Female	46	61	72	33	212
1.3	Sex ratio	98	95	101	80	95
2	HHs size	6.2	5.0	5.7	3.0	5.4
3	Children 6-14 Per HHs	17 1.1	28 1.1	18 0.7	10 0.7	73 0.9
4	Literacy Among Children					
	Total (%) Male Female	16 (94.1) 7 9	25 (89.3) 13 12	18 (100.0) 10 8	8 (80.0) 5 3	67 (91.8) 35 32
5	Literacy All Population (No.)					
	Total % Male % Female %	47 (50.5) 26 (55.3) 21 (45.6)	63 (50.4) 40 (62.5) 23 (37.7)	97 (67.8) 59 (83.1) 38 (52.8)	40 (54.0) 25 (61.0) 15 (45.4)	247 (56.8) 150 (67.3) 97 (45.7)

Table 5.3: Out-Migration among Sample Households

MWC	Total Migrant	Month								All
		1	2	3	7	8	9	10	12	
Kodewara	2	1	-	-	-	-	-	-	1	2
Harekhapayli	5	-	5	1	-	-	-	-	-	6
Kaudikasa	8	-	6	1	-	-	1	-	-	8
Tatoda	8	-	1	1	2	1	1	2	-	8
All	24	1	12	3	2	1	2	2	1	24

Table 5.4 (a): Distribution of Sample Households by Ownership of Land and Irrigation

	Ownership of Land	Villages: (Micro-Watershed)				All
		Kodewara	Harekhapayli	Kaudikasa	Tatoda	
1	Landless	-	5	5	1	11
2	Landed	15	20	20	14	69
2.1	Landholding Size					
(a)	<2.5	-	-	-	3	3
(b)	2.5 – 5.0	2	9	1	2	14
©	5.01 – 7.5	2	3	4	3	12
(d)	> 7.5	11	8	15	6	40
2.2	Access to Irrigation					
(a)	With irrigation	1	3	14	1	19
(b)	Without irrigation	14	17	6	13	50
3	Total (1+2)	15	25	25	15	80

Table 5.4(b): Size of Landholding and Irrigated Land among Landed Households

	Micro watershed	Acres HHs*	
		Landholding	Irrigation
1	Kodewara	4.44	0.10
2	Harekhapayli	6.71	0.91
3	Kaudikasa	6.02	4.99
4	Tatoda	4.07	2.00
	All	5.48 (378.12)*	3.93 (74.76)

*** Includes encroached land**

Table 5.5: Ownership of Livestock among Sample Households

		Kodewara	Harekhapayli	Kaudikasa	Tatoda	All
1	Total livestock	120	145	143	89	497
2	Bullock	26	19	43	17	105
3	Cow	21	21	23	25	90
4	Buffalo	0	1	7	0	8
5	Sheep/Goat	5	33	2	4	44
6	Cock	11	9	5	6	31
7	Others	57	62	63	37	219

Table 5.6: Ownership of Other Assets

Assets	Kodewara	Harekhapayli	Kaudikasa	Tatoda	All
House type: Kachha	15	25	25	15	80
Toilet	1	-	3	1	5
Electricity	12	13	22	10	57
Cycle	15	19	17	13	64
T.V	2	4	6	1	13
Tractor	-	-	3	-	3
Radio	3	4	6	2	15
Stove	-	1	4	-	5
Cooker	-	1	3	-	4

Table 5.7 (a) Average Income from Different Source- Landless (Rs/Year)

		Out-migration	Animal husbandry	Forest + CPLRs	Agri. labour income	Other labour income	HHs income	All
Kodewara	M N	- -	- -	- -	- -	- -	- -	- -
Hareshapayli	M N	- -	1000 (1)	2190 (5)	1375 (4)	2472 (4)	1000 (1)	5668 (5)
Kaudikesa	M N	4900 (4)	4800 (1)	- -	1127 (5)	5338 (2)	7800 (1)	8142 (5)
Tatoda	M N	- -	- -	1000 (1)	6600 (1)	280 (1)	- -	7880 (1)
All	M N	4900 (4)	2900 (2)	1992 (6)	1773 (10)	2978 (7)	4100 (2)	7648 (11)

Table 5.7 (b): Average Income from Different Sources: Landed Households (Rs/Year)

	Sources of income	Micro-Watershed				All
		Kodewara	Harekhapayli	Kaudikasa	Tatoda	
1	Agriculture	7956.0 (15)	8879.0 (20)	2334.0 (20)	6861.0 (14)	12460 (69)
2	Out-migration	8550.0 (2)	3133.3 (3)	5900.0 (2)	3133.3 (3)	4770.0 (10)
3	Animal husbandry	200.0 (1)	6000.0 (1)	7667.0 (3)	0	5840.0 (5)
4	Forest + CPLRs	1509.0 (13)	906.0 (14)	570.0 (6)	2102.0 (14)	1386.0 (47)
5	Farm forestry	1071.0 (9)	512.0 (3)	392.0 (5)	529.0 (7)	702.5 (24)
6	Agricultural labour	1603.0 (13)	1314.0 (18)	1482.5 (12)	2173.0 (12)	1606.5 (55)
7	Other labour	2631.0 (14)	1831.0 (18)	851.0 (13)	1653.5 (11)	1768.6 (56)
8	Service	0	19200.0 (2)	49200.0 (4)	47000.0 (2)	41150.0 (8)
9	Business	3600.0 (1)	0	16800.0 (3)	2000.0 (1)	11200.0 (5)
10	All	15149.0 (15)	151104 (20)	39151 (20)	19918 (14)	23061.6 (69)

Note: Estimates of income from agriculture is based on gross value of entire output (including self consumption and market sales). The cost of cultivation is deducted @ 10 percent of the gross value. This does not include cost of family labour

Table 5.8 (a): Fodder Obtained from Forest

NWC	<30	30-70	>70	All
Kaudikasa				
Winter	-	-	8	8
Monsoon	-	-	15	15
Summer	-	-	-	-
Harkhapayali				
Winter	-	-	8	8
Monsoon	1	-	12	13
Summer	-	-	-	-
Kodawara				
Winter	-	-	18	18
Monsoon	-	1	20	21
Summer	-	-	-	-
Tatoda				
Winter	-	-	7	7
Monsoon	-	-	11	11
Summer	-	-	-	-
All				
Winter	-	-	41	41
Monsoon	1	1	58	66
Summer	-	-	-	-

Table 5.8 (b): Collection of Fuelwood from Forest

NWC	<30	30-70	>70	All
Kaudikasa				
Winter	-	-	15	15
Monsoon	-	-	15	15
Summer	-	1	14	15
Harkhapayali				
Winter	-	-	22	22
Monsoon	-	-	22	22
Summer	-	-	22	22
Kodawara				
Winter	4	4	12	20
Monsoon	5	4	11	20
Summer	5	4	11	20
Tatoda				
Winter	-	-	15	15
Monsoon	-	-	15	15
Summer	-	-	15	15
All				
Winter	4	4	64	72
Monsoon	5	4	63	72
Summer	5	5	62	72

Table 5.9: Cropping Pattern (Rajanandgaon)

	Crops (Kharif)		Kodewara		Harekhapayli		Kaudikasa		Tatoda		All	
				%		%		%		%		%
3	Til	UI	0.25	0.47	-	-	0.15	0.12	-	-	0.40	0.12
24	Paddy	UI	41.00	77.20	77.11	64.20	105.02	81.54	33.75	75.03	256.88	78.08
25	Paddy	I	-	-	0.75	0.62	-	-	-	-	0.75	0.23
27	Kulthi	UI	2.75	5.18	7.15	5.95	-	-	4.58	10.18	14.48	4.40
28	Urad	UI	0.50	0.94	0.30	0.25	-	-	2.85	6.34	3.65	1.11
50	Gourd	UI	0.12	0.23	-	-	-	-	-	-	0.12	0.04
52	Bitter gourd	UI	0.03	0.06	-	-	-	-	-	-	0.03	0.00
67	Semi	UI	-	-	-	-	0.20	0.16	-	-	0.20	0.06
71	Kodo	UI	4.61	8.68	6.84	5.70	0.37	0.29	3.10	6.89	14.92	4.54
72	Kutki	UI	0.50	0.94	3.25	2.71	-	-	0.60	1.33	4.35	11.32
73	Madia	UI	1.00	1.88	0.50	0.42	-	-	-	-	1.50	0.46
74	Arhar	UI	-	-	0.30	0.25	13.50	10.48	0.05	0.11	13.85	4.21
75	Alsi	UI	0.75	1.41	1.50	1.25	-	-	-	-	2.20	0.67
76	Patwa	UI	0.50	0.94	-	-	0.05	0.04	0.05	0.11	0.60	0.18
Total	**Kharif**		**52.01**		**97.7**		**119.29**		**44.98**		**312.43**	
16	Wheat	I	-	-	-	-	3.00	2.33	-	-	3.00	0.91
21	Masoor	UI	-	-	1.00	0.83	-	-	-	-	1.00	0.30
62	Lakhadi	UI	1.00	1.88	3.00	2.50	3.00	2.33	-	-	1.50	0.67
75	Alsi	UI	0.75	1.41	1.50	1.25	-	-	-	-	2.20	0.67
79	Gawar Papdii	UI	-	-	-	-	1.00	0.78	-	-	1.00	0.30
82	Chilly	I	0.15	0.28	-	-	-	-	-	-	0.15	0.05
84	Moong	I	-	-	-	-	2.00	1.55	-	-	2.00	0.61
96	Chana	UI	-	-	0.40	0.33	-	-	-	-	0.40	0.12
98	Masoor	I	-	-	-	-	0.50	0.39	-	-	0.50	0.15
Total	**Rabi**		**1.9**		**5.9**		**9.5**		**0**		**16.55**	
	All		53.11	100.00	120.10	100.00	128.79	100.00	44.98	100.00	328.98	100.00

C = Coarse Cereal, P= Pulse, V= Vegetable, O= Oilseed; F= Fruit
Note : Refers to area under those crops for which main production was reportedTable 5.7 (a) :

Table 5.10: Yield of Major Crops (Rajanandgaon)

	Crops (Kharif)		Kodewara	Harekhaphyali	Koudikasa	Tatoda	All	(n)
3	Til (o)	UI	-	-	-	-	27.5	3
24	Paddy	UI	592.6	482.7	832.9	638.5	663.8	68
25	Paddy	I	-	-	-	-	1200.0	1
27	Kulthi (P)		-	11.7	-	70.3	35.3	12
28	Urad (P)	UI	-	-	-	18.62	23.3	7
50	Gourd (V)	UI	-	-	-	-	33.3	2
52	Bitter gourd (V)	UI	-	-	-	-	66.7	1
67	Semi (veg)	UI	-	-	-	-	500.0	1
71	Kodo (CR)	UI	91.1	84.5	-	-	109.8	14
72	Kutki (CR)	UI	-	-	-	-	93.3	3
73	Madia	UI	-	-	-	-	93.3	3
74	Arhar (P)	UI	-	-	6.9	-	6.71	5
76	Patwa (F)	UI	-	-	-	-	28.3	3
	Rabi							
16	Wheat	I	-	-	-	-	500.0	1
62	Lakhadi	UI					23.6	
75	Alsi-						30.0	
82	Chilly (V)	I	-	-	-	-	153.3	2
84	Mung (P)	I	-	-	-	-	100.0	1
96	Chana (P)	UI	-	-	-	-	7.5	1
98	Massor (P)	I	-	-	-	-	180.0	1

C = Coarse Cereal, P= Pulse, V= Vegetable, O= Oilseed; F= Fruit

Table 5.11 (a): Input Use and Production of Major Crops (per acre) – Chattisgadh

	Kodewara (Paddy UI)	Tatoda (Paddy UI)
Area (Acre)	19.65 (15)	13.56 (14)
FYM (Kg.)	22750 (11)	14600 (10)
DAP (Kg.)	70 (5)	10 (1)
Urea (Kg.)	10 (2)	10 (1)
A.S. (Kg.)	- -	- -
Potash (Kg.)	- -	- -
S.S.P (Kg.)	3 (1)	- -
Irrigation (No)	- -	- -
Main production (Kg.)	13800 (15)	8888 (14)
--- Prod. (Kg.)	12725 (14)	11060 (14)
Prod. Sold (Kg.)	825 (2)	- -
Rate (Rs./Kg.)	5.5	- -

Note : Only one crop is cultivated on the selected plots among sample households

Table 5.11 (b): Input Use and Production of Major Crops: Kaudikasa

	Wheat (I)	Sarsav (UI)	Paddy (UI)	Paddy (I)	Pea (I)	Wagli (UI)	Rohar (UI)	Dhaniya (I)	Masur (I)
Area (Acre)	5.00 (1)	1.00 (1)	35.43 (19)	9.53 (2)	0.55 (1)	1.00 (1)	1.00 (1)	0.55 (1)	0.55 (1)
FYM (Kg.)	- -	- -	61000 (16)	4000 (2)	- -	- -	- -	- -	- -
DAP (Kg.)	150 (1)	- -	825 (18)	100 (1)	- -	5 (1)	5 (1)	- -	- -
Urea (Kg.)	50 (1)	- -	895 (15)	250 (2)	- -	- -	- -	- -	- -
A.S. (Kg.)	25 (1)	- -	260 (3)	- -	- -	- -	- -	- -	- -
Potash (Kg.)	100 (1)	- -	1044 (10)	- -	- -	- -	- -	- -	- -
S.S.P (Kg.)	- -	- -	15 (1)	250 (1)	- -	- -	- -	- -	- -
Irrigation (No)	2 (1)	- -	- -	1 (1)	3 (1)	- -	- -	3 (1)	3 (1)
Main production (Kg.)	1500 (1)	- -	28975 (19)	5750 (2)	120 (1)	5 (1)	- -	8 (1)	90 (1)
Resi Prod. (Kg.)	5000 (1)	- -	27327 (18)	6600 (2)	- -	- -	- -	- -	30 (1)
Prod. Sold (Kg.)	1500 (1)	- -	10675 (7)	2875 (2)	- -	- -	- -	- -	- -
Rate (Rs./Kg.)	10 (1)	- -	4.87	5.7	- -	- -	- -	- -	- -

Table 5.11 (c): Input Use and Production of Major Crops: Harekhapayli

	Bajri (I)	Paddy (UI)	Paddy (I)	Lakhadi (UI)	Alsi (UI)
Area (Acre)	0.20 (1)	23.86 (18)	0.25 (1)	13.31 (3)	0.30 (1)
FYM (Kg.)	- -	10850 (13)	500 (1)	- -	- -
DAP (Kg.)	- -	192 (5)	- -	- -	- -
Urea (Kg.)	- -	632 (15)	- -	- -	- -
A.S. (Kg.)	- -	205 (2)	- -	- -	- -
Potash (Kg.)	- -	56 (3)	- -	- -	- -
S.S.P (Kg.)	- -	155 (3)	- -	- -	- -
Irrigation (No)	- -	- -	1 (1)	- -	- -
Main production (Kg.)	150 (1)	11851 (18)	225 (1)	15 (2)	5 (1)
--- Prod. (Kg.)	688 (1)	26675 (14)	1375 (1)	1042 (3)	- -
Prod. Sold (Kg.)	- -	1650 (2)	- -	- -	- -
Rate (Rs./Kg.)	- -	4.75	- -	- -	- -

Table 5.12: Depth of Water Level in Wells + Tubewell

M.W.C.	Well + Tubewell	Depth				
		<30	31-60	61-100	101-300	All
5	4	4	-	-	-	4
6	5	5	-	-	-	5
7	12	5	2	-	1	8
8	4	3	-	-	-	3
All	25	17	2	-	1	20

Table 5.13 : Time spent for collection of Drinking Water

NWC	<1 hr.	1-2 hrs.	2+ hrs.	Total
Kaudikasa				
Summer Monsoon Winter	8 13 13	6 2 2	1 - -	15 15 15
Harkhapayali				
Summer Monsoon Winter	18 20 22	5 5 3	2 - -	25 25 25
Kodawara				
Summer Monsoon Winter	18 18 18	6 7 7	1 - -	25 25 25
Tatoda				
Summer Monsoon Winter	10 13 14	3 2 1	2 - -	15 15 15
All				
Summer Monsoon Winter	54 64 67	20 16 13	6 - -	80 80 80

Table: 5.14: Soil Analysis Results- Rajnandgaon

Sr. No.	State	District	Block	Block Code	Village Code	Village	Farmer's Name	Plot No.	pH	N	P	K
126	C.G.	3	Mohla	5	16	Kodewara	Hemu/Ansari	1	7	1	1	2
127	C.G.	3	Mohla	5	16	Kodewara	Prem Singh/Mansingh	1	7.3	1	3	2
128	C.G.	3	Mohla	5	16	Kodewara	Kartari/Bisahu	1	7.1	1	1	2
129	C.G.	3	Mohla	5	16	Kodewara	Ranjit/Dayalu	1	7	2	3	2
130	C.G.	3	Mohla	5	16	Kodewara	Ramdayal	1	7.4	2	3	2
131	C.G.	3	Mohla	5	16	Kodewara	Nuksu/Akalu	1	7.3	1	1	2
132	C.G.	3	Mohla	5	16	Kodewara	Raghuveer/Shyam	1	7.1	2	2	2
133	C.G.	3	Mohla	5	16	Kodewara	Ramnath Munshi	1	7.2	1	1	2
134	C.G.	3	Mohla	5	16	Kodewara	Lachan/Ankalu	1	7.3	2	1	2
135	C.G.	3	Mohla	5	16	Kodewara	Dholuram/Chamru	1	7.2	1	1	2
136	C.G.	3	Mohla	5	16	Kodewara	Ankaluram/Baliyar	1	7.3	1	2	2
137	C.G.	3	Mohla	5	16	Kodewara	Mehttar/Sajjan	1	7.4	1	2	2
138	C.G.	3	Mohla	5	16	Kodewara	Sukhuram/Ankalu	1	7	1	1	2
139	C.G.	3	Mohla	5	16	Kodewara	Jhaduram/Lachan	1	7	2	2	2
140	C.G.	3	Mohla	5	16	Kodewara	Prem lal/Lakhan Singh	1	7.4	1	2	2
141	C.G.	3	A.Chauki	4	17	Harekhapayali	Mansha Ram/Manhar lal	1	7.3	1	2	2
142	C.G.	3	A.Chauki	4	17	Harekhapayali	Hatte Ram/Chamaru	1	7.2	1	3	2
143	C.G.	3	A.Chauki	4	17	Harekhapayali	Girdhari	1	7.1	2	2	2
144	C.G.	3	A.Chauki	4	17	Harekhapayali	Ramprasad/Sundar	1	7.1	2	3	2
145	C.G.	3	A.Chauki	4	17	Harekhapayali	Indluram/Mangluram	1	7.4	3	2	2
146	C.G.	3	A.Chauki	4	17	Harekhapayali	Dame Ram/Dholu Ram	1	7.2	2	1	2
147	C.G.	3	A.Chauki	4	17	Harekhapayali	Man Singh/ Moti Ram	1	7.3	1	2	2
148	C.G.	3	A.Chauki	4	17	Harekhapayali	Uday Ram/Sriram	1	7.3	1	3	2
149	C.G.	3	A.Chauki	4	17	Harekhapayali	Prakash Singh/Ramdas	1	7.2	1	2	2
150	C.G.	3	A.Chauki	4	17	Harekhapayali	Phulwati/Ramdas	1	7.1	3	1	2
151	C.G.	3	A.Chauki	4	17	Harekhapayali	Todar Singh/Toran Singh	1	7	1	3	2
156	C.G.	3	A.Chauki	4	18	Sansargarh	Phaguram	1	7.2	1	2	2
157	C.G.	3	A.Chauki	4	18	Sansargarh	Chatra Singh/Johar	1	7.3	1	1	2
158	C.G.	3	A.Chauki	4	18	Sansargarh	Jaypal/Kanjalu	1	7.1	1	2	2

Sr. No.	State	District	Block	Block Code	Village Code	Village	Farmer's Name	Plot No.	pH	N	P	K
159	C.G.	3	A.Chauki	4	18	Sansargarh	Ramjilal/Asa ram	1	7.1	1	3	2
160	C.G.	3	A.Chauki	4	18	Sansargarh	Sumli bai/Shyam	1	7.4	1	2	2
161	C.G.	3	A.Chauki	4	18	Sansargarh	Shyam Sai	1	7.1	2	1	2
162	C.G.	3	A.Chauki	4	18	Sansargarh	Channu Ram	1	7.3	1	3	2
163	C.G.	3	A.Chauki	4	18	Sansargarh	Devanti/Lalsai	1	7.1	1	3	2
101	C.G.	3	A.Chauki	4	15	Kaudikasa	Chironji lal/Banshi lal	1	7	1	2	2
102	C.G.	3	A.Chauki	4	15	Kaudikasa	Latkhor / Dhanau Ram	1	7.1	1	3	2
103	C.G.	3	A.Chauki	4	15	Kaudikasa	Jaggar Singh	1	7.1	1	1	2
104	C.G.	3	A.Chauki	4	15	Kaudikasa	Churaman Singh/Tehgu	1	7	1	2	2
105	C.G.	3	A.Chauki	4	15	Kaudikasa	Kamta/Mehtru	1	7.2	2	3	2
106	C.G.	3	A.Chauki	4	15	Kaudikasa	Ramji/Mitthuram	1	7.2	1	1	2
107	C.G.	3	A.Chauki	4	15	Kaudikasa	Basant / Ghanshyam	1	7.1	1	3	2
108	C.G.	3	A.Chauki	4	15	Kaudikasa	Amar Singh/Shanta Ram	1	7.2	2	2	2
109	C.G.	3	A.Chauki	4	15	Kaudikasa	Bali Ram / Dhanva	1	7	1	1	2
110	C.G.	3	A.Chauki	4	15	Kaudikasa	Harilal/Dhaniram	1	7.2	3	3	2
111	C.G.	3	A.Chauki	4	15	Kaudikasa	Narendra/Nandlal	1	7	2	2	2
112	C.G.	3	A.Chauki	4	15	Kaudikasa	Doman Lal/ Parsaram	1	7.4	1	2	2
113	C.G.	3	A.Chauki	4	15	Kaudikasa	Banwari Ram	1	7.3	2	1	2
114	C.G.	3	A.Chauki	4	15	Kaudikasa	Mahar Singh/Birju	1	7.3	1	2	2
115	C.G.	3	A.Chauki	4	15	Kaudikasa	Lakshman Singh	1	7.4	2	3	2
116	C.G.	3	A.Chauki	4	15	Kaudikasa	Ram Bilas/Mitthuram	1	7	1	1	2
117	C.G.	3	A.Chauki	4	15	Kaudikasa	Charku Ram/Jagatram	1	7.2	2	2	2
118	C.G.	3	A.Chauki	4	15	Kaudikasa	Sundri Bai/Kalyan Singh	1	7.1	1	3	2
119	C.G.	3	A.Chauki	4	15	Kaudikasa	Arjun Singh / Bishan	1	7.1	1	3	2
120	C.G.	3	A.Chauki	4	15	Kaudikasa	Manglu Ram/	1	7.4	1	2	2
166	C.G.	3	Mohla	5	19	Tatoda	Ram Singh/ Rai Singh	1	7.4	1	2	2
167	C.G.	3	Mohla	5	19	Tatoda	Johar Ram	1	7.3	1	1	2
168	C.G.	3	Mohla	5	19	Tatoda	Chamar Singh/ Bisahu	1	7	1	2	2
169	C.G.	3	Mohla	5	19	Tatoda	Gokul Ram	1	7.1	1	3	2
170	C.G.	3	Mohla	5	19	Tatoda	Reman/ Madan	1	7.2	1	1	2
171	C.G.	3	Mohla	5	19	Tatoda	Leela/ Kartik Ram	1	7.2	1	1	2
172	C.G.	3	Mohla	5	19	Tatoda	Tatu Ram / Harde	1	7.1	1	1	2

Sr. No.	State	District	Block	Block Code	Village Code	Village	Farmer's Name	Plot No.	pH	N	P	K
173	C.G.	3	Mohla	5	19	Tatoda	Mehtru / Shyam Singh	1	7.1	1	2	2
174	C.G.	3	Mohla	5	19	Tatoda	Budh ram/ Eshu	1	7.2	1	3	2
175	C.G.	3	Mohla	5	19	Tatoda	Bishnath / Lakshman	1	7	1	1	2
176	C.G.	3	Mohla	5	19	Tatoda	Gottar / Veer Singh	1	7	1	3	2
177	C.G.	3	Mohla	5	19	Tatoda	Madhar Ram/ Punau	1	7.2	1	2	2
178	C.G.	3	Mohla	5	19	Tatoda	Anand Ram/ Phakkir	1	7.2	1	2	2
179	C.G.	3	Mohla	5	19	Tatoda	Dasrath / Agnu	1	7.1	1	2	2

Acidic <6 Normal 6 – 8.5 Alkaline > 8.5 B = 68

		Range		
	Code	N (kg / ha)	P (kg / ha)	K (kg/ha)
Low	1	0.3 - 0.5	5.0 -10.0	200-250
mid	2	0.5 - 0.75	10.0 - 20.0	250-400
High	3	0.75 - 1.0	20.0 - 40.0	400-600
Very Low	4	<.03	<5	<200
Very High	5	>1.0	>40	>600

Chapter 6

Results from the Field Survey: Dehradun

The chapter deals with yet another agro-ecological situation in hills, where checking soil erosion through stabilization of vegetative cover, is the prime concern for a watershed intervention. Nevertheless besides the conservation objective, the project may also have significant influence on people's livelihood since deforestation and soil erosion, have direct bearing on the availability of biomass for livestock and fertility of soil used for crop cultivation. Another special feature of the region, especially from the view- point of the field study is that, the households have multiple holdings, scattered within and out side the watershed, and that cropping pattern is also highly diversified. Moreover the livelihood base, like that in the forest region in Chhatisgadh, is also significantly depends on the rich forest resources. The major constraint faced by people in this region is- natural calamity like flood, landslides, and poor connectivity with markets etc. Given this backdrop, in what follows we may present main results of the field study conducted during December-January, 2003-04 in Dehradun district of Uttaranchal.

6.1 Micro Watersheds: A Profile

Table 6.1 provides broad profile of the four micro watersheds, consisting of 11 villages. It may be noted that the micro watersheds are located in the middle hills, with a maximum elevation ranging 2361 meter in the case of Amtiargadh to 1700 meter in the case of Samaltagadh-B. The selection of micro watersheds in the middle hills thus, gives an opportunity to capture the impact on human settlement and livelihood.

Although, we tried to select micro watersheds on different reaches of a watershed, there were difficulties in identifying such units, given the other criteria adopted for sample selection. As a result, we find that the general slope of all the micro watersheds does not vary significantly; it ranges from 20 % in the case of Amlawagad-2 to about 29 % in the case of Amalawagad-5.

The proportion of arable land is very small i.e < 50 per cent in the case of majority villages except in Kuroli in Samaltagadh-B. We do not have estimates of irrigated area at village level; the official information however suggests very small area under irrigation. The main source of irrigation is small canal-known as `gul' in local parlance. Most of the households in the sample villages own land.

Livestock constitutes an important part of the village economy. Bullock being the major source of draught power, is large in number as compared to the number of landed households in the villages.

While all the villages except three in the control micro watershed have primary school, other infrastructure such as link road, medical services, co-operative societies are seldom prevalent. Nevertheless unlike the study region in Chhatisgadh, the village community in the study villages in Dehradun is relatively well integrated because of the long tradition of out migration from the region. In fact, seasonal migration with livestock to the plains, is fairly common in the hills. We will look into this issue shortly.

6.2 Sample Households: Main Features

Socio-Economic Profile

Table 6.2 provided information about the socio-economic characteristics of sample households. Following observations are important in this context:

i.. The average size of the household is very large i.e. 11.4 persons per household. This is mainly due to the fact that most of the households are joint families, having joint land holdings as reflected by the relatively larger land holding size in these villages. To an extent, this should also get reflected in the income per household as we will see later.

ii. Given the difficulties in connectivity, the literacy levels are low in all the villages except Samaltagadh. The overall literacy level is 51.9 per cent; 62.9 % in case of male and 39.7 % in the case of female population.

ii. Sex ratio is fairly low in all the villages except in Samaltagadh. This may reflect high incidence of out-migration as noted earlier.

As large as 55 per cent of the households reported migration of at least one person from household during the reference year. Of these, about 50 per cent reported duration of migration as six months or more than that. Besides these, 15 households had reported permanent out migration of members of their family (Table 6.3).

Ownership of Land and Irrigation

Table 6.4 presents distribution of sample households by ownership of land and irrigation. Given the fact that incidence of landlessness is fairly limited in the study region, the sample consists of 86 landed and 14 landless households selected from the four micro-watersheds.

It is observed that about 31 per cent of the landed households have holdings smaller than 2.5 acres; another 34 per cent have land holding size in the range of 2.5 to 5 acres; the rest have holdings larger than 5 acres.

As large as 63 per cent of the households having land also had irrigation. This is significantly high as compared to the estimates for other two study regions. Similarly the irrigation in these micro watersheds is likely to be more dependable because major source of irrigation is surface water.

The average size of land holding is 4.33 acres per landed household; ranging from 3.09 in Amalwagad-2 to 5.63 in Amalwagad-5 (Table 6.4b). The average area receiving irrigation is 0.71 acre per household having irrigation. It ranges from 0.24 in Kitroli to 0.93 acres in Amalwagad-5.

Ownership of Livestock and Other Assets

Livestock population, as noted earlier, is relatively higher as compared to that in Amreli and Rajanandgaon. Especially, bullock population is significantly high; the average number of bullocks per landed household is 2.9. This compares fairly well with other two regions under the study. Similarly there are 157 cows and 142 calves among 100 households in the sample. This works out to be a total of 299; almost 3 per sample household. Total population of buffalo including calves is 95. Among total population of cows and buffalos, 72 and 57 were milching at the time of the survey.

What is somewhat concerning is the large population of sheep and goats, though all households may not own these livestock. The total population of sheep and goat is 845. Apart from these, poultry farming is also carried out on a small scale.

Other Assets

Most of the households have pucca or wooden houses. Only 14 households live in Kachha houses (Table 6.6). It may however, be noted that 26 out of the 100 households had reported more than one houses; 23 out of these are traditional wooden houses. The number of households having toilet facility is only 18 whereas those having TV set are 29. Access to electricity is found among 66 households. What is however, note worthy is that only 50 households have fuel saving cooking devices such as pressure cooker and gas connection.

Income from Different Sources

We tried to estimate income from different sources. Table 6.7a presents average income among sample households, which is close to Rs. 53,000 per annum. These estimates however, vary significantly across micro watersheds; it varies from Rs. 70,000 in Samaltagadh to Rs. 34000 in Kiroli. The relatively higher income per households is largely due to the joint holdings reflected in terms of larger size of households and land holdings among the sample households. It may also be noted that the estimates for income from agriculture are based on the information obtained about cost of inputs and gross value of the entire production of each crop (i.e. combining both- self consumption and sale in the market). For livestock the estimates are based on the imputed values of milk assuming zero cost of production. Both these are likely to give somewhat higher estimations. This was however, necessary because of the higher incidence of self consumption unlike that in Amreli where commercial crops dominate.

Among landless, the average income per household is only about Rs. 13,000 per household per annum. These of course, are lower estimates as they do not include value of products collected from forest and other community resources. It may however be noted that collection of forest produce other than fodder (through grazing) and fuel wood is not a very important activity as the case in Rajanandgaon. We tried to enquire about the households who collect fodder and fuel wood from the forest (Table 8). It is observed that slightly more than 50 per cent of the sample households obtain grass and tree fodder from the forest. Of these, less than half of the households obtaining grass fodder and fuel wood get less than 50 per cent of their requirement from the forest. More than 90 per cent of the households obtain major part of the fuel wood requirement from forest. However, unlike Rajanandgaon, only 30 per cent of the sample households obtain fruits or other minor forest produce from forest, which yield them cash income.

Crops, Yield, and Input Use

Table 6.9 provides information about cropping pattern reported by landed households in the sample. It may be noted that the region, unlike the other two, has substantially larger proportion of area under rabi and also summer cultivation. The cropping intensity thus, works out to be 2.23, which is very high. The phenomenon is particularly true of all the micro watersheds except in the control micro watershed.

The main crops grown during kharif season are: maize, pea, paddy, and mandua. Together these crops account for 86 per cent of cropped area during the season. During rabi season the main crop grown is wheat, constituting 46 per cent of the cropped area during the season. This is followed by potato, sarsaon and barley. Vegetables are the major crops during summer, which account for 21 per cent of the gross cropped are by the sample farmers.

Given the favourable agro-climatic conditions, yield levels are found to be relatively higher than the other two regions. For instance, the average yield of maize is about 1100 kgs. per acre. Similarly, the yield of paddy is about 920 kgs. per acre. These two estimates however, do not refer to the grain yield as that in the case of Chhatisgadh. The net yield of grain is generally 30 per cent less than the reported yield. It may however, be noted that the yield estimates are based on those crop-cases where the respondents had reported the quantum of production; there were several cases where estimates of crop production was not reported. We have dropped those cases from the yield estimates given in Table 6.10.

The other crops such as chilly, ginger, onion also have relatively higher yield levels than the state/ all India average. What is however, surprising is the yield of potato, which is significantly low i.e. about 5,000 kg. per acre. It may be noted here that the region has fairly large area under cultivation during post-kharif seasons. This would imply relatively low incidence of crop-failure in the region.

Generally, it would be expected that relatively higher yield in the region is due to higher use of inputs in the region. This however, does not seem to be true. Chemical use is negligible in the case of most of the crops grown by the sample farmers (Table 11a, b, c, d). In fact use of FYM is fairly wide spread among the farmers but, most of them have not been able to report the quantity of its application. It may noted that 65 out of the 86 landed households could not report quantum of FYM used for different crops. A similar phenomenon is observed in the case of urea where 11 households could not furnish the information about the quantity used.

6.3 Institutional Indicators

As noted earlier, watershed projects are being implemented in three out of the four micro watersheds for more since a year. In all these, the PIA has already undertaken entry-point activities. As a result, most of the sample households (i.e. 52 out of 75 households in three micro watersheds) have reported their awareness of the watershed committee in their area. Of these, less than 50 per cent are members of the committee.

We tried to gauge people's expectations from the watershed project. It was observed that a large proportion of the respondents expected irrigation facilities to be created under the project. Other major expectation was wage employment from the various activities carried out under the project. There were however, a substantial number of the sample households who did not express any expectation from the project (See Table 6.12).

Conversely, there were a large number of households, who indicated lack of participatory approaches in the functioning of the watershed committee. This is very important in terms of institution building in future.

None of the sample households is reported to be a member of any self-help group. To a large extent, this is due to the fact that the SHGs are more or less disfunctinal.

Contrary to this, 51 out of 100 households had taken loan from other sources; 26 from bank and 13 from money lenders/traders. Most of them have borrowed for agriculture (37); and other for self consumption (5) and repairing of the house (4). The watershed project may try to address these needs.

6.4 Environmental Indicators

Collection of Forest Produce

Given the fact that the region does not have wells, we have not looked into the status of ground water. Recognising erosion as the central issue in this region we thought of measuring the pace of flow in the streams. This however, was not feasible as it requires frequent observations and, at the time when it is raining. This is possible only when there is support from the local agencies and additional funds for engaging a person for recording the observations from various streams. Alternatively, we have planned for installing silt traps on a small sample of plots. These are to be selected on the basis of erosion class. The readings however, could be obtained only at the end of a annual cycle.

We have also collected information about season wise sources of drinking water in the micro watersheds (Table 6.13). It is observed that, whereas in winter stand post and pipe connections serve as important sources of water besides overhead tanks and streams, the situations changes during summer. During summer time, streams become the major source of drinking water for 50 per cent of the sample households. This is very significant. We have planned to collect information about the discharge rate of different natural springs within the micro watersheds in order to get the idea about infiltration and inflow of water. This would involve recording of readings in different seasons.

Vegetation Mapping

A detailed exercise was conducted during March, 2004 for vegetation mapping on the lines of that in Chhtisgadh.The results are presented in Appendix VI to IX. The main observations are as follows:

The study in Samaltagad-B micro watershed consisted of 15 quadrates on herb layer. For Amlawagad-2 micro watershed the exercise was conducted by selecting 5 quadrates of trees, 5 of shrubs, and 5 for herbs. In all 30 quadrates were selected for the study in two micro watersheds. For studying Trees, Shrubs, Herbs layers the quadrates each of 10m x10m, 3m x 3m, 1m x 1m size were laid down respectively using nested quadrate method (Khan; 1961) for the estimation of vegetation composition of these site.

All the three strata viz; Herb, Shrub & Tree are found in Samaltagad-B micro watershed. The tree layer was dominated by Cedrus deodara. In shrub layer Berberis lycium is dominant species. The presence of Berberis spp. as thorny spp. in the area shows that the area is biotically disturbed, due to over grazing and looping. While herb layer is dominated with highest IVI, by Euphatorium adenophorum (36.7). Data presented in Appendix V suggest that Euphatorium adenophorum with 36.7 IVI was the most dominant or important plant spp, whereas Oplismenus burmanii (IVI, 32.1) Reinwartia indica (IVI, 20.0) &Oxalis corniculata (IVI, 19.9) were the co dominants. The dominant of Euphatorium spp. in hill ridge & lower slope shows the non- platable nature of plant & growing vigorously being as an exotic species.

Similarly, in Amlawagad-2 micro watershed all three strata viz: Herb, Shrub, Tree are present. The tree layer was dominated, with highest IVI by *Quercus leucotrichophora* (92.3), *Rhododendron arborium* (50.1), *Cedrus deodara* (47.7) and *Pinus roughbrughii* (30.1). In shrub layer, *Dabregessia velutina*, *Prinsepia utilis, Rhamanus virgatus* & Zanthoxyllum were the most important or dominant taxa. Herb layer was dominated by *Thalictrum foliolosum, Reinwartia indica, Galium elegans, Barleria cristata* with 30.0, 28.0, 24.0, 22.7 IVI values respectively (See Appendix V thru VII).

The study indicates that under the influence biotic and edaphic factors, the vegetation character tend to change considerably, under prevailing climatic conditions, the Site- (Samalgagad-B) can show good regeneration of *Cedrus deodara* seedlings provided the area is further protected from grazing.

On the other hand, unpalatable plant species would result under the influence of biotic factor in the study sites.

Results of the Soil Tests

Table 6.14 provides results of the testing of soil sample collected from 80 plots owned by the landed households in the sample. It is observed that all the soil samples have ph values within the normal range though, the values are fairly close to the lower end of the range i.e. 6.0 – 8.5.

In terms of soil nutrients 58 samples are found have medium or higher level of nitrogen content. The number in the case of phosphorous content is 47. All the samples except one, have medium or higher level of potash content in the soil. Overall the results suggest better status of nutrient content as compared to Amreli and Chhatisgadh. This obviously, is an important factor for relatively better crop yields in the region.

6.5 Summing Up

The above analysis of the data collected from the field survey bring out following important features of the study villages. First, despite higher land productivity, water still remains to be an important source for augmenting households income. Second, large number of households, irrespective of the land base, are still engaged in collection of forest produce. Third, livestock is an important component of households's asset base, which need proper support. Agriculture is by and large practiced without much use of chemical inputs. This needs to be sustained. Finally, watershed committees need to take a more pro-active role in terms of management of forest collection and credit support such that people's income rae enhanced without any adverse impact on environment. Some of these issues have been discussed in the next chapter.

Table 6.1: Main Features of the Selected Micro-Watersheds in Dehradun

Particulars	Microwatersheds											
	Amlawagad-2				Amlawagad-5	Samaltagad-B			Control (Kitroli))			
1.Maximum Elevation (m)	2199.7				1898	1700			2361			
2.Minimum Elevation (m)	1332				1120	1060			1172			
3.General slope (in %)	20.0				28.8	23.0			27.9			
4.Villages under each microwatershed	Hoda	Magroli	Kwarna	All	Kotha-Tarli	Udpalta	Kuroli	All	Haja	Kitroli	Matad	Dadwa	All
5.Total HHS	10	42	32	84	47	53	19	72	63	27	19	12	121
6.Landed HHS	10	36	29	75	43	46	18	64	59	24	19	12	114
7.Landless HHS	0	6	3	9	4	7	1	8	4	3	0	0	7
8.Population	130	407	311	848	500	493	251	744	625	226	152	152	1155
9.Total Land (acre)	364.8	518.4	343.1	1226.2	1037.1	1077.5	124.8	1202.3	-	-	-	-	-
Arable land	47.8	102.6	84.7	235.2	253.7	357.6	61.1	418.7	-	-	-	-	-
Irrigated	3.68	6.75	6.4	16.8	9.2	37.8	0	37.8	-	-	-	-	-
Community waste land	44.2	95.9	78.3	218.4	244.6	319.8	61.1	380.9	-	-	-	-	-
Area under WDP treatment	224.2	303.4	148.7	676.2	551.2	516.0	61.2	577.2	N.A.	N.A.	N.A.	N.A.	N.A.
Area not under WDP treatment	272.0	407.6	233.4	913.0	805.0	873.5	121.8	995.3	N.A.	N.A.	N.A.	N.A.	N.A.
10.Livestock													
Cow	21	67	57	145	53	44	27	71	114	52	25	47	238
Buffalo	13	24	23	60	35	43	24	67	62	7	6	14	89
Bullock	29	64	57	150	126	105	52	157	171	76	38	42	327
Other	119	256	118	493	244	126	165	291	320	168	139	236	863
Sheep/Goat	138	197	91	426	219	108	73	181	698	312	70	172	1252
11.Source of irrigation	Gool*				Gool	Gool			Gool			
12.Main crops													
Kharif	Paddy, mandua & maize				Maize, mandua & Paddy	Paddy, mandua & maize			Mandua, pea & maize			
Rabi	Wheat & potato				Wheat &	Wheat & potato			Wheat, barley & potato			
Summer	Ginger & Arbi				Ginger & Arbi	Ginger & Arbi			Ginger & Arbi			
13.Drinking water	Public/Pvt. Tap & Natural Spring				Public/Pvt. tap & Natural Spring	Public/Pvt. tap & Natural Spring			Public/P vt. tap & Natural Spring			
14.Schools													
Primary	YES	YES	YES		YES	YES	YES		YES	NO	NO	NO	
Secondary	NO	NO	NO		NO	NO	NO		YES	NO	NO	NO	
15.Hospital													
PHC	NO				NO	YES			NO			
CHC	NO				NO	NO			NO			
Pvt. Clinics	NO				NO	YES			NO			
16.Migration Permanent (No. of HHS)	22				11	14			20			
17.Link road													
Pucca	NO	NO	NO		NO	YES	YES		YES	NO	NO	NO	
Kutcha	NO	NO	NO		YES	NO	NO		NO	NO	NO	NO	
18.Co-op society	NO				YES	YES			NO			
19.PIA	State Soil Conservation Unit, Dakpathar, Dehradun. (Govt)								NA			
20.WDP batch	IWDP 2001-2002				IWDP 2001-2002	IWDP 2001-2002			N.A.			
21.WDP committee	YES				YES	YES			N.A.			
22.SHG	YES				YES	YES			N.A.			
23.Entry point activities	Protection wall for school, chari** for cattle.				Chari for cattle, protection wall for village road.	Protection wall for school & chari for cattle.			N.A.			
24.WDP structures	Gully plugs, plantation of horticultural trees and contour trenches				Plantation of horticultural trees.	Gully plugs & plantation of horticultural trees.			N.A.			

* Small canals ** small water structures to store drinking water for cattle.

Table 6.2: Characteristics of Sample Households Population and Literacy

HHS Variable	Village (MWC)				
	Samaltagad B	Amlawagad 5	Amlawagad 2	Kitroli	All
Total Population Average Size	347 (13.9)	296 (11.8)	259 (10.4)	242 (9.7)	1144 (11.4)
Male	174	157	141	131	603
Female	173	139	118	111	541
Sex Ratio	99.4	88.5	83.7	84.7	89.7
Children 6-14 Years Per HHs	86 (3.44)	66 (2.64)	52 (2.1)	48 (1.92)	252 (2.52)
Literacy among Children Total %	86 (100.0)	60 (90.9)	49 (94.2)	37 (77.1)	232 (92.1)
Male %	43 (50)	30 (50)	31 (63.3)	18 (48.6)	122 (52.6)
Female %	43 (50)	30 (50)	18 (36.7)	19 (51.4)	110 (47.4)
Literacy All Population	239 (68.9)	137 (46.3)	132 (51.0)	86 (35.5)	594 (51.9)
Male	144 (82.8)	86 (54.8)	89 (63.1)	60 (45.8)	379 (62.9)
Female	95 (54.9)	51 (36.7)	43 (36.4)	26 (23.4)	215 (39.7)

Table 6.3(a): Households Having Outmigration by Duration: Reference Year

M.W.C.	Total Mig-ration	Months												
		1	2	3	4	5	6	7	8	9	10	11	12	All
Samaltugad B	10	1	3	2	-	1	-	1	-	-	1	-	1	10
Amlawagad 5	17	5	3	1	1	1	1	2	-	-	1	1	1	17
Amlawagad 2	23	2	1	4	4	-	1	-	2	-	3	1	5	23
Kitroli	5	-	-	-	-	2	-	-	-	-	1	-	2	5
All	55	8	7	7	5	4	2	3	2	-	6	2	9	55

Table 6.3(b): Households Having Outmigration by Duration: Long Term

M.W.C.	Total Migrant	Months			
		13-15	16-20	20+	All
Samaltugad B	4	2	1	1	4
Amlawagad 5	5	4	1	-	5
Amlawagad 2	3	-	2	1	3
Kitroli	3	-	2	1	3
All	15	6	6	3	15

Table 6.4(a): Distribution of Sample Households by Ownership of Land and Irrigation

Type of Households	Micro-Watersheds				
	Samaltugad B	Amlawagad 5	Amlawagad 2	Kitroli	All
1. Landless	4	4	4	2	14
2. Landed	21	21	21	23	86
2.1 Landholding Size					
<2.5	1	5	10	11	27
2.51-5.0	9	5	7	8	29
5.01-7.5	9	7	4	1	21
7.5+	2	4	-	3	9
2.2 Access of Irrigation					
With Irri.	17	11	18	8	54
Without Irri.	4	10	3	15	32
3. Total (1+2)	25	25	25	25	100

Table 6.4(b): Size of Landholding and Irrigated Land among Landed Households

Micro Watershed	Acres/HHS	
	Landholding	Irrigation
Samaltugad B	5.17	0.91
Amlawagad 5	5.63	0.93
Amlawagad 2	3.09	0.59
Kitroli	3.49	0.24
All	4.33 (372.2)	0.71 (38.24)

Table 6.5: Ownership of Livestock

Livestock	Samaltugad B	Amlawagad 5	Amlawagad 2	Kitroli	All
Total Livestock	375	380	454	598	1807
Bullock	67	62	58	61	248
Cow Milk	15	10	20	27	72
Cow Dry	10	15	24	36	85
Cow Calf + She Calf	24	26	39	53	142
Buffalo Milk	24	13	14	6	57
Buffalo Dry	8	5	12	2	27
Buffalo Calf + She Calf	-	5	4	2	11
Sheep/Goat	135	146	204	360	845
Cock/Hen	81	93	61	41	276
Others	11	5	18	10	44

Table 6.6: Ownership of Other Assets

Assets	Samaltagad B	Amlawagad 5	Amlawagad 2	Kitroli	All
Type of house (Kachha)	2	2	1	9	14
Pucca/R.C.C./ R.B.C.	7	9	8	3	27
Wooden	16	14	16	13	59
Toilet	10	1	5	2	18
Electricity	24	21	21	-	66
Cycle	-	-	-	-	-
T.V	15	10	4	-	29
Radio	11	4	7	6	28
Stove	4	1	1	-	6
Gas	2	-	1	-	3
Cooker	16	13	11	10	50

Table 6.7(a): Income from Different Sources: Landed Household

Sources of Income	Micro Watershed				
	Samaltagad B	Amalawagad 5	Amalawagad 2	Kitroli	All
Agriculture*	54882.7 (21)	36309.2 (21)	222070 (21)	21343.3 (23)	33435.6 (36)
Out Migration**	2000 (1)	6800 (3)	25750 (4)	8000 (3)	13582 (11)
Animal Husbandry (a) Cow Milk	3723 (13)	5575 (10)	4742 (13)	5700 (14)	4912 (50)
(b) Buffalo Milk	29430 (16)	17334 (11)	18000 (12)	11776 (6)	21071 (45)
Other Labour	2000 (6)	9800 (3)	21125 (9)	10805 (19)	13463 (37)
Agriculture Labour	5333 (3)	16700 (2)	1883 (6)	6200 (5)	5731 (16)
Service	12750 (4)	60000 (1)	27000 (2)	-	23571 (7)
Business	19600 (5)	36000 (3)	15250 (4)	-	22250 (12)
Pension	-	-	24000 (1)	1200 (1)	12600 (2)
All Sources	70035.60 (21)	59618.90 (21)	65283.4 (21)	33976.7 (23)	53697.1 (86)

* Based on the cropwise information on cost of inputs and gorss value of output (self consumption + sold in market)

** Worked out on the basis of estimated value of milk production assuming zero cost.

Table 6.7 (b): Income from Different Sources: Landless Households

MWC		Animal Husbandry Income		Other income	Agri. labour income	Other labour income	Bus. income	All
		Cow Milk	Buffalo Milk					
Samaltagad	Mean N	-	-	3000 (1)	2750 (2)	11000 (2)	9310 (2)	13180 (4)
Amlawagad	Mean n	- -	- -	-	12000 (2)	8500 (2)	4000 (1)	11250 (4)
Amlawagad	Mean n	6000 (1)	-	-	5266.67 (3)	14750 (4)	-	20200 (4)
Kitroli	Mean n	1800 (1)	-	-	2400 (1)	4000 (2)	-	6100 (2)
All		3900 (2)	-	3000 (1)	5962.5 (8)	10600 (10)	7540 (3)	13622.8 (14)

Table 6.8: Households Collecting Different Produce from Forest

Forest Produce by Seasons	No. of HHS				
	Samaltagad B	Amlawagad 5	Amlawagad 2	Kitroli	All
1. Winter					
Grass Fodder	6 (4)	11 (3)	10 (2)	19 (8)	46 (17)
Tree Fodder	9 (2)	11 (1)	15 (2)	19 (5)	54 (10)
Dry Fodder	1 (-)	4 (-)	02 (-)	9 (1)	16 (1)
Fuel Wood	24 (10)	20 (10)	24 (11)	25 (15)	93 (46)
2. Monsoon					
Grass Fodder	14 (4)	11 (-)	12 (4)	19 (8)	56 (16)
Tree Fodder	1 (1)	7 (1)	5 (1)	9 (2)	22 (5)
Dry Fodder	-	-	-	-	-
Fuel Wood	23 (10)	20 (10)	24 (12)	26 (14)	93 (46)
3. Summer					
Grass Fodder	10 (5)	11 (3)	16 (3)	20 (9)	57 (20)
Tree Fodder	7 (1)	11 (1)	13 (1)	19 (5)	50 (8)
Dry Fodder	2 (-)	5 (-)	3 (-)	9 (2)	19 (2)
Fuel Wood	24 (7)	20 (10)	24 (9)	24 (12)	92 (38)

Note: Figures in parentheses indicate number of households obtaining >50 per cent of different produce from forest.

Table 6.9: Cropping Pattern among Micro-Watersheds: Dehradun

(Area in Acre)

Season Khariff Crops		Samaltagad B		Amlawgad 5		Amlawagad 2		Kitroli		All	
		Ave.	%	Ave.	%	Ave.	%	Ave.	%	Ave.	%
Season: Khariff											
Maize	UI	10.1	23.92	21.4	41.20	11.5	34.48	7.4	7.77	51.1	22.94
Pea	UI	-	-	-	-	1.4	4.19	74.9	78.67	76.5	34.35
Paddy	I	13.4	31.74	7.5	14.44	8.8	26.38	1.4	1.47	31.1	13.96
Mandua	UI	8.8	20.84	15.0	28.88	4.3	12.89	5.3	5.57	33.5	15.0
Kulthi	UI	1.0	2.37	1.3	2.50	0.7	2.09	-	-	3.1	1.39
Chilly	UI	4.6	10.89	4.6	8.85	2.0	5.99	1.0	1.05	12.3	5.52
Lobiva	UI	-	-	-	-	0.7	2.09	-	-	1.5	0.67
Red Razma	UI	1.1	2.60	-	-	0.6	1.79	-	-	1.8	0.80
Kawani	UI	0.6	1.42	-	-	-	-	-	-	0.8	0.35
Sonta	UI	-	-	-	-	0.25	0.74	-	-	0.5	0.22
Duwance	UI	-	-	-	-	-	-	0.6	0.63	0.5	0.22
Fresbean	UI	0.8	1.89	-	-	-	-	-	-	1.7	0.76
Jhangora	UI	0.3	0.71	-	-	-	-	-	-	1.1	0.49
Cholie	UI	-	-	-	-	-	-	0.8	0.84	0.8	0.35
Other Crops Area		1.51	3.57	2.13	4.10	3.1	9.29	3.81	4.00	7.2	2.87
All		42.21 (27.91)	100.0	51.93 (37.49)	100.0	33.35 (44.68)	100.0	95.21 (71.18)	100.0	222.70 (44.70)	100.0
Rabi											
Wheat	UI	16.0	27.65	33.3	62.19	13.3	45.75	14.5	52.72	77.2	45.95
Barley	UI	2.6	4.49	4.5	8.40	2.5	8.59	3.4	12.36	13.2	7.86
Potato	I	8.0	13.82	3.3	6.16	7.9	27.17	2.8	10.18	22.1	13.16
Masoor	UI	0.9	1.56	-	-	0.5	1.72	1.0	3.63	3.0	1.78
Sarso/Todia	UI	9.3	16.0	3.1	5.79	1.5	5.16	1.8	6.54	15.7	9.35
PEA	UI	2.9	5.01	3.9	7.28	1.3	4.47	-	-	8.1	4.82
Onion	I	0.9	1.56	0.7	1.30	0.2	0.68	-	-	1.9	1.13
Garlic	I	1.0	1.73	0.6	1.12	-	-	-	-	1.8	1.07
Potato	UI	-	-	-	-	-	-	3.8	13.8	4.1	2.44
Other Crops Area		16.27	28.11	4.14	7.73	1.87	6.43	0.2	0.72	20.89	12.43
Total Crops Area		57.87 (38.27)	100.0	53.54 (38.65)	100.0	29.07 (38.94)	100.0	27.5 (20.55)	100.0	167.99 (33.72)	100.0
Summer											
Ginger	UI	6.1	11.93	26.9	81.39	6.3	51.55	2.5	22.72	41.8	38.90
Arbi	UI	42.6	83.33	3.8	11.49	4.9	40.0	8.5	77.28	60.0	55.83
Turmeric	UI	-	-	-	-	0.2	1.63	-	-	0.5	0.46
Toar	UI	1.6	3.12	2.1	6.35	0.5	4.0	-	-	4.3	4.0
Other Crops Area		0.82	1.58	0.25	0.76	0.32	2.62	-	-	0.85	0.79
All		5.12 (33.80)	100.0	33.05 (23.85)	100.0	12.22 (16.37)	100.0	11.0 (8.22)	100.0	107.45 (21.57)	100.0
G. Total		151.21		138.52		74.65		133.76		498.14	

Table 6.10: Yield of Major Crops among Micro-Watersheds: Dehradun

(kg/acre)

Crops		Samaltagad B	Amlawgad 5	Amlawagad 2	Kitroli	All
Khariff						
Maize	UI	1171.92	1103.0	1006.97	1250.0	1117.57
Pea	UI	-	-	600.0	109.34	122.50
Paddy	I	936.20	1179.26	707.34	727.74	920.40
Mandua	UI	728.81	659.46	680.23	650.94	679.10
Kulthi	UI	312.19	247.61	198.66	-	260.29
Chilly	UI	973.04	1317.39	612.19	332.38	986.99
Lobiva	UI	-	-	100.0	-	196.66
Red Razma	UI	430.43	-	401.53	-	420.00
Kawani	UI	516.36	-	-	-	414.11
Sonta	UI	-	-	128.0	-	160.00
Duwance	UI	-	-	-	120.0	120.00
Fresbean	UI	377.5	-	-	-	280.58
Jhangora	UI	388.57	-	-	-	431.30
Cholie	UI	-	-	-	368.75	368.75
Rabi						
Wheat	UI	445.55	346.17	435.33	662.06	441.00
Barley	UI	470.56	469.23	617.64	482.60	501.66
Potato	I	2571.25	2387.87	2832.70	1501.75	2500.00
Masoor	UI	298.88	-	198.09	148.57	221.17
Sarso/Todia	UI	53.11	162.70	1937.04	138.33	267.21
PEA	UI	922.41	693.67	636.00	-	766.66
Onion	I	1118.91	3385.71	825.45	-	1911.57
Garlic	I	785.36	406.83	-	-	591.16
Potato	UI	-	-	-	1563.15	1570..73
Summer						
Ginger	UI	2244.59	1051.00	1611.15	2416.00	1391.08
Arbi	UI	142.55	815.84	4193.93	2079.88	796.00
Turmeric	UI	-	-	575.00	-	350.90
Toar	UI	292.30	144.18	402.00	-	230.64

Table 6.11 (a) Input Use and Production of Major Crops: Samlagad B

	Maize (UI) K	Wheat (UI) K	Potato (I) K	Masur (UI) R	Sarsav (UI) K	Pea (UI) R	Paddy (I) K	Mandra (UI)	Udad (UI) K	Ginger (UI) S	Gagil (UI) S	Tur (UI) S	Garlic (I) R	Fra- (UI)	Cauli-flower (UI)
Area (Acre)	1.56 (11)	2.76 (18)	3.48 (5)	0.1 (1)	0.3 (2)	0.05 (1)	3.92 (9)	1.31 (5)	0.1 (1)	0.78 (3)	0.19 (1)	0.19 (1)	0.04 (1)	0.1 (1)	0.12 (1)
FYM (nd)	1600 (6)	7550 (17)	4400 (5)	-	450 (2)	300 (1)	2150 (5)	850 (3)	-	2700 (3)	600 (1)	500 (1)	200 (1)	300 (1)	250 (1)
DAP (Kg.)	-	-	26 (4)	-	-	-	-	-	-	-	-	-	-	-	10 (1)
Urea (Kg.)	-	-	36 (3)	-	-	-	5 (2)	-	-	-	-	-	-	-	-
A.S (Kg.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potash Kg.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SSP (Kg.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Irri. (No.)	-	-	32 (5)	-	-	-	86 (9)	-	-	-	-	-	6 (1)	-	-
Main prod. (nd)	865 (11)	638 (17)	2780 (5)	10 (1)	10 (1)	40 (1)	1450 (9)	197 (5)	15 (1)	1200 (3)	-	20 (1)	85 (1)	20 (1)	-
Resi. Prod.(Kg.)	560 (9)	1275 (17)	-	-	4 (1)	-	466 (8)	68 (5)	-	-	-	7 (1)	-	8 (1)	-
Prod. Sold (Kg.)	-	-	2560 (5)	-	-	40 (1)	-	-	-	600 (3)	-	-	85 (1)	-	-
Price Rs/kg	-	-	4.85	-	-	17.0	-	-	-	20.0	-	-	11.20	-	-

Table 6.11 (b) Input Use and Production of Major Crops: Amlawagad 5

	Maize (UI) K	Wheat (UI) K	Potato (I) K	Sarsav (UI) K	Paddy (UI) R	Mandra (UI) K	Mandra (UI) R	Udad (UI) K	Pea (I)	Ginger (UI) S	Gagli (UI) S	Tur (UI) S	Tomato (I) R
Area (Acre)	2.49 (10)	(14)	4.20 (5)	0.16 (2)	0.78 (6)	1.15 (4)	0.60 (1)	0.42 (3)	0.31 (1)	32.9 (12)	0.84 (3)	0.12 (1)	0.15 (1)
FYM (Kg.)	-	8322 (10)	3897 (5)	-	-	-	-	-	-	9595 (12)	-	500 (1)	60 (1)
DAP (Kg.)	-	-	0.5 (1)	-	-	-	-	-	-	1011 (6)	-	-	3 (1)
Urea (Kg.)	-	-	-	-	2997.5 (4)	-	-	-	-	-	-	-	7 (1)
A.S (Kg.)	-	-	-	-	-	-	-	-	-	-	-	-	-
Potash Kg.	-	-	-	-	-	-	-	-	-	-	-	-	-
SSP (Kg.)	-	-	-	-	-	-	-	-	-	-	-	-	-
Irri. (No.)	-	-	25 (4)	0	54 (6)	-	-	-	-	-	-	-	10 (1)
Main prod. (nd)	3130 (10)	2530 (14)	2500 (5)	30 (1)	1095 (6)	592 (4)	148 (1)	580 (3)	320 (1)	7520 (12)	1160 (3)	-	1500 (1)
Resi. Prod.(Kg.)	5235 (10)	6519 (14)	-	787 (2)	2496 (6)	1443.2 (4)	360.8 (1)	-	-	-	-	-	-
Prod. Sold (Kg.)	-	-	2880 (5)	-	-	-	-	580 (3)	320 (1)	6400 (12)	1160 (3)	-	1500 (1)
Rate (Rs/kg)	-	-	3.90	-	-	-	-	10.30	17.5	18.0	9.0	-	3.0

Table 6.11(c): Input Use and Production of Major Crops: Amlawagad 2

	Maize (UI) K	Wheat (UI) R	Potato (I) R	Masur (UI) R	Sarsao (UI) R	Pea (UI) K	Pea (UI) R	Paddy (I) K	Mondua (UI) K	Kulthi (UI) K	Udad (UI) K	Gingdr (UI) S	Garlic (UI) S	Sarsav (I) S
Area Sun (Hect) n	1.64 (7)	.86 (13)	1.54 (10)	0.80 (1)	0.19 (2)	0.47 (2)	0.41 (2)	1.46 (9)	0.22 (2)	0.80 (1)	0.10 (1)	1.83 (6)	2.36 (9)	0.06 (1)
FYM (Kg)	3550 (6)	5800 (10)	3850 (9)	-	200 (1)	1250 (2)	1250 (2)	700 (2)	-	-	1100 (2)	3150 (6)	4900 (9)	-
DAP (Kg)	-	-	39 (3)	-	-	-	-	-	-	-	-	11 (2)	-	-
Urea (Kg)	-	-	123 (5)	-	-	-	-	30 (3)	-	-	-	-	21 (2)	-
A.S. (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potash (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S.S.P. (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Irri. (No)	-	-	82 (10)	-	-	-	-	90 (9)	-	-	-	-	-	4 (1)
Main Prod. (Kg)	995 (7)	691 (8)	4595 (10)	7 (1)	25 (2)	205 (2)	205 (2)	1150 (9)	55 (2)	9 (1)	270 (2)	2600 (6)	6000 (9)	30 (1)
Resi. Prod. (Kg)	555 (6)	4012 (11)	-	2 (1)	5 (1)	-	-	448 (9)	30 (2)	2 (1)	-	-	-	10 (1)
Prod. Sold. (Kg)	-	-	4515 (10)	-	-	205 (2)	205 (2)	-	-	-	240 (2)	2600 (6)	5760 (8)	-
Rate. (Rs./Kg)	-	-	4.30	-	-	16.5	16.5	-	-	-	11.5	17.41	4.5	-

Table 6.11(d): Input Use and Production of Major Crops: Kitroli

	Maize (UI) K	Maize (UI) R	Wheat (UI) R	Jau (UI) R	Potato (I) R	Pea (UI) K	Pea (UI) R	Wheat (I) R	Paddy (I) K	Udad (UI) K	Udad (UI) R	Ginger (UI) S	Garlic (UI) S	Turi (UI) K	Potato (UI) K	Potato (UI) R	Cholai (UI) K
Area Sun n	3.8 (8)	0.15 (1)	4.06 (10)	0.05 (1)	0.20 (1)	2.31 (14)	0.15 (2)	0.15 (1)	1.00 (1)	10.10 (1)	0.10 (1)	1.25 (7)	0.75 (7)	0.20 (2)	0.20 (2)	0.95 (4)	0.10 (1)
FYM (Kg)	44.96 (5)	-	7793 (8)	-	-	10491 (10)	-	-	-	-	-	500 (1)	4496 (5)	500 (1)	2499 (2)	2498 (2)	-
DAP (Kg)	-	-	-	-	-	1 (1)	-	-	-	-	-	1 (1)	-	-	-	-	-
Urea (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A.S. (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potash (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S.S.P. (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Irri. (No)	-	-	-	-	-	-	-	2 (1)	-	-	-	-	-	-	-	-	-
Main Prod. (Kg)	1386.64 (8)	173.33 (1)	1200 (10)	140 (1)	280 (1)	2165 (14)	155 (1)	280 (1)	90 (1)	40 (1)	40 (1)	2500 (7)	1800 (7)	15 (1)	560 (2)	1120 (4)	80 (1)
Resi. Prod. (Kg)	3287 (8)	411 (1)	1794 (10)	40 (1)	-	4819 (8)	-	80 (1)	40 (1)	-	-	-	-	5 (1)	-	-	20 (1)
Prod. Sold. (Kg)	-	-	-	-	-	1870 (12)	-	-	-	40 (1)	20 (1)	2500 (7)	1800 (7)	-	560 (2)	1120 (4)	-
Rate. (Rs./Kg)	-	-	-	-	-	18.25	-	-	-	18	18	18.0	3.80	-	13.5	6.75	-

Table 6.12: Expectations from Watershed Project

Expectations	Micro Watershed			
	Samaltagad B	Amalawagad 5	Amalawagad 2	All
Check Soil Erosion	9	8	7	24
Irrigation Facility	11	8	14	26
Drinking Water Facility	2	1	6	9
Employment	2	2	2	6
Plantation and Fencing	6	3	2	11
Don't Know about the Project	4	-	2	6
No. Expectations	-	8	-	8

Table 6.13: Sources of Drinking Water

Micro Watershed/Seasons	Sources					
	Stand Post	Overhead Tank	Pipe Connection	Tanks/ Pond	Streams	All
Winter	9	9	5	-	2	25
Monsoon	9	9	5	-	2	25
Summer	5	5	2	-	13	25
Winter	3	8	14	-	-	25
Monsoon	3	8	14	-	-	25
Summer	3	9	8	-	5	25
Winter	11	1	7	1	5	25
Monsoon	10	1	7	1	6	25
Summer	-	3	1	1	20	25
Winter	-	17	-	-	8	25
Monsoon	-	17	-	-	8	25
Summer	-	13	-	-	12	25
Winter	23	35	26	1	15	100
Monsoon	22	35	26	1	16	100
Summer	8	30	11	1	50	100

Table 6.14: Soil Analysis Results – Dehradun

S. No.	State	District	Block	Village	Village Code	Farmer's Name	Plot No.	pH	N	P	K
256	U.A.	2	3	Kotha	7	Mohar Singh	1	7	1.05	35.84	234
257	U.A.	2	3	Kotha	7	Laiyku	1	6.4	1.2	26.88	189
258	U.A.	2	3	Kotha	7	Kachalu	1	7.2	0.48	4.48	247.5
259	U.A.	2	3	Kotha	7	Ratti Singh	2	6.4	0.37	13.44	193.5
260	U.A.	2	3	Kotha	7	Chattar Singh	1	6.7	1.12	94.08	243
261	U.A.	2	3	Kotha	7	Param Singh	1	6.5	0.52	152.32	135
262	U.A.	2	3	Kotha	7	Mehar Singh	2	6.5	0.37	4.48	288
263	U.A.	2	3	Kotha	7	Ratan Das	1	6.6	0.3	4.48	216
264	U.A.	2	3	Kotha	7	Tikam Singh	1	6.3	0.54	8.96	279
265	U.A.	2	3	Kotha	7	Madan Singh	1	6.5	0.46	4.48	238.5
266	U.A.	2	3	Kotha	7	Naik Chand	1	6.6	0.42	62.72	193.5
269	U.A.	2	3	Tarali	8	SabbalSingh	1	6.5	0.69	44.8	256.5
270	U.A.	2	3	Tarali	8	Jalam Singh	2	6.6	0.33	4.48	225
271	U.A.	2	3	Tarali	8	Ratan Singh	2	6.5	1.2	17.92	189
273	U.A.	2	3	Tarali	8	Gulab Singh	2	6.5	0.63	112	229.5
274	U.A.	2	3	Tarali	8	Bhodu Singh	1	6.5	0.75	17.92	292.5
275	U.A.	2	3	Tarali	8	Dhan Singh	2	6.7	0.52	8.96	202.5
276	U.A.	2	3	Tarali	8	Khajan Singh	2	6.5	0.3	4.48	180
277	U.A.	2	3	Tarali	8	Baliram	2	6.4	0.67	13.44	283.5
278	U.A.	2	3	Tarali	8	Maghu	2	6.8	0.22	13.44	189
206	U.A.	2	3	Udpalta	5	Bhagat Singh	1	6.6	1.11	4.48	315
207	U.A.	2	3	Udpalta	5	Singha Ram	1	6.9	0.33	4.48	171
208	U.A.	2	3	Udpalta	5	Sar Singh	1	6.5	0.28	17.92	333
209	U.A.	2	3	Udpalta	5	Sariya Singh	2	6.6	0.64	13.44	180
210	U.A.	2	3	Udpalta	5	Tola Singh	1	6.6	0.93	26.88	193.5
211	U.A.	2	3	Udpalta	5	Kedar Singh	1	6.6	0.33	31.36	252
212	U.A.	2	3	Udpalta	5	Dolat Singh	2	6.7	0.82	17.92	238.5
213	U.A.	2	3	Udpalta	5	Kunwar Singh	1	6.8	0.48	4.48	234
214	U.A.	2	3	Udpalta	5	Dhyan Singh	1	6.7	0.52	8.96	252
215	U.A.	2	3	Udpalta	5	Rajendra Singh	1	6.8	0.69	13.44	315
216	U.A.	2	3	Udpalta	5	Mahendra Singh	1	6.7	0.48	112	139.5
217	U.A.	2	3	Udpalta	5	Parmanand	1	6.6	0.33	4.48	202.5
218	U.A.	2	3	Udpalta	5	Dayal Singh	2	6.9	0.4	8.96	225
219	U.A.	2	3	Udpalta	5	Chamko devi	1	6.8	0.54	8.96	337.5
220	U.A.	2	3	Udpalta	5	Hari Singh	2	6.6	0.97	13.44	228
221	U.A.	2	3	Udpalta	5	Mohan Das	1	6.7	0.85	31.36	225
222	U.A.	2	3	Udpalta	5	Mitthan Singh	1	6.6	0.36	107.52	342
223	U.A.	2	3	Udpalta	5	Sallo Devi	1	6.7	0.36	49.28	328.5
229	U.A.	2	3	Kuroli	6	Ran Singh	2	6.4	0.46	35.84	171
230	U.A.	2	3	Kuroli	6	Vijay Rai	2	6.7	1.14	40.32	256.5

S. No.	State	District	Block	Village	Village Code	Farmer's Name	Plot No.	pH	N	P	K
181	U.A.	2	3	Kwarna	9	Bhav Singh	2	6.3	0.78	76.6	238.5
182	U.A.	2	3	Kwarna	9	Kishan Singh	1	6.3	0.52	26.88	261
183	U.A.	2	3	Kwarna	9	Guman Singh	2	6.3	0.82	4.48	4.4
184	U.A.	2	3	Kwarna	9	Mohar Singh	2	6.3	0.6	17.92	337.5
185	U.A.	2	3	Kwarna	9	Virendra Joshi	1	6.3	0.9	35.84	162
186	U.A.	2	3	Kwarna	9	Kunwar Singh	2	6.2	1.12	98.56	238.5
187	U.A.	2	3	Kwarna	9	Sasiya	1	6.3	0.52	67.2	427.5
189	U.A.	2	3	Kwarna	9	Gulab Singh	1	6.4	0.78	94.08	262.5
192	U.A.	2	3	Magroli	10	Bhagat Singh	1	6.1	0.97	67.2	180
193	U.A.	2	3	Magroli	10	Sant Ram	1	6.2	0.67	80.64	243
194	U.A.	2	3	Magroli	10	Chaitu	1	6.3	0.82	80.64	202.5
195	U.A.	2	3	Magroli	10	Manu	1	6.4	0.9	8.96	270
196	U.A.	2	3	Magroli	10	Kedar Singh	1	6.4	0.82	53.76	207
197	U.A.	2	3	Magroli	10	Dhum Singh	1	6.5	0.6	35.84	270
198	U.A.	2	3	Magroli	10	Ratti Rana	2	6.8	0.67	44.8	279
199	U.A.	2	3	Magroli	10	Amar Singh	1	6.2	1.2	40.32	144
202	U.A.	2	3	Hoda	11	Singa Singh	2	6	1.05	31.36	171
203	U.A.	2	3	Hoda	11	Mor Singh	1	6.4	0.9	8.96	202.5
204	U.A.	2	3	Hoda	11	Kal Singh	1	7.2	0.75	53.76	423
205	U.A.	2	3	Hoda	11	Kunwar Singh	1	6.5	0.97	17.92	382.5
231	U.A.	2	3	Kitroli	12	Dhanu	1	6.2	1.12	98.56	450
232	U.A.	2	3	Kitroli	12	Prabhu	1	6.5	0.45	40.32	270
233	U.A.	2	3	Kitroli	12	Khima	1	7	1.2	53.76	360
234	U.A.	2	3	Kitroli	12	Kishan Singh	1	6.5	1.05	13.44	292.5
235	U.A.	2	3	Kitroli	12	Rajendra Singh	1	6.4	1.27	40.32	405
236	U.A.	2	3	Kitroli	12	Chaitu	1	6.5	1.2	76.16	306
237	U.A.	2	3	Kitroli	12	Kaitu	1	6.6	1.5	67.29	162
238	U.A.	2	3	Kitroli	12	Jaithu	1	6.5	0.75	13.44	274.5
239	U.A.	2	3	Kitroli	12	Surat Singh	2	6.6	0.82	125.44	342
240	U.A.	2	3	Kitroli	12	Bhawan Singh	2	6.3	0.67	17.92	234
241	U.A.	2	3	Kitroli	12	Shurveer Singh	1	6.2	0.82	13.44	342
242	U.A.	2	3	Kitroli	12	Jeevan Singh	1	6.7	0.97	67.2	382.5
243	U.A.	2	3	Kitroli	12	Hari Singh	1	6.7	0.52	53.76	427.5
247	U.A.	2	3	Dadwa	13	Dhan Singh	2	6.7	0.79	67.2	450
248	U.A.	2	3	Dadwa	13	Bhuwan Singh	1	6.9	1.2	31.36	306
249	U.A.	2	3	Dadwa	13	Singa Ram	1	6.5	0.6	8.96	211.5
251	U.A.	2	3	Dadwa	13	Tikam Singh	1	6.5	0.37	17.92	423
253	U.A.	2	3	Matad	14	Bhotia	1	6.4	0.6	80.64	423
254	U.A.	2	3	Dadwa	13	Narayan Singh	1	6.7	0.39	53.76	351
255	U.A.	2	3	Dadwa	13	Mohar Singh	1	6.3	0.48	98.56	324

Acidic < 6.0 Normal 6.1-85 Alkaline >8.5

	Very Low	Low	Medium	High
N	0.0 – 0.20	0.21 – 0.50	0.51 – 0.80	>0.80
P	0 - 10	10.1 – 20	20.1 – 40	>40
K	0 – 50	51 – 100	101 – 250	>251

Chapter 7

Conclusion and Future Direction

The foregoing analysis of the need, approach, and main results of the bench mark survey conducted in the three different agro-ecological systems have brought to the fore a number of methodological issues and data gaps that need special attention. However, before we discuss these issues it would be useful to recapitulate some of the major features of the exercise.

7.1 Methodology and Findings: Some Highlights

Recognising the methodological difficulties in assessing the impact of watershed projects, the present exercise tried to evolve and also operationalise a benchmark survey in three agro-ecological situations in the country. These are dry land (Gujarat), forest (Chhatisgadh), and hills (Uttaranchal). While the basic approach adopted for carrying out the survey in three situations was more or less same, a number of modifications had to be made to suit the location specific requirements.

One of the important features of the approach is that- it has tried to capture not only socio-economic but also, some bio-physical (or environmental) as well as institutional aspects of the micro watershed area and communities within that. Accordingly, three sets of indicators were identified in order to capture the pre-project scenario with respect to socio-economic conditions, natural resource status, and need for institutional support and people's participation therein.

The schematic approach adopted for the survey is- a combination of `before-after' and `with-without' situation. The benchmark survey has been carried out in four micro watersheds – four in each agro-ecological situation. Of these, three are covered by watershed projects, whereas one represents a control situation.

The sample of micro watersheds has been selected from a district in each state, representing the core feature of the agro-ecological situation. These districts are Amreli in dry land region, Rajnandgaon in forest based system, and Dehradun in Hills. The primary consideration for selection of micro watersheds within a district has been order of stream. The other criteria for selection were: year of inception of the watershed project, and area covered. There were however, difficulties in getting appropriate micro watersheds, confirming the above criteria simultaneously. Nevertheless, the sample micro watersheds, by and large, are located on different reaches of a watershed, where the project implementation has started less than two years back; and the area covered is in the range of 400-600 hectares. The reference year for the survey is: January 2002 to December 2003.

The data collected by the survey pertain to three sets of units- micro-watershed or village; sample households; and selected plots cultivated by the sample households. Besides structured questionnaires, information was also solicited through group discussions, and resource mapping/testing. In all data have been collected from 280 households, about 60 wells; and 470 plots under cultivation. Some of the important results of the sample micro-watersheds/households/plots can be summarized as follows:

i. While average size of the households is 6.2 in Amreli and 5.4 in Rajanandgaon, it is fairly large i.e. 11.4 in the case of Dehradun. To a large extent this is due to joint holdings and joint family system in the latter. One would therefore expect that the average income of the household is relatively higher in Dehradun as compared to the other two. This is, partly supported by the survey results, which indicate significantly higher income in Dehradun as compared to those in Rajanandgaon. Both these have substantial part of the income / products being obtained from forest, valuation of which is fairly difficult.

ii. Imputing the values of income from collection of forest produce and unsold products from farm as well as livestock, the average income per landed households work out to be about Rs. 76,000 in Amreli; 23,000 in Rajanandgaon; and 54,000 in Dehradun. For landless households, these estimates are 31,000, 7,600, and Rs. 13,000 respectively. Relatively higher income estimates in Amreli is mainly attributable to larger land holding size, combined with higher level of commercialization of agriculture in the region. Besides these, income from diamond industry is significant among land less households in the district.

iii. Irrigation is fairly limited in all the three regions. It ranges from 9.6 per cent in Amreli, and 10.2 per cent in Dehradun, and to 20 per cent in Rajanadgaon. To a large extent, irrigation in Rajanandgaon is concentrated in one village, which receives water from an irrigation dam. Sources of irrigation however, vary significantly across locations. Whereas tube/bore well is the main source of irrigation in Amreli, irrigation dam and dug wells in Rajanandgaon, and surface irrigation in Dehradun. Surprisingly, farmers in Rajanandgaon do not tend to exploit ground water resources despite the fact that level as well as quality of ground water is fairly good. Unlike this, farmers in Amreli have over exploited ground water, with a result that ground water has become saline, and many wells/tube wells have become defunct.

iv. Yield of the major crops are moderate. For instance, yield of the major crops in Amreli is 581 kgs. per acre in the case of Groundnut and 460 kgs. in the case of cotton. In Chattisgadh, the average yield of Paddy is 664 kgs. per acre which is 920 kgs. in the case of Dehradun. Similarly, yields of Maize and chilly are found to be fairly high in Dehradun.

v. Given the dependence of forest resources and/or physical remoteness, farming in Rajnandgaon is found to be subsistence in nature. Farmers in these villages, (except one) cultivate rain fed crops, during monsoon, mainly for self consumption and abstain from using modern inputs like chemical fertiliser. Unlike this, farmers in Dehradun grow multiple crops through out the year, despite their substantial dependence on forest. Enhancing irrigation facilities thus, becomes major priority for watershed development in Amreli, whereas the major challenge in Dehradun is checking soil-water erosion; in Rajanadgaon the central theme appears to be regeneration of forest and other community resources emerged as the main issue in Rajanandgaon.

vi. Ownership of livestock is fairly limited especially, in Amreli and Rajanadgaon. One of the possible reasons for limited livestock population in Amreli could be frequent occurrence of droughts in the region. Among other, house and land were the major assets owned by the sample households though, there are a few in Amreli and Dehradun who owned TV set and motored vehicle.

vii. Most of the sample households have multiple sources of income. Migration is limited to 30, 24, and 55 households in Amreli, Rajanandgaon, and Dehradun respectively.

viii. Literacy is fairly low except in Amreli where the literacy level is 67.5 per cent. The estimates for Rajanadgaon and Dehradun are 56.8 and 51.9 per cent respectively.

ix. While pasture are severely degraded in Amreli, that in the other two regions make important contribution towards fodder requirement. Pastures and forests are of course major sources of fuel wood among sample households in all the three regions. This is despite the fact that a large proportion of the sample consists of landless households.

x. Most of the villages under study have been covered by the state supported schemes for drinking water. For most of the households the average time spent for collection of drinking water is 1-2 hours per day. During summer it goes upto 3-4 hours per day. However, for Amreli, the major problem appears to be that of adequacy, dependability and quality of drinking water rather than its availability per se.

xi. A majority of households except in Dehradun are not members of the watershed committee or self help groups created under the watershed project. They do not play any active role in the committees as yet. Against these a majority of the sample households have borrowed from other sources like bank and money- lenders. While this suggests an important need for institutional support, the main expectations from the watershed project appears to be irrigation facility and employment in the case of Amreli and Dehradun. In Rajanandgaon, the respondents did mention about employment benefit, they seem to be more or less indifferent to the project. This could be mainly due to the fact that the project is heavily tilted towards forest development and that the forest department being the PIA, people do not envisage much of their role in watershed management.

xii. The vegetation mapping does indicate a fairly rich bio-diversity in both Chhatisgadh and Dehradun.

xiii. Soil test results also show ph values within the normal range. However, soils are found to deficient in phosphorous in the case of Amreli and nitrogen in the case of Rajanandgaon. Better status of soil nutrients in Dehradun may have contributed better crop productivity in the region.

7.2 Data gaps and Future Direction

The above description of the socio-economic-environmental and institutional characteristics of the study region and community however, is constrained by several limitations –methodological, logistic and financial. The basic problem arises from the fact that the survey is a one -time exercise hence, provides only a snap shot of the ground reality. We have tried to capture seasonal variations, to the extent possible. But, this may vary over time depending on the rainfall and other agro-climatic conditions. It is difficult to gauge these kind of variations over time unless, one goes for repeated surveys on the basis of a panel.

Another major difficulty arises with respect to physical measurement and testing of the environmental indicators selected for the study. For instance, ground water table or flow of water in a stream, need to be measured fairly frequently. This would involve engaging and training local personnel- both these involve costs in terms of time and money, beyond the means of the present study. Similarly, analysis soil texture and moisture content was difficult because of the limited facility available in the study region. Since the soil laboratories at the central place have limited capacity, it was not possible to get these tests done for the soil samples collected from the field. Finally, vegetation mapping and rainfall monitoring also need to be carried out more than once. This was not possible because of the limited funds.

Finally, and more importantly, the results from the micro watersheds need to be placed in the larger context of a watershed of which these are integral parts. This would need information about the major structures and other bio-physical features that obtain at the time of the bench mark. Unfortunately, such information is non-existent since most of the micro watershed projects are selected on an ad hoc basis, and often without proper demarcation of the boundaries. All these difficulties limit the accuracy of the bench- mark survey.

Nevertheless, the exercise has made a major leap forward in so far it has tried to quantify the major indicators of watershed- based development prior to the implementation of the major treatments. Another major achievement is that the exercise has helped identifying the major problems while conducting the surveys in three different locations, and also worked out practical solutions in context specific situations. Finally, the study has highlighted some critical data gaps that need to be sorted out at policy level. Given this backdrop, we suggest following modifications/ supplementary data collection for bench- mark survey to be carried out in future.

i. Installing a rain gauge and periodical recording after every rain is essential. This requires cooperation from the village institution, as the rain gauges tend to get washed away under the conditions of heavy rainfall. While the cost of the rain gauge is minimal, it requires institutional support over a longer period of time.

ii. It is essential to collect information about input –use and output for selected crops for all seasons during the project period. This is essential to separate out the impact of variations in rainfall and other agro-climatic factors.

iii. Monitoring of ground water table should to be carried out for selected wells located at different distance from the stream and water harvesting structures within a micro watershed.

iv. Analysis of soil texture should be carried out periodically for at least major types of soil within a micro watershed.

v. Detailed analysis of sub-surface water and water balance should carried out for the respective watershed.

vi. Information about the slope of the selected plots should be obtained through topo sheets/GIS based information.

vii. Detailed mapping of the community pastures along with the use-status should be carried out with the help of the local community. This needs to be done for every season for all the years during the project.

The above approach of course, would involve additional resources. It may be noted that there is no separate allocation for an information system despite the repeated plea for benchmark data and information prior to initiating a watershed project. There is of course, some mention of survey as an activity that can be taken up under the works component and some provision for

PRA exercises. What is however, needed is a separate allocation for data/information gathering, resource literacy and capability building with regard to natural resources. The limited experience in natural resource data management systems by combining participative and scientific methods show that an allocation of 7.5% of the total cost of watershed expenditure (2.5% to come from the PIA funds and 5% to come from the works component) should be adequate to meet the required cost (SOPPECOM, 2004).

Nevertheless in the specific context of the present study, it could be suggested that the exercise may be carried forward with additional financial support from the funds that are already allocated for monitoring and evaluation of watershed project at the state/district levels. This, ideally, should be undertaken on a long-term basis in collaboration with the PIAs or local agencies. The value of this exercise therefore lies in initiating a process of continuous monitoring of at least selected indicators during the project period. This, as argued here, is essential for getting a realistic assessment of the impact of watershed projects under different agro-ecological conditions in the country.

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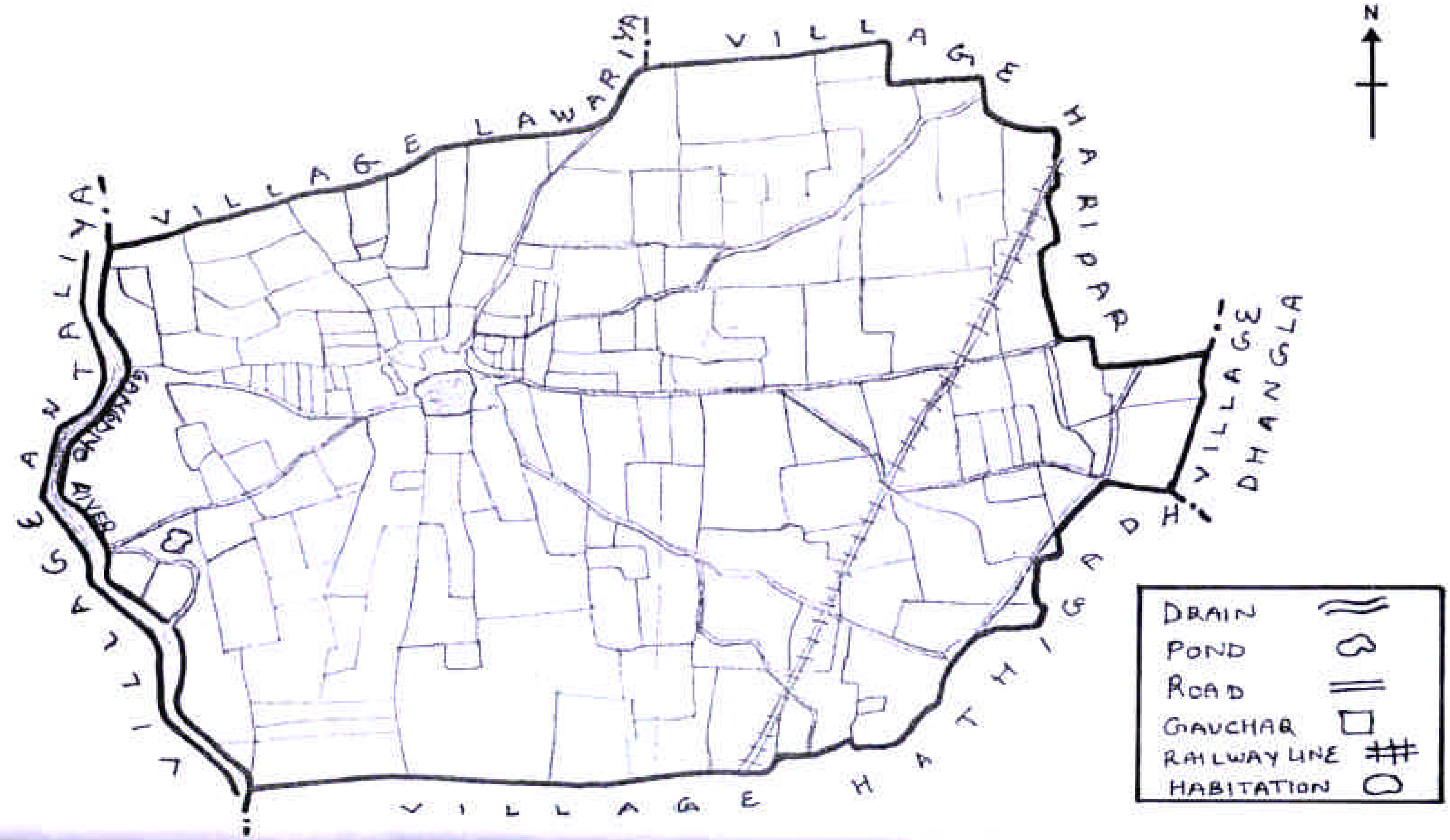
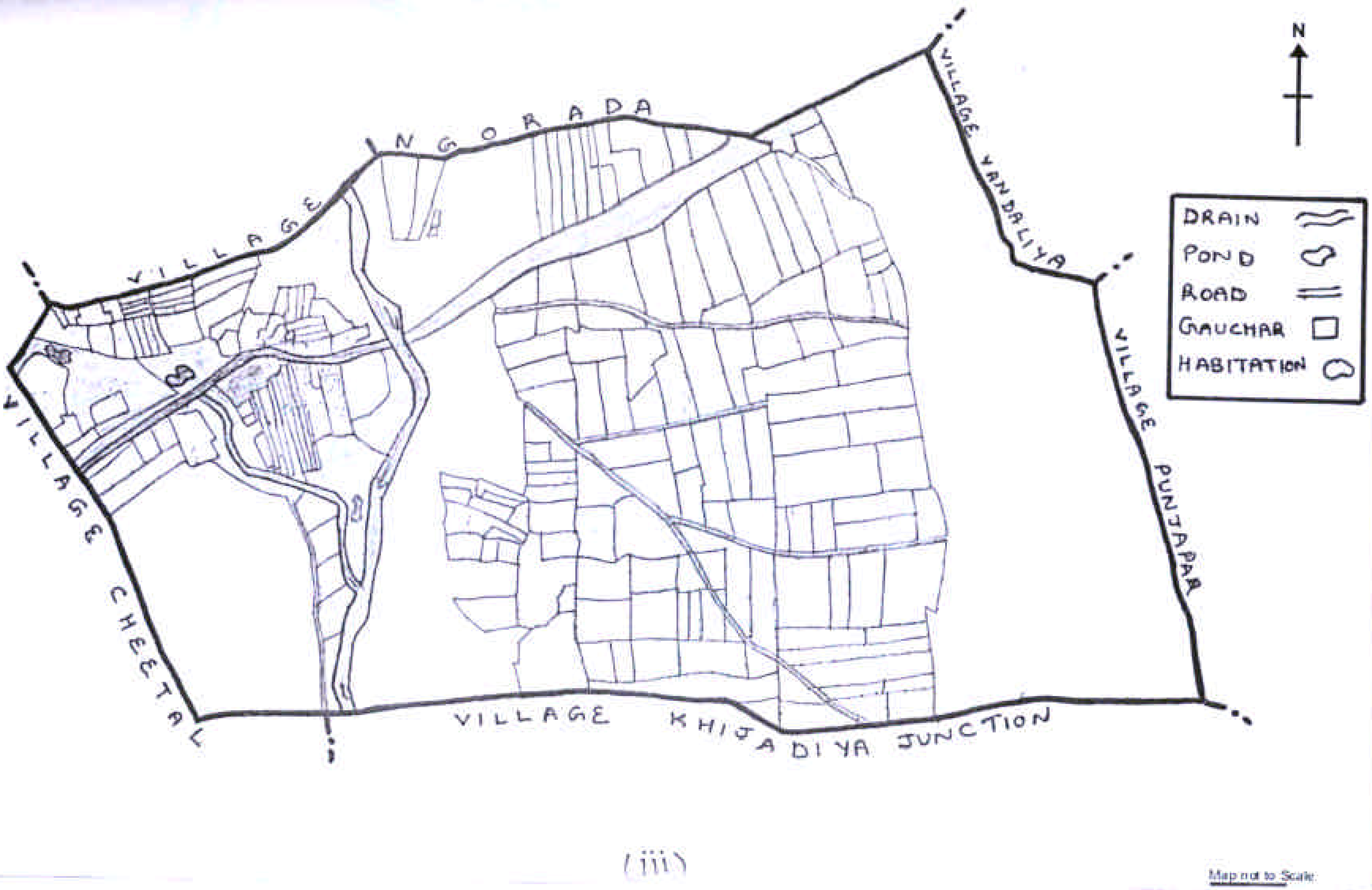
LOCATION OF AMRELI, DEHRADUN & RAJNANDGAON IN THEIR RESPECTIVE STATES

SAJANTIMBA
(CONTROL MICROWATERSHED)




VILLAGE NGORADA
VILLAGE VANDALIYA
VILLAGE PUNJAPAR
VILLAGE KHIJADIYA JUNCTION
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N
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ROAD
GAUCHAR
HABITATION
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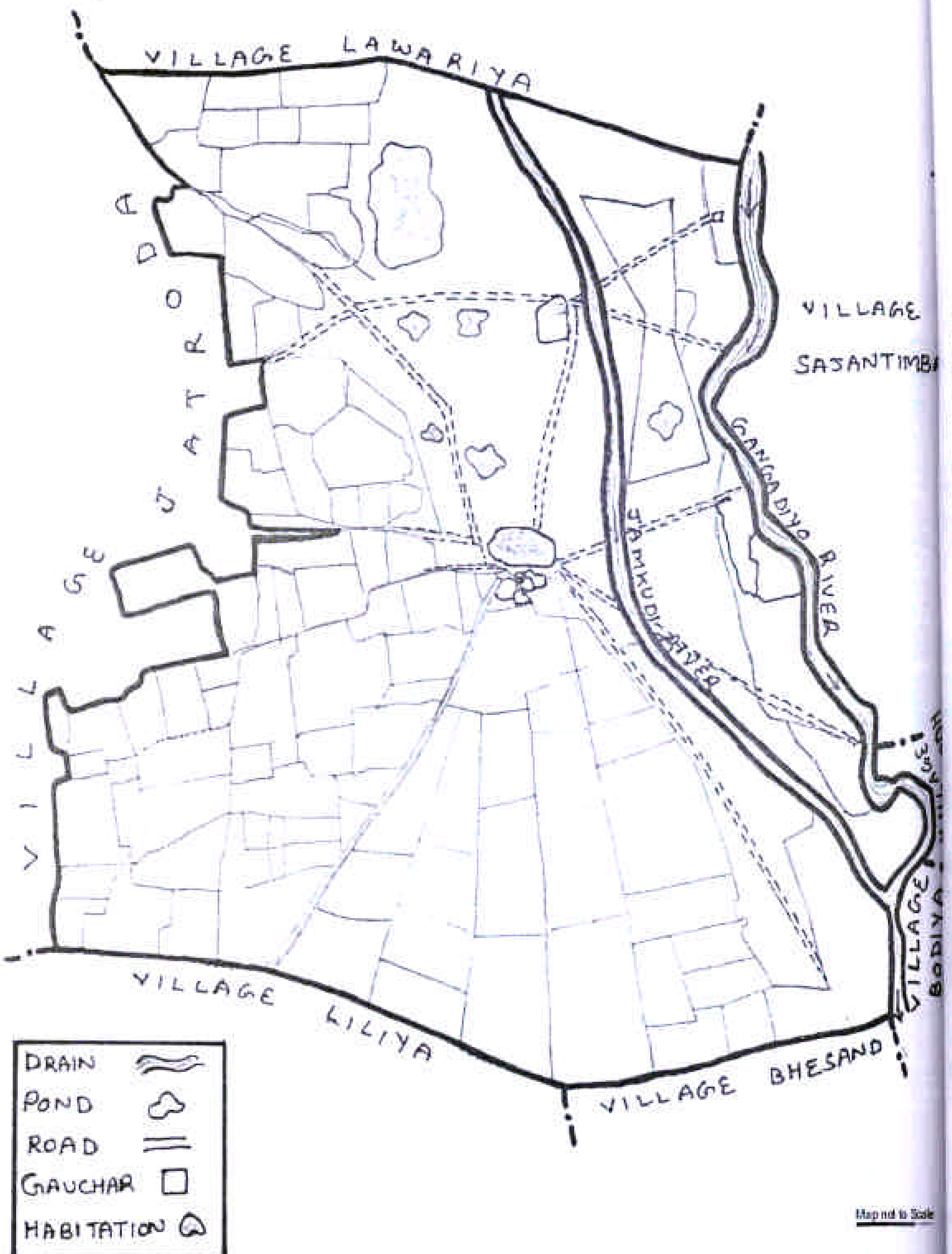
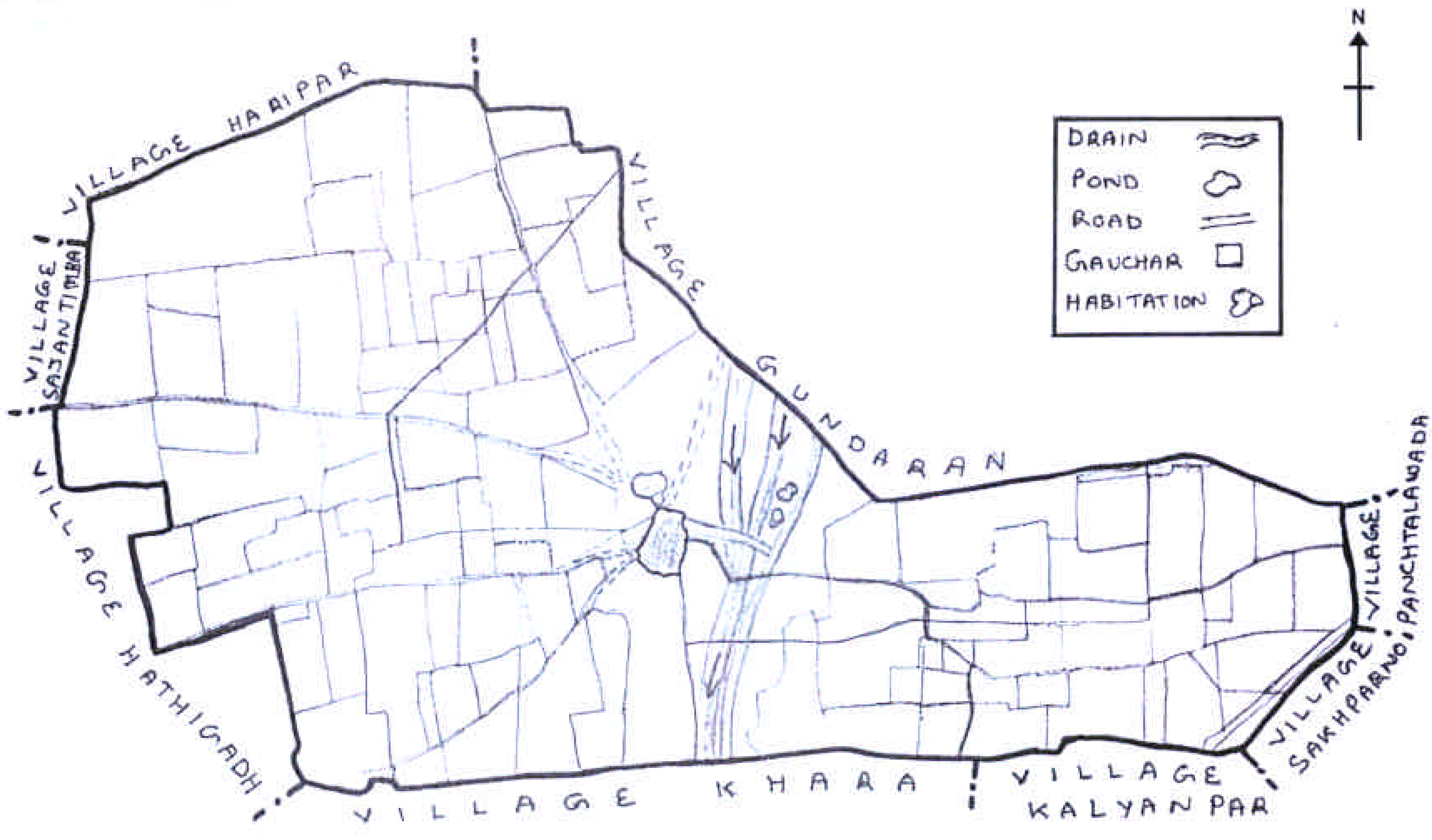
ANTALIYA MICROWATERSHED



DHANGLA MICROWATERSHED



(V)

Map not to Scale

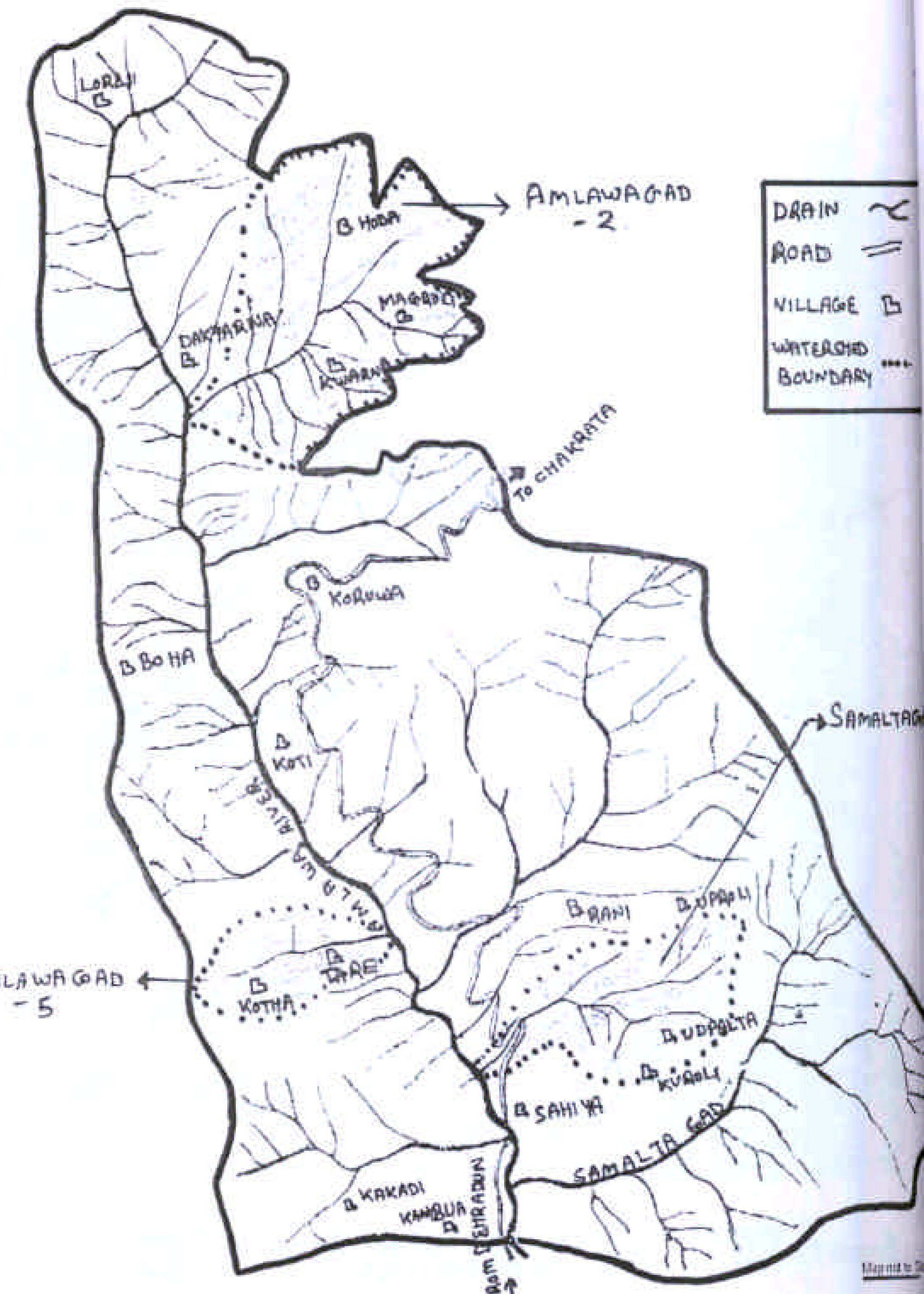
KAUDIKASA & HAREKHAPAYALI MICROWATERSHEDS

FOREST ▢ MICROWATERSHED BOUNDARY (INDICATIVE) ▢

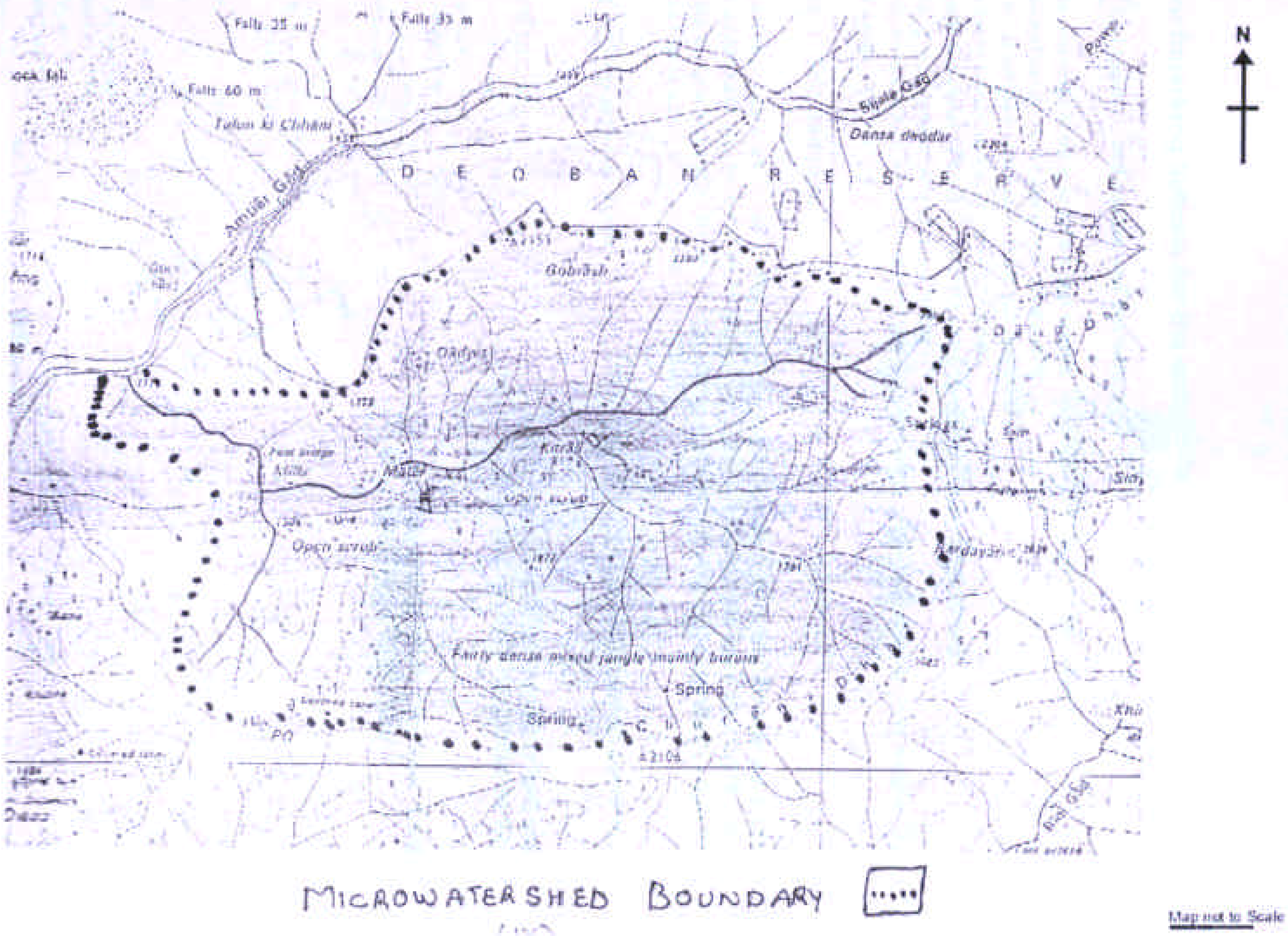
Map not to Scale

KODEWARA & TATODA(CONTROL) MICROWATERSHEDS

AMLAWAGAD-2, AMLAWAGAD-5 & SAMALTAGAD-B MICROWATERSHEDS



KITROLI (CONTROL) MICROWATERSHED



Map not to Scale

APPENDIX -I

Benchmarking options for the selected parameters

(Soil quality – soil texture, soil nutrients, soil pH, soil organic matter, soil biota)

The conventional thing is to take a soil sample and get it analysed from a laboratory on a professional basis. In the simplest scheme of things, the entire job is entrusted to a lab. However, if we take into account the participative and capability building aspects, then it may be more useful and more cost-effective to handle as much of it as possible in a participative manner. The following activities describe some of the characteristic testing methods, giving greater weight to participative methods that can be applied in the field with simpler apparatus with a good deal of accuracy, though some of the results may not be as accurate as a lab test.

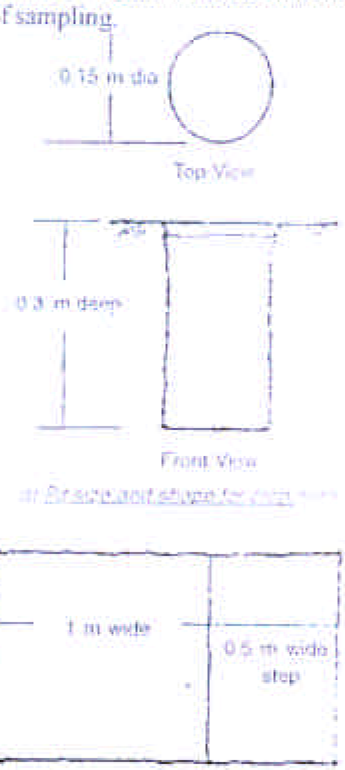
Activity 1: Soil Sampling

Soil sampling is an activity that should be carried out in a participative manner since it is easy to understand and follow. The method described here assumes that we need an aggregate sample and aggregate properties to be determined. Test in which soil horizons need to keep separate would require different kind of sampling.

Sampling in Crop areas and Biomass areas

Crop areas:

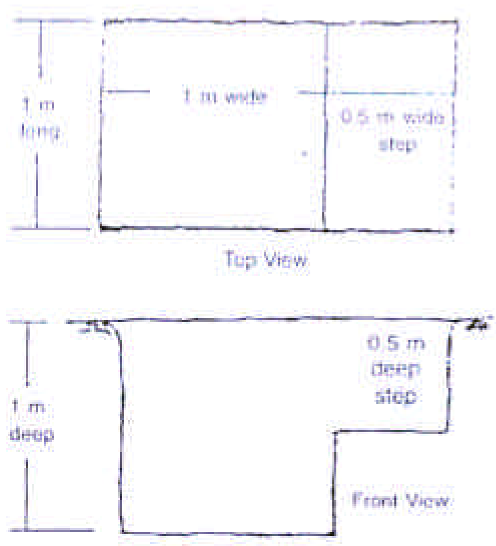
1. Remove the top 5 cm layer.
2. Take a pit of about 30 cm depth and approximately 15 cm in diameter by manual digging or augering (Fig. 4.2).
3. Prepare the sample by coning and quartering as described below.
4. In the crop area the root zone depth is generally limited to 25 to 30 cms and therefore soil samples are routinely collected from up to a depth of 30 cms only. A few selective samples from depths beyond 30 cms may be collected if required.



[illegible]

Biomass *(non-crop) area:*

1. Take a pit of the size of 1 m x 1 m x 1 m.
2. Take the pit by step method as shown (Fig. 4.3). Collect the soil together, mix it thoroughly and prepare the final sample by coning and quartering as described below.
3. In the non-crop biomass area the roots extend often up to a depth of 1 m or beyond. The soil samples are therefore collected from at least this depth.
4. In the non-crop biomass area there are often no defined field boundaries and in such cases the soil samples should be collected by grouping together strips which show similarities when visually examined of the area for soil colour, texture, slope, etc.



2. Coning and Quartering

i. Remove the top 5 cm layer of soil to get rid of vegetation and silt deposit etc.

ii. Dig a hole about 30 cm deep with a crow bar and collect about 5 to 6 kgs of soil.

Fig. 4.3: Pit shapes and sizes for collecting soil samples from crop areas and biomass areas. Agricultural crops have relatively shallow roots and trees have much deeper root systems. So the samples are collected from pits dug to different depths.

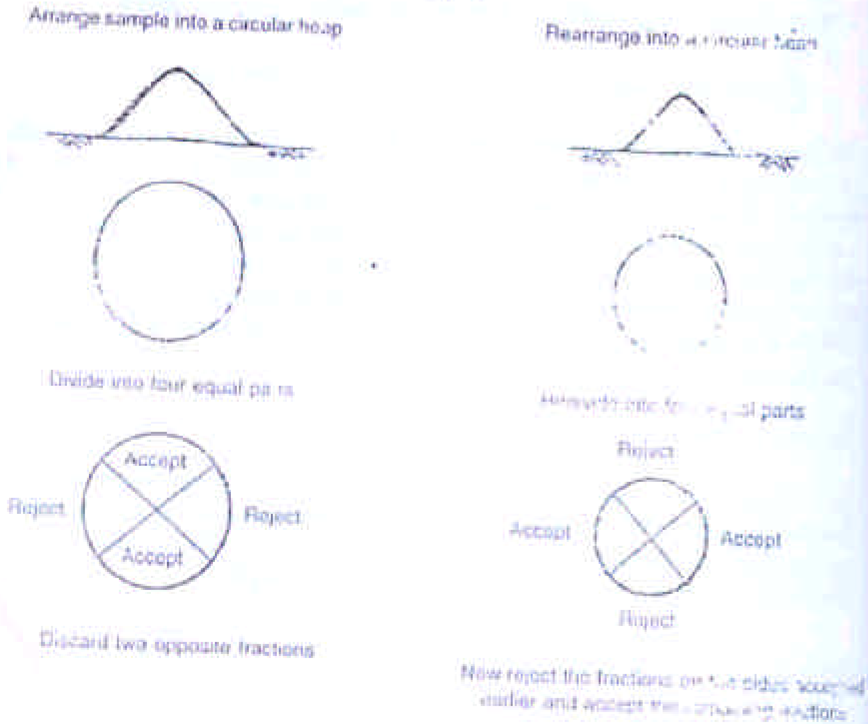


Fig. 4.4: Coning and quartering is a method of mixing the soil sample to ensure that the end sample is thoroughly mixed and properties of soil sample represent average properties for the [illegible].

iii. Mix the soil thoroughly and make the heap of soil as shown in Fig 4.4.

iv. Divide the soil heap into four equal parts by steel or wooden plate or stick (Fig. 4.4).

v. Collect the two equal and opposite parts. Reject the other parts of the soil sample.

vi. Mix thoroughly the soil collected from two equal and opposite sides, make a heap again, and [illegible] again into four equal parts as was done earlier.

vii. This time collect the diagonally [illegible] parts and reject other [illegible].

viii. Mix the collected soil thoroughly.

ix. The sample is now ready for packing and labelling for identification as described below.

3. Packing the Sample

Pack the sample in a good quality, transparent, plastic bag of 1 kg capacity. Seal the plastic bag using a stapler or by sewing.

4. Sample Identification and Number

i. Take a 12 cm x 5 cm sampling paper of good quality.

ii. On the sampling paper, with a good ball point pen note down the following [illegible]: Location, Sample No., Weight of sample, Date, Depth, Survey No. of plot, name of the farmer/owner. A neatly tabulated example would be as shown on the next page.

iii. Attach this paper to sample bag and seal the sample bag carefully. Samples are now ready for testing!

Activity 2: Soil Gradation by West Sieving Method

The following method describes a wet sieving method that only needs the appropriate sieves as specialized equipment. The rest of it, in principle, could be handled by sample kitchen equipment and a balance as well!

i. Collect the soil sample, by coning and quartering method as described earlier.

ii. Collect approximately 1 kg of soil sample.

iii. Allow the sample to dry completely by sun drying or by air drying.

iv. After the sample has cooled, take a known weight of dry soil sample (first weight, W_1 say 500 gm).

v. Soak the soil sample for 24 hours.

vi. After soaking it for 24 hours, wash the wet soil sample through 0.05 mm sieve size (or the nearest size to it that you can get in the market but not more than 0.075 mm). Collect whatever soil remains on the sieve and allow it to dry completely, either by sun drying, air drying or in a sand bath.

vii. After the sample has cooled, take the weight of the dry soil which has not passed the .05 mm sieve (second weight, W_2.

viii. Now sieve this dry soil through the 2 mm sieve size. Now collect separately both soil portions, whatever soil passes through the sieve as well as whatever remains on this sieve.

ix. Take the weight of both portions, the one that has passed the 2 mm sieve (third weight, W_3) and the one that has remained on the sieve (fourth weight, W_4).

Example:

Suppose 500 gm of soil sample is taken.

The following are the weight noted in the various steps described before

W_1 = 500 gm. W_2 = 195 gm. W_3 = 125 gm. W_4 = 70 gm.

Then,

Gravel = W_4 = 70 gm and 70/500x100 = 14%

Sand = W_3 = 125 gm and 125/500x100 = 25%

Silt and Clay = $W_1 - W_2$ = 500-195 = 305 mg and 305/500x100 = 61%

Activity 3: Determining Soil Textural Class Based on Soil Properties

A sample of soil was screened and had the size separates in material smaller than 2 mm determined by particle-size (mechanical) analysis, with the following results:

Sand content (2-0.05 mm) – 140g Silt content (0.05 – 0.002 mm) = 38g,
Clay content (less than 0.002 mm) = 22 g and Total dry soil weight: = 200g

Determine the textural class name

Solution

Textural names consider only the less than 2 mm portion

Sand = 140 gm/200 gm = 70 percent sand

Silt = 38 gm/200 gm = 19 percent silt

Clay = 22 gm200 gm = 11 percent clay

Using the textural triangle given earlier, place the triangle with 100 percent clay at the top and read across parallel with the base along the 11 percent line. Keeping this line in mind, turn the triangle so 100 percent silt is now at the top, and read across parallel to the new base of the triangle along the 19 percent line. The 11 percent clay and 19 percent silt lines intersect in the sandy loam. The percentage sand value could have been used as easily as either clay or silt values, because the lines for all the three size fractions intersect at the same point. The content of organic matter is ignored. If the soil contains more that 15 percent (by volume) of particles larger than sand a “coarse fragment” adjective is added to the textural name (i.e., gravelly sandy loam).

The correct complete name for the textural class of the soil sample is Sandy Loam.

Activity 4: Field Classification and Gradation of Soils Based on Physical Behaviour

Preparation of Soil Sample

i. Soak the soil sample for 24 hours. This is a must for every type of soil.

ii. Sieve the soil sample through a standard sieve of 0.425 mm size.

iii. Collect the portion that passes through the 0.425 mm sieve and test it for (1) Dilatancy, (2) Dry strength and (3) Toughness as described below.

Testing for Dilatancy (Reaction to Shaking)

i. Remove particles larger than 0.425 mm sieve size.

ii. Prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

iii. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times.

A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles.

The raplaity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

- Very fine clean sands give the quickest and most distinct reaction.
- A plastic clay has no reaction.
- Inorganic silts such as a typical rock flour, show a moderately quick reaction.

Testing for Dry Strength (Crushing Characteristics)

i. Remove particles larger than 0.425 mm sieve size.

ii. Mould a pat of soil to the consistency of putty, adding water if necessary.

iii. Allow the pat to dry completely by oven, sun or air drying.

iv. Then test its strength by breaking and crumbling between the fingers.

This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

- High dry strength is characteristics for clay of the CH group.

- A typical inorganic silt possesses only very slight dry strength.

- Silty fine stands and silts have about the same slight dry strength, but cal be distinguished by the feel when powering the dried specimen.

- Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Testing for Toughness

i. Remove particles larger than the 0.425 mm sieve size.

ii. A specimen of soil about one-half inch cube in size is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation.

iii. The specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter.

iv. The thread is then folded and re-rolled repeatedly. During the manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles.

   - Tough and stiff threads show presence of clay.
   - Weak threads show presence of silt and stands
   - Highly organic clays have a very weak and spongy feel.

v. Observe the results of above test and from the Casagrande's chart note down the group of soil e.g. CH, Cl, ML etc.

The relation between the unified soil classification from Casagrande's chart and soil texture classes as given be Israelsen is given below:

No.	Isrealsen's Texture Class	Unified Soil Classification (Casagrande's Chart)
1	Sandy	SP-SW
2	Sandy Loam	SM-SC
3	Loam	Sand, silt and clay in equal proportions and the behaviour would largely depend on the activity of clay and silt fraction
4	Clay Loam	CL
5	Silty Loam	ML or CL
6	Clay	CH

Activity 5: Determining Moisture content of soils

The quantity of soil sample taken for determination of moisture content varies with the soil type.

- For homogeneous clays and silt take a sample of about 30 gms;
- For medium grained soils take a sample of about 300 gm;
- For coarse grained soils take a sample of about 3 kg.

i. Take the sample, weigh it in the field itself (with an accuracy of the order of 1 gm) (W1).

ii. Pack the sample properly.

iii. Heat the sample by sand bath method (Fig. 4.5).

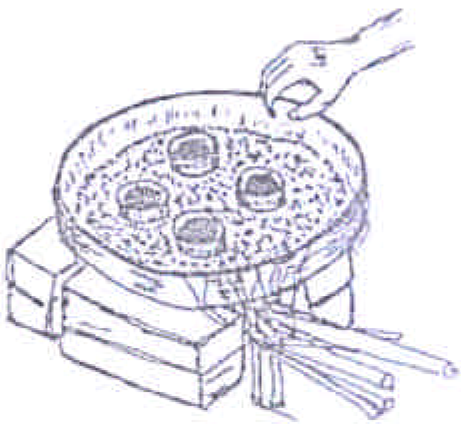


Fig. 4.5: The sand bath is a simple method of drying and can be set up with the most 'primitive' equipment.

iv. Cooling of the soil sample should be done carefully.

Put the sample in a air tight container (or dessicator). Put some silica gel in the container to absorb the moisture present in the container's open space. Allow it to cool slowly.

v. After the sample has cooled take the dry wt of the sample (W_2).

vi. Subtract the dry wt (W_2) from the initial wet weight (W_1).

vii. The difference ($W_1 - W_2$) gives the amount of moisture in the soil sample. The moisture content is then given by:

$$\frac{\text{Initial wt - Dry wt of sample}}{\text{Dry wt of sample}} \times 100$$

Activity 6: Determining Field Capacity and Wilting Point of Soils

Field Capacity

i. Saturate the field location from which the sample is to be taken.

ii. Take the soil sample from the field 2 days after the saturation to allow all gravitational water to drain off.

iii. Take the weight of the wet soil sample in the field itself (W_1).

iv. Dry the sample by sand bath method as described earlier.

v. Take the dry wt of the sample after it has cooled (W_2). Then,

$$\text{Field Capacity} = \frac{\text{Initial weight } (W_1) - \text{Final weight } (W_2)}{\text{Final weight } (W_2)} \times 100$$

Permanent Wilting Point

i. As an approximation, the permanent wilting percentage can be estimated by dividing the field capacity by a factor varying from 2.0 to 2.4 depending up on the amount of silt in the soil. For soils of high silt content 2.4 should be used and for soils with low silt content the factor of 2 is used.

Activity 7: Determining Infiltration Rate of Soils

a) Stand pipe method for determining infiltration rate of soils

Apparatus needed

i. One PVC pipe of 100 mm diameter and 1 m height;
ii. One end cap of 110 mm diameter;
iii. One nozzle with check nut of 1/2 diameter;
iv. One adjustable pinch cock, one meter long flexible rubber pipe of 1/2" diameter;
v. M-seal;
vi. Stop watch;
vit. Measuring cylinder of 1000 cc (1 liter) capacity.

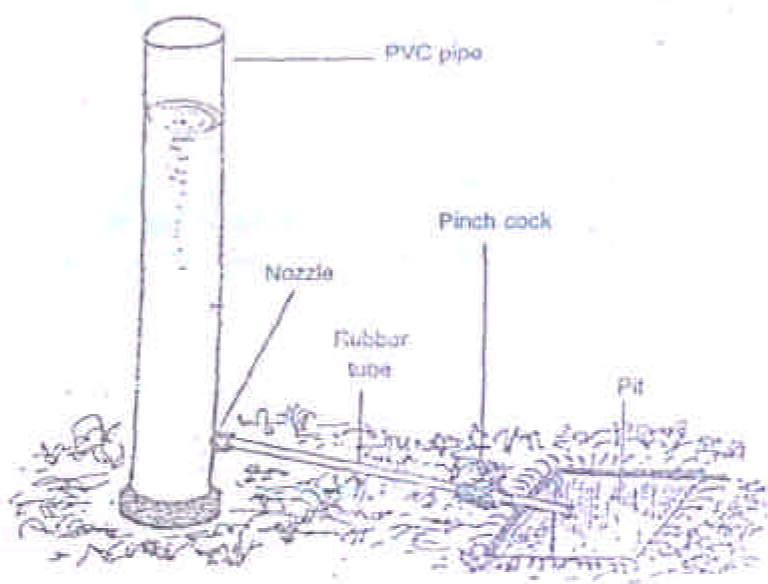


Fig. 4.6: The apparatus to be used in the stand pipe test

The following steps are followed to set up the test rig (Fig. **4.6)**

I. Seal the pipe at one end with end cap.
ii. Make the hole just above end cap of 1/2 inch diameter.
iii. Fix the nozzle with check nut in the hole.
iv. Fix one end of the rubber pipe in nozzle.
v. Apply M-seal at connection of PVC pipe and nozzle and ensure that there is no leakage.
vi. Fix the pinch cock at other end of the rubber pipe.

Conducting the infiltration test

i. Make the pit as shown.

ii. Saturate the pit (or 24 hours by pouring water in it till it is full, and adding water two to three times in the day if required.

iii. The next day put up the test set up.

iv. Fill the stand pipe with water.

v. Before starting the test first pour some water in the pit taking care that water should not overflow from it.

vi. Then with help of pinch cock control the water flow from the PVC pipe into the pit so that the water level in the pit does not change.

vii. While stabilising the water level in the pit, also keep the water level in the stand pipe constant by adding water to it.

viii. Continue this process for 15 to 20 min.

ix. Measure the flow of water in a measuring cylinder for a fixed time, noting the volume of water collected in cc (V) in a given time in seconds (I).

Then the permeability of the soil is given by

$$K = \frac{(V/t)}{5.5 \times r \times h}$$

K = Permeability cm/sec.
V = Volume of water collected in given time t (cc)
t = time taken for collecting the volume of water V (seconds)
r = Radius of the pit (cm)
h = Wetted height of the pit (cm)

b) Twin ring method for determining infiltration rate of soils

Apparatus needed

i. Two rings made from MS sheet {about 3 mm thick) with diameters of 60 cm and 30 cm respectively and a height of 15 cm.

ii. The apparatus and set up described above for the stand pipe method

iii. Scale

iv. Stop watch or ordinary wrist watch

Conducting the test

i. The top 5 cm soil is scraped to remove the loose soil from a 3 m x 3 m test area at site and it is saturated for 24 hours by filling it and adding water 2 to 3 times in a day if needed.

ii. Drive both the rings vertically into the soil (see Fig. 4.7).

iii. The soil that is disturbed along the walls of the inner ring is sealed by local clays and outer ring is sealed by bentonite slurry or sticky clay..

iv. A scale is fixed inside the inner ring and another one in the annular space between the rings to check water level in the rings,

v. Add water to the inner ring and also to the annular space between the rings.

vi. Now add water from the stand pipe and adjust the flow so that it maintains the same water level in the rings while maintaining a constant head in the stand pipe.

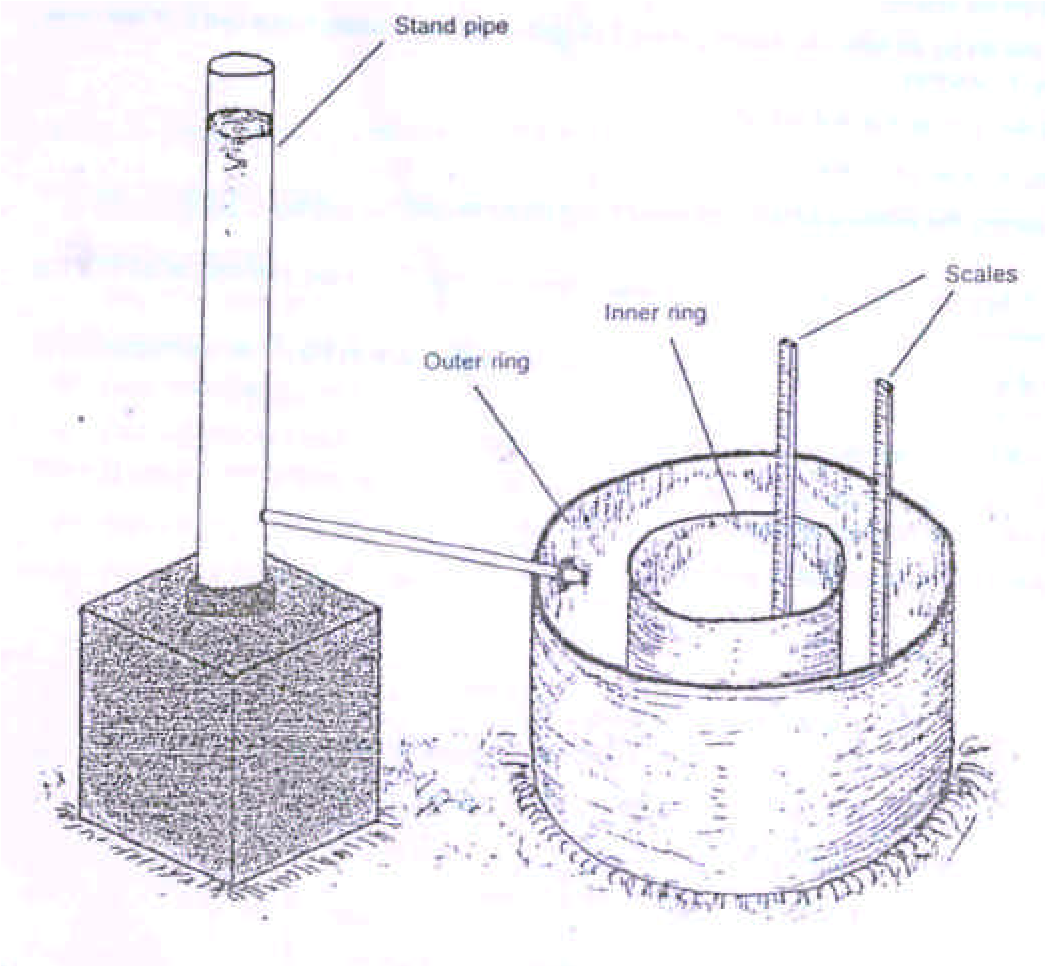


Fig. 4.7: The set up and apparatus for the twin ring infiltration test.

viii .Once the level is maintained constant in the rings, collect the water flowing out of the stand pipe (V, in cc) in a graduated jar of 1000 ml in a given time (t. in seconds). The time interval, t, depends on the rate of flow from the stand pipe. Collect appreciable flow volume of between 250 to 750 cc.

Permeability of soil is now calculated as:

$$K\ (cm/sec) = \frac{V\ (cc) \times 4.57 \times 10\text{-}4\ (cm/cc)}{t\ (seconds)}$$

(From Soil and Water Training Notes by V. N. Gore)

Activity 8: Determining Dry Density or Apparent Specific Gravity and Pore Space

Sand Replacement Method for Finding Bulk Density

i. Keep ready a volume of dry, free flowing sand which should pass through 1000 micron sieve and be retained on 600 micron sieve.

ii. Take a 30 cm deep and 15 cm diameter pit at site from where the sample is to be drawn. Carefully collect all the soil, this is important, without losing a single particle.

iii. Take the weight of the collected soil in the field itself (W in gm).

iv. Pour sand in the pit measure by measure and note the amount of sand required to fill the pit (V in cc).

Then bulk density is given by W*N* gms/cc

Finding Dry Density from Bulk Density and Moisture Content

Once we know the bulk density (method of determination described above) we can determine the dry density if we determine the moisture content (method of determination described earlier).

Dry density is given by

$$\text{Dry Density} = \frac{100 \text{ x Bulk Density}}{100 + \text{Moisture Content (\%)}}$$

Determining Pore Space

i. Pore space is space occupied by air or water in soil, Pore space can be computed if the value of bulk density, that is, apparent specific gravity (S_a) and the true particle density (S_r) are known.

ii. True particle density is taken as 2.65 gm/cc for most soils.

Pore space (n) in % is then given by

$$n = (1 - S_a / S_r) \text{ x } 100$$

Activity 9: Determining CEC and Exchangeable Cations

One of the simple methods of estimating CEC is based on making use of known composition of the soil and known values of CEC for different soil colloids. First, estimate or measure the clay and humus percentage. Then assign an average CEC value to each per cent of clay or humus. Next, add all the CEC contributions.

For example, consider (a) a soil with a montmorillinite clay percentage of 13% and a humus percentage of 1.7% and (b) a soil with 24% of kaolinite clay and 85% humus.

Using the values from the table below work out an average value for each per cent of humus, 200/100 = 2 centimoles per kg of soil; and similarly for montmorillinite 100/100 = 1 centimole, and 8/100 – 0.08 centimole.

Then for soil (a), we have CEC = 36 x 1 + 1.7 x 2 – 39.4 centimoles/kg of soil.
And for (b), CEC = 24 x 0.08 + 85 x 2 – 171.92.

Soil Colloid Fraction	**Cation Exchange Capacity (Normal Range)**
Humus	100 to 300
Vermiculite (similar to hydrous mica)	80 to 150
Smectites (montmorillonite)	60 to 100
Hydrous mica	25 to 40
Kaolinite	3 to 15
Sesquioxides	0 to 3

Appendix II: Importance Value Index (IVI) of the Tree Layer in Kodewara Micro Watershed

S. No.	Tree Species	% Fre-quency	% Density	Basal Area	Relative Fre-quency	Relative Density	Relative Domi-nance	Impor-tance Value Index
1	*Tectona grandis*	60	2.5	43.5	14.3	26	4.5	44.8
2	Terminalia tomentosa	50	1.1	85.1	11.9	11.5	8.8	32.2
3	Cleistanthus collinus	30	1.6	35.3	7.1	16.7	3.6	27.4
4	Sainha*	50	0.8	34.4	11.9	8.3	3.5	23.7
6	Diospyros melanoxylon	60	0.6	18.3	14.3	6.3	1.9	22.5
7	Madhuca indica	10	0.2	175.0	2.4	2.1	18	22.5
8	Anogeissus latifolia	40	0.8	41.4	9.5	8.3	4.3	22.1
9	Pterocarpus marsupium	20	0.3	138.0	4.8	3.1	14.2	22.1
10	Dendroclamus strictus	10	0.4	147.0	2.4	4.2	15.2	21.8
11	Modeh*	20	0.3	65.0	4.8	3.1	6.7	14.6
12	Buchanania latifolia	20	0.2	47.8	4.8	2.1	4.9	11.8
13	Schleichera oleosa	10	0.3	35.0	2.4	3.1	3.6	9.1
14	Dhawai*	10	0.2	45.0	2.4	2.1	4.6	9.1
15	Girchi*	10	0.1	30	2.4	1	3.1	6.5
16	Dhanbohar*	10	0.1	15.0	2.4	1.0	1.5	4.9
17	Macau tendu*	10	0.1	14.0	2.4	1	1.4	4.8
		420	9.6	969.8	100.0	100.0	100.0	300.0

* Local names

Appendix III: Importance Value Index (IVI) of the Shrub Layer in Kodewara Micro Watershed

S. No.	Shrubs Species	% Fre-quency	% Density	Basal Area	Relative Fre-quency	Relative Density	Relative Domi-nance	Impor-tance Value Index
1	Diospyros melanoxylon	60	3.1	6.9	23.1	24.4	7.7	55.2
2	*Tectona grandis*	30	3.2	9.4	11.5	25.2	10.4	47.1
3	Cleistanthus collinus	60	1.9	7.3	23.1	15	8.1	46.2
4	Kekti*	20	1.8	4.5	7.7	14.2	5	26.9
5	Sainha*	20	0.6	10.5	7.7	4.7	11.7	24.1
6	Terminalia tomentosa	20	1.1	6.8	7.7	8.7	7.6	24
7	Girchi*	10	0.4	14.5	3.8	3.1	16.1	23
8	Buchanania latifolia	20	0.3	9.5	7.7	2.4	10.6	20.7
9	Macau tendu*	10	0.1	14	3.8	0.8	15.6	20.2
10	Embilica officinalis	10	0.2	6.5	3.8	1.6	7.2	12.6
		260	12.7	89.9	100.0	100.0	100.0	300.0

* Local names

Appendix IV: Importance Value Index (IVI) of the Tree Layer in Tatoda Micro Watershed

S. No.	Tree Species	% Frequency	% Density	Basal Area	Relative Frequency	Relative Density	Relative Dominance	Importance Value Index
1	*Tectona grandis*	60	5.5	26.0	15.8	42.3	2.5	60.6
2	Koriya*	60	2.3	20.8	15.8	17.7	2	35.5
3	Pterocarpus marsupium	30	0.3	174.7	7.9	2.3	17.1	27.3
4	*Madhuca indica*	30	0.4	113.3	7.9	3.1	11.1	22.1
5	*Terminalia tomentosa*	20	0.3	143.3	5.3	2.3	14	21.6
6	*Diospyros melanoxylon*	30	1.1	20.2	7.9	8.5	2	18.4
7	Sainha*	30	0.8	28.3	7.9	6.2	2.8	16.9
8	Butea monosperma	30	0.7	25.8	7.9	5.4	2.5	15.8
9	Modeh*	10	0.2	120	2.6	1.5	11.7	15.8
10	*Schleichera oleosa*	10	0.4	88.75	2.6	3.1	8.7	14.4
11	Anogeissus latifolia	10	0.1	100	2.6	0.8	9.8	13.2
12	Masia*	20	0.7	16.1	5.3	5.4	1.6	12.3
13	Kokai*	10	0.1	70	2.6	0.8	6.8	10.2
14	*Embilica officinalis*	10	0.1	35	2.6	0.8	3.4	6.8
15	Harra*	10	0.1	25	2.6	0.8	2.4	5.8
16	Bhelwa*	10	0.1	16	2.6	0.8	1.6	5
		380.0	13.0	1023.3	100.0	100.0	100.0	300.0

* Local names

Appendix V: Importance Value Index (IVI) of the Shrub Layer in Tatoda Micro Watershed

S. No.	Shrubs Species	% Frequency	% Density	Basal Area	Relative Frequency	Relative Density	Relative Dominance	Importance Value Index
1	*Tectona grandis*	40.0	2.7	13.6	11.8	21.8	15.7	49.3
2	Diospyros melanoxylon	70.0	1.9	8.7	20.6	15.3	10.0	45.9
3	Koriya*	50.0	2.1	9.1	14.7	16.9	10.5	42.1
4	Cleistanthus collinus	50.0	1.5	8.5	14.7	12.1	9.8	36.6
5	*Buchanania latifolia*	30.0	1.1	7.8	8.8	8.9	9.0	26.7
6	Sainha*	30.0	0.7	9.1	8.8	5.6	10.5	24.9
7	Terminalia tomentosa	10.0	1.0	9.7	2.9	8.1	11.2	22.2
8	*Butea monosperma*	20.0	0.7	6.6	5.9	5.6	7.6	19.1
9	Chind*	20.0	0.4	4	5.9	3.2	4.6	13.7
10	Masia*	10.0	0.1	6	2.9	0.8	6.9	10.6
11	Kekti*	10.0	0.2	3.5	2.9	1.6	4.0	8.5
		340.0	12.4	86.6	100.0	100.0	100.0	300.0

* Local names

Appendix VI: Importance Value Index (IVI) of the Herb Layer in Samaltagad-B Micro Watershed

S. No.	Plant Spp.	% Fre-quency	% Density	Basal Area	Relative Fre-quency	Relative Density	Relative Domi-nance	Impor-tance Value Index
1	*Euphatorium adenophorum*	80	4.1	1.6	11.7	17.6	7.4	36.7
2	*Oplismenus burmanii*	73.3	3.6	1.3	10.7	15.5	6.0	32.1
3	*Reinwartia indica*	60	2.2	0.4	8.8	9.5	1.8	20.0
4	*Oxalis corniculata*	73.3	2	0.1	10.7	8.6	0.6	19.9
5	*Cotoneaster microphylus*	40	0.7	1.4	5.8	3.0	6.5	15.3
6	*Cedrus deodara* (seedlings)	40	0.8	1.3	5.8	3.4	6.0	15.3
7	*Geranium grandiflora*	53.3	1.5	0.2	7.8	6.4	0.7	15.0
8	*Rubus ellipticus*	20	0.2	2.4	2.9	0.9	11.1	14.8
9	*Galium elegans*	40	1.6	0.3	5.8	6.9	1.4	14.1
10	*Berberis lyceum*	20	0.2	2.1	2.9	0.9	9.7	13.5
11	*Galium asperifolium*	20	0.3	1.5	2.9	1.1	6.9	10.9
12	*Ageratum conyzoides*	20	1.1	0.3	2.9	4.6	1.4	8.9
13	*Cardamine impatiens*	20	1.2	0.2	2.9	5.2	0.7	8.8
14	*Dicliptera rouxburghiana*	6.6	0.1	1.2	1.0	0.3	5.5	6.8
15	*Viola canescens*	6.6	0.3	1	1.0	1.1	4.6	6.7
16	*Adiantum spp*	13.3	0.7	0.1	1.9	3.1	0.5	5.5
17	*Potentila nepalensis*	6.6	0.1	0.9	1.0	0.3	4.1	5.4
18	*Cynodon dactylon*	13.3	0.5	0.2	1.9	2.3	0.9	5.1
19	*Rumex hastatus*	6.6	0.1	0.8	1.0	0.3	3.7	4.9
20	*Youngia Japonica*	6.6	0.3	0.5	1.0	1.4	2.3	4.7
21	*Leucas lanata*	6.6	0.1	0.7	1.0	0.3	3.2	4.4
22	*Stellaria media*	6.6	0.4	0.3	1.0	1.7	1.4	4.1
23	*Selaginella spp.*	6.6	0.6	0.1	1.0	2.6	0.5	4.0
24	*Pennisitum orientale*	6.6	0.1	0.6	1.0	0.3	2.8	4.0
25	*Nepeta hindostana*	6.6	0.2	0.3	1.0	0.9	1.2	3.0
26	*Dryopteris spp.*	6.6	0.2	0.2	1.0	0.9	0.9	2.7
27	*Anagalis arvensis*	6.6	0.1	0.2	1.0	0.6	0.9	2.4
28	*Asparagus adscendens*	6.6	0.1	0.2	1.0	0.3	0.9	2.1
29	*Asplenium dalhousiae*	6.6	0.1	0.2	1.0	0.3	0.9	2.1
30	*Chrysopogon serrulatus*	6.6	0.1	0.2	1.0	0.3	0.9	2.1
		685.5	23.28	21.7	100.0	100.0	100.0	300.0

Appendix VII: Importance Value Index (IVI) of the Tree Layer in Amlawagad-2 Micro Watershed

S. No.	Plant Spp.	% Fre-quency	% Density	Basal Area	Relative Fre-quency	Relative Density	Relative Domi-nance	Impor-tance Value Index
1	**Quercus leucotrichophora**	100	4.6	215	21.7	48.9	21.6	92.3
2	*Rhododendron arborium*	80	1.2	198.3	17.4	12.8	20.0	50.1
3	*Cedrus deodara*	80	1.4	153.3	17.4	14.9	15.4	47.7
4	*Pinus rouxburghii*	40	0.6	149.3	8.7	6.4	15.0	30.1
5	*Zanthoxyllum alatum*	40	0.4	24.5	8.7	4.3	2.5	15.4
6	*Acsculas indica*	20	0.2	63	4.3	2.1	6.3	12.8
7	*Ficus hispida*	20	0.2	60	4.3	2.1	6.0	12.5
8	*Palmae humilis*	20	0.2	49	4.3	2.1	4.9	11.4
9	*Celtis australis*	20	0.2	29.2	4.3	2.1	2.9	9.4
10	*Ficus glomerata*	20	0.2	27.8	4.3	2.1	2.8	9.3
11	*Pistacia integerrima*	20	0.2	24	4.3	2.1	2.4	8.9
		460	9.4	993.4	100.0	100.0	100.0	300.0

Appendix VIII: Importance Value Index (IVI) of the Shrub Layer in Amlawagad-2 Micro Watershed

S. No.	Plant Spp.	% Fre-quency	% Density	Basal Area	Relative Fre-quency	Relative Density	Relative Domi-nance	Impor-tance Value Index
1	**Dabregessia velutina**	80	1.0	3.0	28.6	33.3	15.6	77.5
2	*Principia utilis*	60	0.6	2.4	21.4	20.0	12.5	53.9
3	*Rhamnus virgatus*	40	0.4	2.2	14.3	13.3	11.5	39.1
4	*Zanthoxyllum alatum*	20	0.2	3.5	7.1	6.7	18.2	32.0
5	*Sinarundinaria anceps*	20	0.2	2.4	7.1	6.7	12.5	26.3
6	*Pyrus pashia*	20	0.2	2.0	7.1	6.7	10.4	24.2
7	*Urtica dioica*	20	0.2	1.9	7.1	6.7	9.9	23.7
8	*Daphne papyracea*	20	0.2	1.8	7.1	6.7	9.4	23.2
		280	3.0	19.2	100.0	100.0	100.0	300.0

Appendix IX: Importance Value Index (IVI) of the Herb Layer in Amlawagad-2 Micro Watershed

S. No.	Plant Spp.	% Fre-quency	% Density	Basal Area	Relative Fre-quency	Relative Density	Relative Domi-nance	Impor-tance Value Index
1	*Thalictrum foliolosum*	80	2.4	0.4	10.0	11.9	8.2	30.0
2	*Rienwaratia indica*	80	2.4	0.3	10.0	11.9	6.1	28.0
3	*Galium elegans*	80	2	0.2	10.0	9.9	4.1	24.0
4	*Barleria crustata*	60	1	0.5	7.5	5.0	10.2	22.7
5	*Quercus (seedling)*	20	0.2	0.9	2.5	1.0	18.4	21.9
6	*Primula denticulate*	60	2	0.2	7.5	9.9	4.1	21.5
8	*Rumex dentadus*	60	1.8	0.2	7.5	8.9	4.1	20.5
9	*Oplismenus burmanii*	60	1.6	0.2	7.5	7.9	4.1	19.5
10	*Berberis lyceum*	60	1	0.3	7.5	5.0	6.1	18.6
11	*Viola canescens*	60	1.4	0.2	7.5	6.9	4.1	18.5
12	*Geranium wallichianum*	40	1.2	0.2	5.0	5.9	4.1	15.0
13	*Pyrus pashia*	20	0.4	0.5	2.5	2.0	10.2	14.7
14	*Zingiber*	40	0.4	0.3	5.0	2.0	6.1	13.1
15	*Potentilla geradiana*	40	0.8	0.2	5.0	4.0	4.1	13.0
16	*Trifolium repens*	20	1.4	0.1	2.5	6.9	2.0	11.5
17	*Setaria glauca*	20	0.2	0.2	2.5	1.0	4.1	7.6
		800	20.2	4.9	100.0	100.0	100.0	300.0

Appendix X

Rainfall Data from Chakrata Observatory

(in mm)

Month	Year					
	1999	2000	2001	2002	2003	2004
January	41.7	122.5	26.8	36.3	26.4	78.9
February	0.0	157.7	16.2	71.4	92.5	25.6
March	0.0	61.5	50.9	69.9	83.8	0.0
April	N.A.	25.2	77.2	70.6	82.6	64.0
May	66.2	51.9	104.0	82.1	48.7	76.8
June	123.0	231.8	259.7	219.2	76.3	40.1
July	374.4	424.0	313.5	182.8	287.0	N.A
August	302.7	330.9	370.2	441.5	232.6	N.A
September	127.2	148.8	33.5	178.9	0.0	N.A
October	4.5	0.0	0.0	8.5	0.0	N.A
November	0.0	0.0	5.4	0.0	6.0	N.A

December	3.2	0.0	21.5	0.2	26.3	N.A