Global Theme on Agroecosystems

Report no. 47

Community Watershed as a Growth Engine for Development of Dryland Areas

A Comprehensive Assessment of Watershed Programs in India

ICRISAT
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INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Ministry of Agriculture and
Ministry of Rural Development

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Abstract

The Comprehensive Assessment (CA) of Watershed Programs in India was undertaken by the consortium of institutions led by ICRISAT. The CA undertook macro- and micro-level studies, detailed analysis of secondary data and detailed case studies covering different agroecologies, different watershed projects, different implementing agencies, various watershed approaches covering pan-India studies. Main findings of the CA indicated that watershed programs in India are silently revolutionalizing the rain-fed areas with a mean B:C ratio of 2 and internal rate of return (IRR) of 27 per cent and can become growth engine for inclusive and sustainable development of vast dryland areas. Only less than one per cent of watershed projects are uneconomical with <1 B:C ratio. Watershed programs need upgradation as 65 per cent of projects are performing below average B:C ratio (2.0).

There is an urgent need to unify the efforts around a new paradigm which shifts the objectives from merely drought-proofing and agricultural production to sustainably increasing agricultural productivity, protecting the environment and building human and natural resource resilience to cope with future challenges, including climate change. There is need for common guidelines with a single effective national and state mechanisms for coordination and a move from a subsistence to a business model by establishing market links and public private partnerships (PPP). Drivers of collective action such as tangible economic benefits for individuals, income-generating activities for women and vulnerable groups, good local leadership, knowledge-based entry point activity, collective action through cooperation and collegiate mode of community participation, technical support and market linkage etc., enhanced impact of watersheds. Impact assessment studies revealed that baseline data are lacking in most studies.

A few benchmark watersheds in each agroecoregion can be monitored for detailed impact assessment and using new science tools such as GIS, remote sensing and simulation modeling, extrapolation could be undertaken. Capacity building is identified as the weakest link for scaling-up and scaling-out the watershed program. The CA has provided detailed recommendations for enhancing the impact of watershed program in the country.

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Foreword

The world is facing multiple and complex challenges that are threatening social and political institutions. Current global food stocks are at their lowest in the last two decades. Food prices have skyrocketed. Countries such as Vietnam, Thailand, India and China have banned rice exports to ensure domestic availability at decent prices. Meeting the Millennium Development Goal of halving the proportion of people who suffer from hunger by 2015 is becoming a daunting challenge for planners. Water scarcity too is staring us in the face. A recent global assessment of Water for Food and Water for Life indicates that the goal of food security can be met with the available water resources only with drastic and urgent changes in the way we produce food worldwide, more so in the developing arid, semi-arid, sub-humid and humid tropics.

There is an urgent need to harness the vast untapped potential of rainfed agriculture in Asia and Africa by substantially boosting financial and technical investments on it. In India, 65% of the 142 million hectares of arable area is rainfed with very low productivity (1 to 1.5 t ha^{-1}), largely due to low rainwater use efficiency (35-45%) for crop production. Current yield levels in rainfed farmers' fields are far below achievable yields, requiring technologies, institutions and policies to bridge the yield gap.

The last two decades have seen the Government of India adopting a watershed management approach. During the 11th Five Year Plan, the Government of India decided to increase its investments in rainfed areas. To date, watershed programs in India have had impacts such as increased water availability, reduced soil erosion, increased cropping intensity, more rural employment and increased crop productivity and incomes. However, these benefits have been largely confined to a few successful watershed programs.

In fact, almost two-thirds of the watershed programs performed below average, as indicated by a meta-analysis jointly undertaken by ICRISAT and ICAR. Two nodal ministries of the Government of India implementing watershed programs, namely the Ministry of Agriculture and Cooperation and the Ministry of Rural Development, jointly sponsored a Comprehensive Assessment (CA) of their impacts. ICRISAT in partnership with ICAR institutions, state agricultural universities, a number of state Government departments and non-government organizations, undertook the assessment during the last two years, and concluded that community watershed programs could serve as growth engines for the development of rainfed areas with prospects of doubling productivity.

The 11th Five Year Plan provides an opportunity to build on the past achievements in watershed work by seeking to address issues of production, environment, poverty and resilience within the watershed context. At the same time, it recognizes that the approach is applicable to all rainfed regions, with specific technical and social interventions tailored to suit different rainfall regions. Hence a paradigm shift is called for in approaching watershed development not just as another scheme but as a *sine qua non* for rainfed areas.

This comprehensive publication, which is a must read for policy makers, development investors, researchers and development workers, highlights the recommendations of the CA for developing watersheds as a business model and not merely as a soil and water conservation structure, paving the way for inclusive and sustainable growth of dryland areas worldwide.

William D Dar
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Acronyms

AGY	Adarsh Gaon Yojana
BAIF	Bharatiya Agro Industries Foundation
CA	Comprehensive Assessment
CAZRI	Central Arid Zone Research Institute
CBO	Community-based Organization
CPLR	Common Property Land Resources
CPR	Common Property Resources
CRIDA	Central Research Institute for Dryland Agriculture
CSWCRTI	Central Soil Water Conservation Research and Training Institute
DDP	Desert Development Program
DFID	Department for International Development
DPAP	Drought Prone Area program
EAPs	Externally Aided Projects
EPA	Entry Point Activities
GBPUAT	GB Pant University of Agriculture and Technology
GIDR	Gujarat Institute of Development Research
GIS	Geographical Information System
GoI	Government of India
ICRISAT	International Crops Research Institute for the Semi-arid Tropics
ICTs	Information and Communication based Technologies
IEG	Institute of Economic Growth
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
INM	Integrated Nutrient Management
IPM	Integrated Pest Management
IRS	Indian Remote Sensing Satellites
ISEC	Institute for Social & Economic Change
ISRO	Indian Satellite Research Organization
IWDP	Integrated Wasteland Development program
IWM	Integrated Water Management Institute
JAU	Junagadh Agricultural University
MDG	Millennium Development Goal
NAEP	National Afforestation and Eco-development Project
NARS	National Agricultural Research System
NCAP	National Centre for Agricultural Economics and Policy Research
NGO	Non-Governmental Organization
NPV	Nuclear Polyhydrosis Virus

NRSA	National Remote Sensing Agency
NREGS	National Rural Employment Guarantee Scheme
NWDPRA	National Watershed Development Project for Rain-fed Area
PIA	Project Implementing Agency
PRIs	*Panchayati Raj* Institutions
RAS	Reclamation of Alkali Soil
RGWM	Rajiv Gandhi Watershed Mission
RRSSC	Regional Remote Sensing Service Centre
RVP&FPR	River Valley Project & Flood Prone Region
SDC	Swiss Agency for Development and Cooperation
SHG	Self-Help Group
SPWD	Society for Promotion of Wastelands Development
TNAU	Tamil Nadu Agricultural University
WDF	Watershed Development Fund
WDPSCA	Watershed Development in Shifting Cultivation Areas
WDT	Watershed Development Team
WOTR	Watershed Organization Trust

1. Executive Summary

This Executive Summary provides policy makers with a brief, non technical, action-oriented synthesis of the Comprehensive Assessment and of the options it presents. Our aims are clear, succinct, comprehensive yet comprehensible, to point what is good in current watershed practice and what could be built upon in order to add value. The foregoing recommendations are rigorous and self explicit and will not be repeated in what follows.

The Importance of Rain-fed Agriculture and Watershed Management in the Realization of Government's Goals

The Government of India has before it a wealth of reviews and reports concerning agriculture in general and rain-fed agriculture and water in particular. The report of the Technical Commission on Watershed Program in India argues for greater emphasis on a reformed watershed program in the rain-fed parts of Indian agriculture - a program which would be 'location specific' and which offers the greatest potential for productivity increases, to help meet food security in 2020 and alleviate poverty. The reports of the National Commission on Farmers talk in similar vein about the importance of the rain-fed areas. The Comprehensive Assessment of Water Management in Agriculture highlights the need for urgent action in improving water management and the opportunity in this for 'low yield farmers' to raise their yields to 80% just as what 'high yield farmers' obtain, with the greatest potential increase in yields being in rain-fed areas.

Certainly, governments' policy makers have a number of hoops to jump through to attain various goals: the millennium development goal (it is especially important for India to achieve these goals on a global scale); the production goal of four per cent annual growth in agricultural output if food self-sufficiency is to be maintained; environmental goal, including a mandate to reduce the amount of wasteland; and a goal to address rural poverty.

The various other reports and the Comprehensive Assessment (CA) of watersheds contend that effective watershed management of rain-fed areas can simultaneously address all these goals and address them in a fashion which builds resilience in the social structure as well as in the natural resource base such that future economic changes or of climate can be better met.

Current 11th Five Year Plan recognizes the 'rain-fed cum watershed' theme. This report may help with guidance to operationalise the theme for the 11th Five Year Plan, providing an opportunity to build on what has already been achieved in watershed work and giving a momentum by consciously seeking to address these different goals: production, environmental, poverty and resilience within the watershed context, while recognizing that the approach is applicable to all rain-fed regions though the specific technical and social interventions are different in areas of different rainfall and that a paradigm shift in thinking is needed, to approach watershed development not just as another scheme but as a *sine qua none* for the rain-fed areas.

This would seem a perfectly feasible policy to run parallel to that of focusing in irrigated areas like the Gangetic Plain on the better utilization of groundwater. In the rain-fed areas as in the Gangetic Plain, soil and water conservation and technology alone cannot achieve the desired result, a complete integrated package is needed for natural resource management, social upliftment and connection to markets and infrastructure. The watershed approach is not a new fad, its tenets have been tried and tested and its weak points identified.

Watershed Program in India and Evolution of the Concept

The importance of watersheds to Government of India is witnessed by the resources being invested and the constant interest in improvement. Government has spent US$ six billion on watershed program through the ministries of Agriculture, Rural Development and Environment and Forests. The expenditure was augmented due to the efforts of various research and donor agencies and some non-governmental organizations (NGOs). Current intentions are to invest Rs 360 billion over the next five years on 38 m ha/watersheds. The start of the 11th Five Year Plan provides an excellent opportunity to augment the program and greatly enhance its impacts.

The watershed concept was introduced in the late 1950s as an approach for increasing the productivity of rain-fed areas by the physical management of soil, water and forest in its natural context - from a ridge to a watercourse. Research into watersheds started in the '70s, there was increasing donor and NGO experimentations in the 1980s and the involvement of major donors and national institutions in the late 90s. The new millennium saw the start of involvement by private sector too.

In common with general rural development theory and practice, the watershed approach has evolved. At first there was single discipline interventions of specific aim – primarily starting with soil and water conservation and moving to more food from higher yielding crop varieties. This concern broadened to embrace the cropping system and then the farming system of crops, grazing, forest and income generating enterprises. From the mid 90s came a greater consideration of the people of the watershed and their livelihoods, especially the poor, and the realisation that the land and water focused activities of watershed program excluded significant numbers of landless and thus emerged a requirement to do more about equity, women, the poor and non-land based income generation activities. Now best practice embraces the total environment of the watershed and the livelihoods of all the people within it.

The Government has moved the watershed agenda forward in various ways: with constitutional amendment to put more responsibility for rural development in the hands of *panchayati raj* departments; by refining watershed guidelines as lessons have been absorbed; by converging the drought prone area, rural employment guarantee and watershed program around unified watershed guidelines; and most recently by unifying the guidelines and establishing a National Rain-fed Area Authority (NRAA). Further, the Planning Commission has taken cognisance of the recommendations of various task force groups. There are studies of public-private sector partnerships in watershed execution. The Government of Andhra Pradesh (AP), which accounts for 40% of the national total of watersheds being implemented, has adjusted watershed budgetary allocations so that 27% goes to women; and the Government of Madhya Pradesh (MP) appointed NGOs as watershed implementing agencies throughout the State. Since 2003, several countries have approached India for assistance in piloting watershed work.

The Common Features of the Watershed Development Model

Government agencies, development thinkers, donors, researchers and NGOs have gradually learnt one from another, (though some are ahead of the field and others deficient in some aspect or other, principally in people participation or in the science.) But generally nowadays the better models have some or all of the following features in common:

- participation of villagers as individuals, as groups or as a whole, increasing their confidence, enabling their empowerment and their ability to plan for the future and thereby enhancing their self determination

- capturing the power of group action in the village, between villages and from federations, e.g. capturing economies of scale by collective marketing
- the construction of basic infrastructure with contributions in cash or labour from the community
- better farming techniques, notably the improved management of soil, water, diversifying the farming system and integrating the joint management of communal areas and forest
- the involvement of the landless, often in providing services
- arrangements for the provision of basic services and infrastructure
- the establishment of village institutions and links with the outside world
- improved relationships between men and women
- employment and income generation by enterprise generation in predominantly but not exclusively agricultural-related activities.

And sometimes:

- the fusion of research and development (R&D) by capturing the extraordinary power of participatory technology development, including variety selection and breeding with direct links to germplasm collections
- complete avoidance of corruption so that trust is engendered and all the benefits pass to the community
- involvement with enforced migration.

Recent Additions to the Watershed Model

- The pragmatic use of scientific knowledge as the entry point rather than money, leading to tangible economic benefits from low-cost interventions that generate rapid and substantial returns at an acceptable low level of risk. Among these are novel interventions focusing on seeds of improved cultivars, integrated pest management, micro-nutrients, and soil conservation and water table recharge structures.
- A broad-based approach to income generation, involving private sector associated with scientific advances and markets. For instance, in the remediation of micro-nutrients deficiencies; in the marketing of medicinal and aromatic plants; with premium payments paid by industrial processors for aflatoxin-free maize and groundnut; with high sugar sorghum, and selected crops such as jatropha and pongamia sold to industry for ethanol and bio-diesel production; the production for sale of commercial seed, hybrid varieties and bio-pesticides.
- Using new science methodologies to improve performance like remote sensing for monitoring and feed-back to farmers, yield gap analysis, rapid assessment of the fertility status of the watershed.
- Building productive partnerships and alliances in a consortium for research and technical backstopping, with the members brought together from the planning stage.
- A concern to create resilience in the watershed and its community to climate change and to events post program intervention.

Where best applied, the model has led to profound farming system changes, improved food self sufficiency, expanded employment and commerce and enhanced incomes. Where indifferently

executed the approach has led, as we shall see in what follows. There is indeed something here analogous to the 'yield gap' exhibited between research station and farmers' yields. Much of the difference can be captured by implementing agencies 'catching up' with best practice. The more recent linking of natural resource science with the private sector, markets and with people's broader livelihoods in consultation with them, is transforming the dynamic and success rate of development efforts.

The Comprehensive Assessment Objectives and Methods

This Comprehensive Assessment reflects the importance of watersheds to government and was commissioned jointly by the Ministries of Rural Development and Agriculture in order to assess the impact of the various watershed programs, identify the drivers of success and make suggestions for policy, institutional and technical change to improve performance. The context is of using the watershed approach to help achieve government's goals in agricultural productivity increase, poverty reduction, and environmental improvements. To these we have added a fourth assessment consideration – of using watersheds to generate social and eco-system resilience to future change and shock.

The assessment has comprised:

- inventory and review of existing evidence
- macro and micro level studies
- case studies - issues, methods and practices
- the use of new science tools.

Broad Overall Conclusions about Watershed Performance and Impact

The importance of rain-fed agriculture to India has been underscored by a multiplicity of recent studies. The watershed approach is a paradigm that works in all rain-fed circumstances, has delivered important benefits and impacts and needs to be implemented on a large scale. But watershed impact covers a spectrum from 'no better than *ad hoc* development schemes' to impressive improvements of the natural resource endowment and of agricultural production, and a transformation of the socio-economy.

The difference in result between indifferent and best watershed practice is analogous to the 'yield gap' in crop production. In part, this is because the watershed approach has been rapidly evolving and the assessment has been looking at a field in which the goal posts have repeatedly been moved. In part, it is also due to deficiencies in execution.

To consolidate and build upon the foundation already laid and universally gain the impact that is possible, requires government to do some difficult things, most noticeably introducing a new 'mindset' or different form of approach that accepts:

- watershed development is not just a means to increase production or to conserve soil and water but an opportunity for the fully integrated and sustained development of human and natural resources
- the approach is valid across various rainfall regimes over vast tracts of India and can contribute in large measure to the simultaneous achievement of government's production, environmental and social goals

- sustainability and better social impact and equity are very important issues with pro-poor interventions not as a spin-off or after-thought but planned and integral to the whole
- there are vast opportunities to reduce costs and increase output by improving the appropriateness and reach of technology
- there is an obvious value in converging government schemes in the interest of impact and sustainability, rather than a spread of activity. This is particularly important in the case of water and of schemes aimed to reach the poor.

Watersheds should be seen as a business model. This calls for a shift in approach from subsidised activities to knowledge-based entry points and from subsistence to gaining tangible economic benefits for the population of the watershed at large. This is being done with productivity enhancement, diversification to high-value enterprises, income-generating activities, market links, public-private partnerships, micro-entrepreneurship and a broad-based community involvement.

Moving forward requires that a lack of capacity to effectively implement programs is addressed.

Implementing agencies need to expand and broaden their capacities and skills and reach; while communities need to strengthen their institutions and their skills. This will require a longer implementation period of seven to eight years with more time spent in preparation and in post intervention support. It also requires additional funds and more flexibility in using budgets and the engagement of specialist service providers.

One of the weakest aspects lies in the generation and dissemination of technology. A big improvement is needed in making appropriate technology and information accessible to the watershed community. The remedy lies in devising technology for the drier and wetter parts of the rain-fed area, more participatory development and research and in forming consortia, and employing agencies to provide specialist technical backstopping.

There is a crucial need to improve monitoring and evaluation (M&E) and the feedback of the information obtained to constantly improve performance. Only a few key indicators need to be monitored in all watersheds. At one or two representative watersheds in each district, a broad range of technical and socio-economic parameters should be measured to provide a scientific benchmark and a better economic valuation of impact than is currently possible.

Main Findings of the Meta Analysis

First a word about the statistical veracity of the conclusions reached by the comprehensive assessment. Outside of research watersheds, the assessment faced a lack of baseline data. Further, because of the evolution of the watershed approach, there is little uniformity in objectives and approach, and in what others have measured. Many findings are qualitative or subjective rather than quantitative or objective. Extraneous activity in watersheds poses the difficult problem of attribution. All this leads to statistical imperfections. Nevertheless, there are many watersheds and many studies and we have sufficient confidence in the findings to make our recommendations. However, perhaps the statistical 'credibility index' is less than optimum.

The assessment has shown a benefit to cost ratio of 2.01 and internal rate of return of 27.43% with rural incomes enhanced by 58%, agricultural productivity increased by 35% and additional environmental and social benefits. There is vast scope to improve upon these figures since only 35% of watersheds are performing above average while 65% of watersheds are below the average.

Macro watersheds (>1,200 ha) achieved better impact than micros of 500 ha. Development needs to be undertaken in clusters of at least four to six micro-watersheds together (2000-3000 ha) and the new guidelines might be useful to propose this. Macro units offer economies of scale, more technical options and greater hydrological efficiency and, would ease collaboration between agencies and their interface with the community.

Between 700 mm and 1,100 mm of rainfall, there is good technology available. Above and below this, the appropriateness and range of current technology is not good enough and needs to be researched in concert with watershed communities. The 11th Five Year Plan could direct that this is attended to.

The drivers of success are: tangible economic benefits; empowerment through knowledge; equal partnership, trust and shared vision; good local leadership; transparency and social vigilance in financial dealings; equity through low-cost structures; pre-disposition to work collectively; activities targeted at the poor and women; increased drinking water availability; income-generating activities for women.

The current allocations are insufficient to 'treat' a complete watershed or to adopt the livelihood approach. To make watersheds engines of growth need at least Rs. 20,000 per ha. However, some of the additional funds required can be raised in cash or kind by the community; or come from leveraging private sector money or from cost savings. More timely release of funds and creating sufficient flexibility so that money can be vired between tasks would also help.

There is opportunity to reduce costs through more cost-effective water structures; economies of scale from using the macro watershed as the development unit; convergence of action to avoid duplication; getting things right first time to avoid repeat expenditures; avoiding the adverse costs of environment deterioration. The cost benefit ratio would be much improved by more efficient use of technology to increase productivity; by bringing wasteland into productive use; and by a total accounting of socio-economic and environmental benefits.

Interventions to benefit women and vulnerable groups developed social capital and increased sustainability.

National and state planning for and selection of watersheds might best be based on a matrix of the potentials for impact on production, poverty, environment, and community involvement.

The Impact of Technology

Technologies for Four Agro-Climatic Zones

The Comprehensive Assessment clearly points to the watershed approach being applicable to four principle rain-fed agro-climatic zones: the arid; the dry semi-arid tropics (SAT), the moist SAT and the sub-humid. It also points to the need for distinct technical approaches and recommendations for each of these zones. Technical emphasis and success to date has principally been in the 700 to 1,100 mm rainfall areas but a different water management approach and different emphases are needed in the drier and wetter zones.

In the drier rainfall areas, the end-use of water will likely be more towards high-value fodders, micro-irrigated horticulture, and the strategic irrigation of short duration varieties. Beyond this, dryland horticulture, agro-forestry, improved dryland grazing and non-agricultural sources of income will clearly be important.

Soil and water conservation practices vary with rainfall and soil type: the driest areas require arid land technologies. With low rainfall and soil-profile storage water-harvesting become even more important. Drainage is important in wetter areas. Clearly multidisciplinary, participatory and poverty focused research is needed for each different zone, leading to broad recommendations for implementation.

Information Generation and Flows

The 'Yield Gap', the difference between performance during research and that on farms has been well recorded and analysed. Current rain-fed farmer yields are lower by two to five folds than achievable yields. In general, the yield gap is wider with higher rainfall. In the better managed watersheds, the gap is being narrowed by a combination of physical improvements to the natural resources, the use of a broad spread of technology, changes in social awareness and access to knowledge, and by community activities which improve the servicing of agriculture. For many crops, major increases in yield result from transfer of information and materials from the best farmers.

But in general in India, knowledge is not percolating to villages. Only 8% of farmers get agricultural extension as revealed by National Sample Survey and watershed programs are often the only time that poor people get exposed to technology improvements. This is one reason for the yield gap between the research station and farmer's field. There is need to enhance the reach of technology.

How best can the watershed community access information and remedy one of the weakest links in all watershed programs? All the ideas are out there: farmer field schools for capacity building; computer information hubs in the village; participatory technology development. One particular promise is promotion of information and communication technologies (ICT)-based knowledge-sharing and agricultural extension to speed up transfer of agro-technologies to watershed villages and link farmers to markets and to research and development agencies.

As development has become more inclusive, it has demanded contributions from new disciplines and from multiple disciplines. Hence, the emergence of such terms as farming system and livelihood system, integrated and holistic. But the current system of research and extension has the intrinsic problems of specialist institutions dealing with one science or crop or theme being separated one from another, and of scientists separated from extensionists and from direct contact with the people they are aiming to help. Institutional walls and barriers may separate one discipline from another, even with the multi-discipline institutions like Central Soil Water Conservation Research and Training Institute (CSWCRTI), Central Research Institute for Dryland Agriculture (CRIDA), Central Arid Zone Research Institute (CAZRI) and ICRISAT.

If it is to be taken up, especially by the resource poor, technology has to be appropriate and this requires participatory technology development. Participatory methods to identify and develop pro-poor and gender-sensitive technologies have proven to be particularly effective and powerful, but require a change of mindset in researchers and the acquisition of new sets of skills.

In keeping with the concept of watersheds as a business model, research and development of commodities should be viewed as a value chain from production through processing and packing to marketing.

All this implies a shift of resources towards technology development and dissemination, either by revisiting budget allocations within the watershed regime or an additional budget. Noteworthy here is the difference in ability between Ministry of Agriculture (MoAg) and Ministry of Rural Development (MoRD) to flexibly use budgets. In fact, a lot of watershed money seems currently unused.

Quick Returns from Proven Productivity Enhancing Initiatives

From watershed practice to date a number of best-bet technical options have emerged. These, together with those adumbrated on pages 156/7 of the Parthasarthi report, provide a cafeteria of tried and tested technologies and approaches which would offer quick and substantial returns were it mainstreamed by a concerted effort. Here is a selection:

- combining an improved variety with water conservation and appropriate fertilization
- the integrated management of nutrients and pests and diseases, including biological pest control and the application of micro nutrients
- *in-situ* moisture conservation with broad-bed and furrow, contour furrow cultivations and other suitable landforms
- supplemental irrigation from harvested water for high-value crops
- chickpea grown on residual moisture in the rice fallow system
- commercial horticulture and post harvest crop management
- improving the availability and timeliness of use of inputs and of marketing with community organization.

Integrated nutrient management with an improved variety gives between 30% and 250% yield increase, land management 8% and 30%, supplementary irrigation 18% and 80%, and integrated pest and disease management of 18%. Using these technologies often created an opportunity to grow more cash crops and had environmental benefits.

The speed, economy and impact of participatory crop selection and participatory cultivar selection has been well demonstrated and needs to become the norm for poor rural communities.

From watershed work has emerged the realization of how all-pervasive are micro-nutrient deficiencies, how easily they may be remedied, and what an opportunity there is for a major national impact if a remediation campaign was mounted.

Beyond all this, is a rich vein of technologies and income-generating ideas generated by Indian Council of Agricultural Research (ICAR) institutes, ICRISAT, state universities and other players like the larger NGOs and the UN Small Project Scheme. All of these really need to be collected, collated, assessed and put to wider use. The National Agricultural Innovation Project (NAIP) may be able to play a vital role in this work.

Which new science tools and methods should be mainstreamed?

- Use of computers in the village as information hubs is showing tremendous promise.
- Improvements in the cost and availability of remote sensing and GIS now render their routine use in monitoring and evaluation and in system modeling.
- There is now a capacity to undertake preparatory work to characterize each watershed in terms of its natural resources, soil and hydrological resources and their potential, constraints and opportunities. Such a base data would identify needful action and, for example, permit locally specific fertilizer recommendations to be made with confidence, and to avoid unnecessary activities and waste, to continue the fertilizer example, like applying potassium when it is not needed.

Water Considerations

Some facts and observations:

- they say there are three things important to poor villagers in the rain-fed areas, 'Water, water and water'. Water is used for human and livestock drinking, for irrigation and supplementary irrigation, for domestic and village industrial use and for sanitation
- irrigation accounts for one third of the water used in agriculture, two thirds is rain-fed, yet water management is commonly talked about in irrigated areas but rarely for rain-fed areas. This is an example of how the distinction between irrigated and rain-fed areas is unhelpful. The Comprehensive Review of Water for Food Production commends that the distinction be broken
- the water component of watershed programs, often one of the most costly budgetary items, has tended to be supply led when what is needed is better management of what falls from the sky, more efficient use of it, and avoidance or reduction of losses to the system
- the number of people benefiting from water schemes is very small
- the watershed guidelines don't describe what water structures should be built. So the influential in the community vote for concrete structures
- groundwater is an efficient way to store water as it does not suffer the evaporation losses of surface storage, and its controlled use should be part of every watershed program. Its overuse for economic gain is a precarious development strategy.

The Comprehensive Assessment has clearly shown the following:

- widespread improvements to groundwater tables and soil and surface water storage, but, especially in the drier areas, dropping groundwater levels due to over-exploitation by bore wells, first leave the drinking water supplies of the poor high and dry and then pose environmental problems. The remedy would be to regulate and introduce management strategies, including pre-negotiated social regulation
- an opportunity to substantially improve the productivity of rainfall with an integrated approach to soil-rainfall harvesting and soil fertility management which embraces seed choice, seed priming, balanced nutrient management, agronomic and husbandry techniques, strategic or supplementary irrigation, and the avoidance of waste
- that effort to date has primarily focused on people endowed with the resources to take advantage of modern technology. There is great scope to profoundly improve equity in the access and use of water with pro-poor and gender-sensitive technology and communal management of water supplies, small scale irrigation schemes and capacity building of communal water management institutions
- how moving the average location of water harvesting structure towards the upper parts of the watershed and the average type more towards pits, earthen checkdams and cheaper concrete structures, the cost to harvest a m^3 is lowered, the distribution of benefits is more equitable and fewer professional engineers are needed
- the main recommendation emerging (20) is for the perception about water in rain-fed areas to change, and for water policy to expand from augmentation of supply to water demand management and water use efficiency, paying especial attention to prioritizing drinking water needs, regulating groundwater extraction, providing incentives for efficient irrigation methods and low water requiring crops and disincentives for the opposite, and promoting participatory monitoring and management of all water resources in the watersheds

- as with other aspects of watershed implementation, the joint planning and execution of water schemes would bear dividends and the Department of Water Resources may wish to consider how this might best be brought about. Using the macro watershed as the implementing unit would assist collaboration, improve the efficiency of hydrological management and the synergy between hydrological and social objectives.

Drought and Dry Spell Proofing

Climate change seems destined to move some parts of the SAT towards aridity and most parts to more frequent fluctuations within the average and an increased frequency of extreme events. This poses challenges and opportunities. Against this backdrop, working towards eco-system and livelihood adaptation and resilience to the changes in store would seem prudent.

'Managing Water in Rain-fed Agriculture' (Rockström et al., 2006) makes clear the distinction between meteorological and agricultural droughts, and between droughts and dry spells. Meteorological droughts result in complete crop failure once or twice every decade and require social resilience and coping strategies. A component of every watershed program should be to help communities prepare to deal with these inevitable events by encouraging alternative livelihoods, financial resilience, seed banks and local food storage.

Dry spells on the other hand, whether of climatic or human cause can be bridged by improved water management and offer an opportunity for large increases in yield. Villages benefiting from watershed management increase food produce and market value by 63% as compared with non project villages, even during dry spell years. (Wani et al., 2006).

Beyond this is a major opportunity to bring in predictive science and information technology and advise farmers before and during the season of the likelihood of rain being above or below average so that they may reduce investment in bad years to avoid waste and capitalize on the best years by improving yields. The success rate of predictions, the speed of information flow, the channels used for it, the optimal size of the zone for recommendations and how information hubs can be brought to bear, all need further work.

One key implication of meteorological predictions lies with seed supplies and availability of seed. Seed banks offer a solution.

By integrating the management of moisture stress and nutrients and seed, and with life saving irrigation from farm ponds or wells that are recharged by improved watershed management, farmers can make better use of what they have got and change the common ratio of five years good, three poor, and two failure.

The likely increased frequency of both droughts and dry spells with climate change, underscores the importance of all this work.

The Impact on Gender and Vulnerable Groups

The reality of poverty in the rural areas is stark. The landed poor are the small and marginal farmers on the upper reaches of the watershed on poor soils. The landless, frequently women, unemployed youths, the disabled and the socially marginalized, comprise the other major vulnerable group. These often have no easy access to drinking water and the common property resources that are so important

to them. Drudgery, indebtedness, ill health, under-nutrition, lack of self worth and lack of influence are the common problems. In Orissa, South Bihar and Eastern MP, such people often comprise 50% of the rural community.

This is not new, and the Comprehensive Assessment points to the opportunity to better engage these vulnerable groups in the rural economy through the medium of watershed work.

There are clear opportunities to strengthen policy statements on women's active participation which should start right from the outset, rather than being an 'add-on' and with increased clarity among watershed staff about what are the ends-in view. Indeed gender concerns should form non-negotiable components of the initial phase and of the monitoring framework throughout the project cycle. Similarly, the landless, by definition excluded from landed activities, need mainstream inclusion.

These are very recent considerations for Government of India but the watershed guidelines now cover employment and common property activities for the poor, and the 11th Five Year Plan addresses vulnerable groups as an important issue.

Nevertheless, there is a gap between intention and practice and outcome, and a multi-pronged approach is required, which follows a development path within the project and provides policy change, additional investment in support organisations, and a longer time frame than is current.

Policy changes could easily:

- promote the representation of vulnerable groups in watershed management so as to leverage benefits for them during and after the program
- target interventions and budgetary allocations within the watershed program for capacity building, institutional support and post implementation activities
- promote labour intensive conservation measures and sustainable farm practices by gradually shifting the subsidy for intensive use of inputs.

Staff should have a list of outcomes which might include functional literacy and numeracy; reduced drudgery, measured as freed up time and energy; adequate representation (page 68-69 of Parthasarathy report) in decision making committees and in the development and regeneration of common property resources, especially water, grazing and forest, and the upfront allocation of long-term user rights to them, so that the benefits last beyond project period.

Where water supplies are augmented, particular attention is needed to allocating an equitable share to vulnerable groups. Gram sabhas should set priorities and norms for water use and women's groups may play important role in managing water allocation.

Small livestock are often important to the poor and there should be special support for fodder banks and seed money for women's self help groups (SHGs) to enable them to enhance income from livestock.

Other measures include participatory technology development for vulnerable groups. For example in tools and homestead enterprises. Vulnerable groups benefit from new opportunities emerging with development of natural resources and market-led diversification.

There could be better co-ordination among government programs, especially those dealing with employment, literacy and numeracy, sanitation, child care and nutrition.

Access to finance is crucially important, as revolving funds to teach financial skills and as credit to fund enterprise and initiative and support community resilience to events post project. Subsidies are a separate issue.

Institutions and Policies

What do we know about watershed institutions? They operationalise the program and play a key role in sustaining what is done. They are formal or informal. They belong to the implementing agency or to the community or are linked to external institutions like federations and banks. They only need to exist as long as they have a clear role; i.e. sustainability per se is only useful so far. They need an enabling environment. What has the Comprehensive Assessment added to this understanding?

Firstly, a variety of institutional mix is possible and even desirable but the common denominator seems to be flexibility rather than straight-jacketing. A major breakthrough was to make things participatory.

The *gram sabha* rather than the *gram panchayat* has proved the most democratic and effective village institution. Capacity building needs to focus on them and their role and responsibility needs to be clarified. The Parthasarathy report (page 136) reached the same conclusion. The *gram panchyat* of course has the advantage of being integrated with government and may be concerned with more than one watershed. It should play an important role in the governance of watersheds and in post-project support.

Both at the outset and post-program, support is needed to enhance the ability of institutions to operate and evolve and to generate and manage finance. With a phased approach, community–based organisations (CBO) can evolve from user and SHGs into a watershed committee, a common interest group (CIG), federation and even a resource centre. Federations of local organizations seem to have the best links with the technical line departments which operate at cluster level. Institutional arrangements, which provide a location at which information and knowledge is accessed, have also proved invaluable.

Self-help groups may or may not be land based but where they are landless, they have tended to dissolve after the generation of employment once watershed implementation has ceased. The performance and sustainability of watersheds might be substantially improved by strengthening and supporting small area groups (AGs) in place of user groups (UGs).

When inputs and other things have been given free, only a small proportion of the community get them and these are often the ones who are able to pay. This should be the case with the money put into the watershed development fund or a revolving fund.

We are conscious of policy makers being pulled in several directions at once. In general, we see advantage in reducing the number of government policies and schemes and institutions and to concentrate on the pragmatics of execution and reducing the conflicts of interest caused by different agencies operating on watershed areas. An example here would be small dam and tank construction independent of the watershed plan.

How this convergence is best achieved is a moot question but there are clear opportunities to use watershed programs to improve co-ordination between government agencies and programs. The efficient and equitable management of surface, ground and drinking water and of sanitation requires the various agencies concerned to plan and interface for common purpose and help

establish community institutions which manage water, and water and energy policies which regulate groundwater exploitation. Programs dealing with employment, literacy, numeracy, child care and nutrition would similarly benefit from joint planning and execution. If the macro watershed becomes the common implementing unit, then this should make co-ordination easier and promote easier inter-village collaboration and the evolution of apex institutions.

Watershed implementing institutions need to change their perception of watershed work from the current focus on agricultural production to a fully-integrated development of human and natural resources, and strengthen their understanding of objectives, their capacity to attain them and their ability to access, experiment with and disseminate multi-disciplinary information and to undertake M&E. National and state consortia of agencies from research and development, civil society and the private sector would help in this, as would engaging service providers of capacity building, technical backstopping, knowledge dissemination and program evaluation. Local specialists, termed para-workers or barefoot doctors, have repeatedly proven their worth. They often develop into influential members of the community, and should be seen as an important component of this work.

Finally, the initial capacity building, collection of baseline information, and preparatory work all take time and we recommend the implementation period be extended from five years to seven or eight years.

The Haryali Guidelines have introduced complications as many watershed programs are implemented by credible NGOs, whereas Haryali operates through village panchayat government and district institutions. Recent common watershed guidelines from NRAA have corrected this and good NGOs involvement for implementing watersheds is recommended.

Monitoring and Evaluation

The Comprehensive Assessment has identified a weakness in the current M&E of watershed programs and opportunity to improve the feedback of information, which government can use at a macro scale to inform itself of the progress with this major budget item, and which implementers of watershed programs may use in their work.

A major problem with the assessment was the lack of uniformity in what was being measured. The concept and practice of watersheds evolved over the years, and most especially over the last five years, that evaluators are chasing a moving target. Apart from this, different sponsoring ministries have different objectives. Clearly, a more standardized approach with common objectives would overcome this.

There is a profound lack of baseline data against which progress can be monitored. A few monitoring stations exist in each agro-ecological zone but baselines need to concern social as well as physical attributes and an assessment of the total environmental and socio-economic impacts needs to be taken rather than the current focus on income, productivity, water enhancement, and employment generation. It also means the inclusion of qualitative parameters.

There are spatial and time scale dimensions too. Our recommendation to increase the size of management unit to the macro watershed will have M&E implications. The spread of benefits beyond the watershed also needs to be observed. There would be great value in a sequence of 'photographs' of what is going on: mid term, immediately after project completion and then beyond this. In monitoring hydrological and environmental quality, for example, it may take ten to fifteen years to observe effects.

Any improvements to this state of affairs need to be pragmatic i.e. expenditure should be proportional and cost effective, and the data collected commensurate with what will serve the purpose and can realistically be analyzed. Essentially, this means only a few indicators need to be tracked, some by participatory methods and process monitoring of a random selection of watersheds to support the more usual practices.

Indicators must relate to program objectives and would therefore embrace access to drinking water, increases in food production and incomes, reduction in drudgery, improvements in soil and biomass, groundwater and sanitation, confidence in the community and awareness of what is going on, skills acquisition, the effect on migration. In each district, one or two representative watersheds should be monitored for runoff, soil and nutrient loss, water quality, carbon sequestration and other parameters. Monitoring hydrological and environmental data at selected benchmark watersheds for each agroeco-region is essential and needs adequate financial support. This will provide essential data needed for more cost-effective and sustainable watershed development.

There is clearly a role for high science too. Advances in remote sensing (RS) and GIS have brought down the costs of these products but remaining access problems and shortage of skilled staff may limit their use for the moment to key areas rather than having them deployed in every village. Information technology provides an opportunity for rapid feedback and analysis and to share the results with the community. Simulation modeling also will help in making a preparatory M&E work that would be part and parcel of watershed selection since the criteria to select watersheds must be based on technical, social and pragmatic concerns. Some of the concerns are the social mix and dimensions of poverty, the availability of drinking water, the willingness of the community to work with a watershed program and their prior agreement to do or not to do certain things. Broad assessment is useful, especially across different agroecologies in areas where there has been sustained implementation of best practice and a large proportion of watersheds treated within a sub-basin.

So important is the need to improve matters that we recommend additional funds and that release of funds be contingent upon some mandatory and preparatory M&E action.

Recommendations

Watershed Policies and Guidelines

1. To enhance the impact of watershed program, government needs to unify its effort around a new paradigm, shifting the objectives from merely drought-proofing and agricultural production to sustainably increasing agricultural productivity, reducing poverty, protecting the environment, and building human and natural resource resilience to cope with future challenges, including climate change.
2. The key-strategies required are the fully-integrated development of human and natural resources, coordinating the programs of different ministries and agencies with common guidelines, single and effective national and state mechanism, making better use of technology and moving from a subsistence to a business model by establishing market links and public-private partnerships.
3. To help meet the national goal to conserve, manage and efficiently use scarce water resources, watersheds need to be recognized as the most appropriate framework in which various agencies concerned with surface, ground and drinking water and sanitation can interface for a common purpose. This requires joint planning within an enabling framework of macro-policies and market

incentives, and building watershed institutions to manage water, especially by community institutions.

4. Macro watersheds of 1,200 ha and above have achieved impacts more effectively than micro-watersheds of 500 ha. Thus, clusters of, say, six micro-watersheds together need to be the operational development unit. This can be done without by-passing social and administrative concerns.
5. Many implementers of watershed program lack full understanding of objectives and a capacity for attaining them. Knowledge and information flows are also weak. There needs to be effort at national and state levels to address these issues. Firstly, we recommend the establishment of consortia comprising the key research and development institutions, civil society organizations and private sector. Secondly, the engagement of quality service providers to augment what can be achieved by individual programs in capacity building, technical backstopping, and knowledge dissemination for improving performance. Finally, the initial capacity building, collection of baseline information, and preparatory work all take time and we recommend the implementation period be extended from five years to seven or eight years.
6. The current approach which uses subsidy-based entry points conveys to the community an incorrect impression of project goals. The strategy should be to build self-sufficiency within the community and this is best achieved by starting with knowledge-based activities that deliver immediate tangible economic benefits, and thereby, capturing the attention and enthusiasm of the community, and resulting in collective action.
7. The current funding of watershed program is insufficient to effectively embrace social, environmental, and sustainability objectives. The performance of watersheds would be greatly improved by attending to the following aspects of funding:
    - to augment the allocation for the capacity development of primary stakeholders and for pro-poor technologies that enhances the productivity of small and marginal farmers
    - to provide new funds for income-generating activities for landless and vulnerable groups; development of common property resources, post-project institutional support, and technical backstopping and strategic research
    - to ensure timely release and flexibility to meet location specific needs
    - to provide central and district resources for monitoring and evaluation, including for the application of new science tools.

We recommend a sum of Rs. 20,000/- hectare for integrated watershed development.

8. In order to effectively deal with sustained income generation, capacity building, monitoring, and technology generation and extending treatment coverage throughout each watershed, additional funds will be required. These may not entirely be new money but can be sourced from:
    - various cost savings identified for project implementation
    - money disparately spent by various government agencies
    - the mobilization of private sector, community contributions, and institutional finance.

Whatever the source, we believe a sum of about Rs. 20,000 per ha is required to effectively enhance the impact of watershed programs.

Institutional Arrangements

9. The project implementation agency and *panchayati raj* institutions, particularly the gram sabhas, should have clearer roles and responsibilities. *Panchayati raj* institutions should play an important role in the governance of watersheds and in post project support.
10. The performance and sustainability of watersheds can be substantially improved by exploring the option of strengthening and supporting user groups based on secondary and tertiary drainag lines and common interests in the watershed in their planning and execution.

Monitoring and Evaluation

11. Mid-term evaluation, impact assessment after program completion and post-project evaluation after four to five years will enable implementing agencies to make mid-course corrections and governments to adjust policy. M&E information should be put in the public domain.
12. Clearly, government should be able to access accurate impact information for the large sums of money spent on watershed programs. We recommend an assessment be made that takes into account of total environmental and socio-economic impacts rather than the current focus on income, productivity, water enhancement, and employment generation. Such a broad assessment would best be conducted across different areas where there has been sustained implementation of best practice and a large proportion of watersheds treated within a sub-basin. The work could be augmented by simulation modeling.
13. Baseline information and needs-assessment in uniform format must be undertaken before funds for works are released. Further, only limited numbers of separate, tangible and easily measurable indicators need to be tracked and concurrent participatory monitoring, resource mapping and social audit will enhance transparency and equity. Government may wish to make all this mandatory, use certified and independent agencies and assess the role of GIS, remote sensing and simulation modeling for various aspects of the work.
14. Cost-effective and sustainable watershed development needs hydrological and environmental data from benchmark watersheds in each agroecoregion and district. This will also enable an assessment of impacts outside the watersheds. Such work needs adequate financial support.

Technology

15. Different agroecoregions vary in their biophysical potential, constraints, opportunities and socioeconomic conditions for agricultural development. Although, watershed approaches seem to have universal application for effective management of natural resources, sustainable agricultural production and income generation, the Comprehensive Assessment showed greatest impacts in the region with 700-1100 mm of annual rainfall. Clearly, more suitable agro-technologies and interventions need to be developed for the higher and lower rainfall regions.
16. The Comprehensive Assessment has identified a range of best-bet options, some of which offer the opportunity for major and widespread impact on poverty reduction, environmental improvement, agricultural productivity and resilience. These include:
    - cost-efficient water harvesting structures
    - *in-situ* moisture conservation measures
    - increased availability and adoption of improved cultivars

- efficient use of limited water for supplementary irrigation
- rehabilitating wastelands/common property resources (CPRs) through community participation
- reduced use of pesticides with integrated pest and disease management

Wide promotion and dissemination of these technologies will require that all project implementation agencies are made aware of them.

17. Widespread deficiencies of secondary and micro-nutrients are severely holding back crop productivity and effcient use of water. At a stroke, government could increase crop yields by 30-80% with an initiative to diagnose soil health in rain-fed areas and apply appropriate remediation.
18. There is a need to build capacity within the research establishment to undertake effective technology development for poor people. This requires specific financial allocation, change in mindsets, multi-disciplinary teams with participatory skills and the involvement of poor people from the outset for identifying their particular needs.
19. Current agricultural extension does not fulfill the growing need for information for rain-fed farmers and the poor. We recommend extending government's 'emphasis on Information and Communication Technology (ICT)' for the rapid transfer of appropriate information to the various stakeholders within a watershed and link farmers to markets.
20. To date, water policy has focused on augmentation of supply, but this now needs to be expanded to embrace water demand management and water use efficiency. There are a number of aspects:
    - watershed programs should prioritize drinking water needs, put them as indicators of success and ensure equitable access to the water supplies to the poor
    - devise and implement policies to regulate groundwater extraction by individuals and promote participatory monitoring and management of all water resources in the watersheds
    - ban the cultivation of high water requiring crops such as paddy and sugarcane in watershed areas
    - encourage cultivation of low-water requiring crops with market incentives
    - promote efficient irrigation methods through water-saving devices and the creation of community-based water assets.
21. Advances in weather forecasting have created opportunities to reduce farming risks and mitigate the effects of climate change. The use of long-range weather forecasts for crop planning and of medium and short-range weather forecasts for crop management should become the norm.

Gender and Vulnerable Groups

22. Equity and gender concerns regarding women, the resource-less and those without adequate representation need to be brought to the forefront of watershed planning and execution. There are clear opportunities to strengthen policy statements to address this issue as follows:
    - emphasis on women's active participation should start right from the beginning rather than as an add-on, with increased clarity among watershed staff about the objective
    - gender concerns should form non-negotiable components of the initial phase and also in the monitoring framework through out the project cycle

- adequate representation of women and vulnerable groups in decision-making committees, targeted interventions, institutional support and financial allocations all need to be integral to the watershed program.

23. Common property resources can effectively be regenerated as pasture, biofuel, and energy plantations, and can be used to generate income when managed by vulnerable groups. This requires long-term leases, usufruct rights, and financial allocation for development, which may need to last beyond project period.
24. New income and market opportunities are emerging with watershed interventions. These need to be channelized to benefit vulnerable groups. This calls for a comprehensive support for capacity building, credit and market links through increased and clearly defined financial allocations.
25. Once again, there are clear opportunities to use watershed programs for improving co-ordination among government programs dealing with employment, literacy and numeracy, sanitation, child care and nutrition.

2. Context

Holistic development of the rain-fed areas is one of the prime concerns of the Government of India (GoI). In order to meet the Millennium Development Goal (MDG) of reducing number of 221 million poor people by half and to achieve inclusive growth to reduce migration of rural poor to cities in search of livelihoods, GoI is emphasizing development of rain-fed areas in the country. In addition, it was estimated by International Water Management Institute (IWMI), Colombo, Sri Lanka, that by 2025, one third of developing countries including 50% of poor residing in India will be facing physical scarcity of water resources (Molden et al. 2007).

Degradation of land resources due to water erosion, wind erosion, nutrient depletion and accumulation of salts and other toxic elements, water logging and loss of biodiversity is reaching alarming levels in India. About 60% of total arable land (142 million ha) in the country is rain-fed, characterized by low productivity, low income, low employment with high incidence of poverty and a bulk of fragile and marginal land. Rain-fed agriculture is complex, diverse and risk-prone and is characterized by low levels of productivity and low input usage. These areas witness acute moisture stress during critical stages of crop production, which make agriculture production vulnerable to pre and post production risks. Development of watersheds/catchment is one of the most trusted and eco-friendly approach to manage rainwater and other natural resources, which has paid rich dividends in the rain-fed areas and is capable of addressing many natural, social and environmental intricacies (Samra 1998, Wani et al. 2002, 2003 a, b, Rockstorm et al. 2007). Management of natural resources at catchment/watershed scale produced multiple benefits in terms of increasing food production, improving livelihoods, protecting environment, addressing gender and equity issues along with biodiversity concerns (Rockstorm et al. 2007, Wani et al. 2003).

Watershed development programs are therefore, considered as an effective tool for addressing multiple problems (land degradation, water scarcity, environment protection, low agricultural productivity, poverty, migration from rural areas and development of social and human capitals) and are recognized as a potential engine for agricultural growth and development in fragile and marginal rain-fed areas (Joshi et al. 2005). The Government of India has accorded high priority to the holistic and sustainable development of rain-fed areas through the integrated watershed development program since the 7th Five Year Plan (1985-90). A number of watershed programs have been specifically launched in the rain-fed areas with the sole objective to improve the livelihood of poor rural households in a sustainable manner.

2.1 Watershed Program in India - Status

India gives considerable emphasis on augmentation of water resources by encouraging community watershed projects. Majority of watershed development projects in the country are sponsored and implemented by the Government of India with the help of various state departments, non-governmental organizations (NGOs), self-help groups (SHGs), etc. River Valley Project (RVP) and Flood Prone Region (FPR), Drought-Prone Area Program (DPAP), Desert Development Program (DDP), National Watershed Development Project for Rain-fed Area (NWDPRA), Watershed Development in Shifting Cultivation Areas (WDSCA), Integrated Watershed Development Project (IWDP) are some of the important development programs that plan, fund and implement watershed development projects. A total sum of US$ 6 billion has been invested till 2006 on various watershed development projects since the inception of watershed development programs in the country. Several international organizations such as Department for International Development (DFID), Duetsche

Gesellschaft for Technische Zusammenarbeit (GTZ), Swiss Agency for Development and Cooperation (SDC), The World Bank (WB), International Fund for Agricultural Development (IFAD) also sponsor and implement watershed development projects but a significant proportion (about 70%) of the investment in watershed development programs is being made by the Government of India.

a. Policies

The Government of India attaches very high importance to the watershed development as it is reckoned as the engine of growth for sustainable development in the rain-fed and drought-prone areas. The watershed development program enjoys good policy support from the central and state governments in the country. Several programs were launched to target watershed development with a focus to improve food security, alleviate poverty and sustain the quality of the natural resource base. This section covers some important policies and programs launched by the Central Government that affect the success of the watershed programs. The most important policies and guidelines including the National Agricultural Policy, Water Policy, Land Policy, Forest Policy and the Watershed Development Guidelines are highlighted.

Agricultural Development Policy

The new agricultural policy provides a national guideline for addressing wide-ranging problems of the agricultural sector. It targets an inclusive agricultural growth rate in excess of 4% over the next two decades. The watershed management approach has been identified as a major intervention strategy for integrated and holistic development of the rain-fed areas and the policy accorded considerable emphasis on strengthening the watershed development programs. It also attempts to intensify integrated and holistic development of rain-fed areas by conservation of rainwater by vegetative measures on watershed basis and augmentation of biomass production through agro and farm forestry with the involvement of the watershed community. All spatial components of a watershed, ie, arable land, non-arable and drainage lines, will be treated as one geo-hydrological entity. Management of grazing lands will receive greater attention for augmenting availability of animal feed and fodder. A long-term perspective plan for sustainable rain-fed agriculture through watershed approach will be vigorously pursued for development of two thirds of India's cropped area which is dependent on rains" (Government of India, 2000b).The policy defined at the national level is very conducive and favorable to watershed development. Its implementation may, however, depend on the capacity at the state and local levels.

Water Policy

The National Water Policy recognizes that "water is a scare and precious national resource to be planned, developed, conserved and managed". It identifies water management as one of the most crucial elements in the development planning of the country. The policy intends to promote watershed management through extensive soil conservation, catchments-area treatment, preservation of forests and increasing the forest cover and the construction of check-dams. It clearly suggests that efforts shall be made to conserve water in the catchments (Government of India, 2002). The policy recognizes the problems of drought-prone areas and suggests to cope with the drought through soil-moisture conservation measures, water harvesting practices, minimization of evaporation losses, development of the groundwater potential. Pastures, forestry or other modes of development, which are relatively

less water demanding should be encouraged. The needs of the drought-prone areas should be given priority while planning water resource development projects.

'Vision for Integrated Water Resources Development and Management' by the Ministry of Water Resources, Government of India, also stresses the need for rainwater harvesting, preventing soil erosion, providing sustainable irrigation and mitigating the problem of drinking water. The action plan set to accomplish rainwater harvesting is to support non-governmental efforts in rainwater harvesting both financially and technically (Government of India 2003). Similar thrust has been given by various state governments in their respective 'Vision 2020' documents, implying that watershed programs would receive high priority for conserving rainwater, preventing soil erosion, and overcoming vulnerability of the poor in the rain-fed areas. These policies clearly demonstrate the commitment of national and state governments for the development of rain-fed areas through watershed management. The missing elements in these policies are related to the lack of clarity on the rights to surface water and groundwater and incomplete recognition of the rights of communities to manage water resources through collective action.

Land Policy

Land reforms, land ceilings and restrictions to sell agricultural land were the important policy decisions taken at the national level. The purpose of land reform was to abolish tenancy, give land rights to the tiller and consolidate the fragmented lands. The aim was to protect the interest of the farming community and landless laborers. Similarly, the Agricultural Land Ceiling Act was passed to protect the interest of small and marginal farmers. The purpose was to discourage large farmers, who because of their economic and social power, accumulate land and exploit the small and marginal farmers, and thus bring social justice and equity in land distribution. Another important policy decision was to restrict the sale of agricultural land. Due to urbanization and industrialization, the agricultural lands are targeted. In the absence of such policy, the investments made for land improvement under the watershed programs in areas where the non-agricultural demand for land is high, may be in vain.

In spite of all these sincere efforts, about 82% of landholdings in India are of less than 2ha with an average size of 1.1ha. Small and fragmented landholdings are one of the major obstacles to enhance private investment in watershed programs. The small and fragmented holdings make it difficult for the farming community to make investments on land improvements and discourage planting high-value crops, which need intensive care and protection. Land consolidation encourages investment on land improvements due to economies of scale and reduces cost of protection. The watershed development programs provide opportunities to small and marginal farmers for collective action that allows a consistent treatment of adjoining pieces of land and reduces costs due to economies of scale. Future land policies need to discourage further decline in landholdings and their fragmentation.

Forest Policy

As such, the National Forest Policy does not mention watershed development as a strategy for enhancing land cover or rehabilitate degraded ecosystems, but its objectives and strategies are by and large consistent with those of the watershed development programs. The key objectives of the forest policy that are relevant to the watershed programs include: (i) maintenance of environment stability through preservation and, where necessary, restoration of ecological balance that has been adversely disturbed by serious depletion of the forests; (ii) prevent soil erosion and denudation in the catchment areas of rivers, lakes and reservoirs in the interest of soil and water conservation for mitigating floods

and drought and for reducing siltation of reservoirs; (iii) control further problem of sand dunes in the desert areas of Rajasthan and along the coastal tracts; (iv) expand the forest/tree cover in the country through massive afforestation and social forestry programs; (v) meet the growing demand of fuel-wood, fodder, minor forest produce and small timber of the rural population; and (vi) make the afforestation programs a people's movement with the involvement of women. Today, these could be viewed as integral components of watershed development programs. It is to be noted that one of the intervention points of watershed development is to rehabilitate, conserve and manage degraded lands, and augment production of fuel and fodder through community participation. This goal is commonly shared with the forest policy of the country. More and better integration of the forest policy with the watershed management approach is expected to enhance the synergy and complementarity of the two approaches. It is generally felt that with better integration of forest policies, watershed programs impact can be substantially enhanced by treatment of upper catchments which are under forest and current compartmentalization does not result in adoption of ridge to valley treatment approach. One important mechanism for implementing the National Forest Policy in the dryland areas is through the watershed development programs.

Since land laws are governed by the state governments, the policy document mentioned that these land laws need to be modified to facilitate and motivate people and institutions to undertake tree-farming and grow fodder plants, grasses and legumes on their own land. It emphasized that degraded lands should be made available for this purpose either on lease or based on the land grant rules. Appropriate regulations should govern the felling of trees on private holding.

b. Watershed Development Guidelines

Several government departments and state governments took up watershed development programs. Until 1997, watershed development projects have been taken up under different programs launched by the Government of India. Notably, the Drought Prone Area program (DPAP), and the Desert Development program (DDP) adopted the watershed approach in 1987. The Integrated Watershed Development Projects initiated by the National Wasteland Development Board in 1989 also aimed at developing wastelands based on the concept of integrated watershed development. Since their inception, these programs were taken up by the Ministry of Rural Development. The other major program based on the watershed concept is the National Watershed Development program in Rain-fed Areas (NWDPRA) under the Ministry of Agriculture. All these programs had their own guidelines, norms, funding patterns and technical components based on their respective and specific aims (Government of India 1994). In 1994, the Ministry of Rural Development issued a new comprehensive guideline for all its projects. It was realized that while the focus of these programs may have differed, the common objective of these programs has been land and water resource management for sustainable production. Therefore, common guidelines for all the programs under the Ministry of Rural Development were developed in 1994 and have been implemented since 1995. These guidelines were used by the central-sponsored schemes for the watershed development under the Ministry of Rural Development and the Ministry of Agriculture. Based on the common principles the Ministry of Agriculture developed a new guideline in 1997 for implementation of NWDPRA.

The 1994 guidelines provide special emphasis to improve the economic and social conditions of the resource-poor and the disadvantaged sections of the watershed community:

- more equitable distribution of the benefits of land and water resources development and the consequent biomass production, and greater access to income generation opportunities and focus on farm resource development
- participating villages should be selected based on the community's willingness to provide voluntary contribution and take over management of the assets created through the project when the project activities cease
- at least 5% of the cost of investment should come from the village community or *panchayat* or users, who are likely to derive the benefits of such investments.
- at least 10% of the cost of investment on individual works on private property must come from the beneficiary users (5% for schedule castes, schedule tribes and people below poverty line).

In each selected village, a watershed of approximately 500 ha was to be identified and selected by the watershed development team (WDT) in consultation with the *panchayat*/village community. The area can be increased or decreased subject to the condition that the project implementing agency (PIA) handles a total area of 5000 to 6200 ha. If a small part of the watershed is outside the village boundary, it may be taken up for development with the consent of the neighboring village/*panchayat*. Other criteria of selecting the watershed area are:

- the area has acute shortage of drinking water
- large population of schedule castes and schedule tribes depend on it
- preponderance of wastelands and common lands
- actual wages are significantly lower than minimum wages
- contiguous to another watershed, which has already been developed.

Depending upon the ecosystem and major problems faced by different districts/blocks, each watershed development project was eligible for funds. The amount was to be divided amongst the different project components subject to the pre-decided ceiling. The funds are released in installments with 25% of the project outlay released in the first year, 40% in the second year, 25% in the third year, and the remaining 10% in the fourth year. Every year the funds are released in two installments. After the first installment, the disbursement is dependent on 50% utilization of the funds released earlier. During the first year, 15% of the funds are released to the PIA at 3% for administrative costs, 3% for training, 4% for community organization and 5% for development works.

The guidelines also specify different training activities for the WDT. The important one is the training program for one-month of four modules of one week each. The four modules are:

1. watershed treatment technologies and alternate land uses with emphasis on low-cost structure, vegetative barriers, farmers' innovations and production technologies
2. participatory rural appraisal methods and community organization techniques, group behavior and convergence of services
3. project management tools and techniques
4. administrative and accounting procedures, measurement and recording procedures, inspection and audit, computerization and report writing, etc.

Common Guidelines

The 1994 guidelines of the Ministry of Rural Development were in operation for five years. This period has seen many successes as well as some failures in watershed development. Hence, greater flexibility of the guidelines was essential to enhance the robustness of the response to the regionally differentiated demands that characterize rural India. Since different ministries were involved in the watershed development, it was decided to develop common guidelines. The 1994 guidelines were instrumental for developing the common guidelines. The Ministries of Agriculture and Rural Development jointly developed the 'Common Approach/Principles for Watershed Development' in 2000 (Government of India, 2000a). The two ministries and Ministry of Forest and Environment then adopted these guidelines as common principles for implementation of watershed development projects.

The Ministry of Agriculture brought out the new guidelines based on the 'Common Approach' in 2000 as 'WARSA – Jan Sahbhagita', Guidelines for National Watershed Development Project for Rain-fed Areas (Government of India, 2000). A similar document of revised guidelines (Guidelines for Watershed Development) based on the common principles was also issued by the Ministry of Rural Development (Government of India, 2001a). The new guidelines give more flexibility that was needed at village/watershed level. These guidelines, inter alia, envisage the convergence of different programs of the Ministry of Rural Development, Ministry of Agriculture and other ministries and departments. Following the 73rd and 74th Amendments to the Constitution of India in early 1990s, the *panchayati raj* institutions (PRIs) are mandated with enlarged role in the implementation of developmental programs at the grass-root level, and accordingly their role has been more clearly brought out. The new guidelines also emphasize specific and focused project with destination, roadmap and milestones. The 1994 guidelines were made more flexible, and workable with more participation of the community. The new guidelines provide more emphasis on local capacity building through various training activities and empowering community organizations.

The new guidelines also specify detailed criteria for selection of watershed villages, which include participatory rural appraisal exercise, preparation of strategic plan for watershed development, demand-driven approach, withdrawal strategy by PIA/WDT, and mechanism for allocation of watershed budget. Approximately Rs. 2.25 million and Rs. 3.0 million are allocated to a watershed of 500 ha with less than 8% and more than 8% slope, respectively, for a period of four years. A broad allocation of funds based on the 2000 Common Approach is for major components.

Another most important feature of the new guidelines is the development criteria for success of the watershed. Among others, the exit protocol for the PIAs is developed. One can easily rate the watershed based on the criteria developed under the guidelines.

From Hariyali to Neeranchal

The recent report 'From Hariyali to Neeranchal', generally referred as Parthasarthy Committee Report of the Technical Committee on Watershed programs in India, constituted by the Ministry of Rural development suggested changes in guidelines on various aspects of watershed development.

Institutional Arrangements for Watershed Development

The watershed development guidelines and approaches which evolved since the early 1990s have clearly articulated the need for different institutional arrangements from the community to district

and state levels. A number of institutions have therefore been conceived and established at different levels. Besides creating new institutions, existing institutional arrangements are also used for facilitating participation of the people. The PRIs (eg, the rural local bodies), women's groups, youth groups and cooperative societies that already existed before project implementation are also used as platforms for discussion of needs related to the watershed development program. The PRIs should play an important role in the implementation of watershed development, as the recently adopted 73rd Constitutional Amendment Act strengthened their position to plan and manage rural development activities (including watershed management, agriculture, forestry, fuel and fodder and the maintenance of community assets). The following institutions are generally found at the district and village levels in both government as well as non-government approaches to watershed management in the country. These institutions are created based on the provisions of the Common Approach and Principles for Watershed Management, jointly conceived and developed by the Ministries of Agriculture and Rural Development.

Self-Help Groups

Self-help groups (SHGs) usually are homogeneous groups consisting largely of landless individuals with common or similar sources of income such as animal husbandry, goat rearing, poultry and agricultural labor. These are more often women's groups having 15–30 members in each group. The primary activity of these groups is thrift and credit. Under the watershed guidelines, a revolving fund of Rs 50000 (for a period of four years) is allocated to each watershed project for supporting the SHG members to scale-up their activities or to invest in productive assets for increasing incomes.

c. Achievements

As per reports of Working Group on Natural Resource Management for the 11th Five Year Plan constituted by the Planning Commission, New Delhi, an area of 50.89 million ha have been developed since inception upto end of 10th Five Year plan with an expenditure of Rs 19251 crores through implementation of various national level and externally aided watershed development projects (Table 1). As per the estimate of the Working Group on Watershed Development, Rain-fed Farming and Natural Resource Management for the 10th Five Year Plan, 88.5 million hectares are wasteland including rain-fed areas and these need development. It is obvious that still 38 million hectares of land is remaining for the development. Government of India through 11th Five Year Plan (2007-12) hopes to treat the 38 million hectares of wasteland by utilizing about Rs. 360 billion (GoI, 2007).

d. Dilemmas

There is always a strong trade off between high growth and sustainability of natural resources. As a civilized society this is our moral response to conserve, protect and pass on these intergenerational equity to the generations to come. Moreover, the increasing environmental concerns have also brought the issues of sustainability to the forefront. Ensuring resource use efficiency is imperative to utilize the scarce and vulnerable natural resources to achieve sustainable growth in the rain-fed areas.

Area : lakh hectares
Expenditure: Rs. in crore

Table 1. Physical and financial progress under various watershed development programs

Sl	Ministry/Scheme and year of start	Progress since inception upto IXth Plan		Progress in Xth Plan* 2002-07		Total since inception upto Xth Plan*	
		Area	Exp.	Area	Exp.	Area	Exp.
A.	Ministry of Agriculture (Department of Agriculture & Cooperation)						
	NWDPRA (1990-91)	69.79	1877.74	23.30	1147.82	93.09	3025.56
	RVP&FPR (1962 & 1981)	54.88	1516.26	9.98	727.98	64.86	2244.24
	WDPSCA (1974-75)	2.58	166.27	1.35	129.31	3.93	295.58
	RAS (1985-86)	5.81	76.39	1.30	45.35	7.11	121.74
	WDF (1999-00)	0.00	0.00	0.59	26.02	0.59	26.04
	EAPS	13.35	2039.81	4.80	1927.54	18.15	3967.35
	Sub-total	146.41	5676.47	41.32	4004.02	187.73	9680.49
B.	Ministry of Rural Development (Department of Land Resources)						
	DPAP (1973-74)	68.95	3284.74	68.32	1557.76	137.27	4842.50
	DDP (1977-78)	33.56	797.38	45.17	1152.50	78.73	1949.88
	IWDP (1988-89)	37.34	616.51	62.22	1821.64	99.56	2438.15
	EAPs	1.40	18.39	3.60	274.28	5.00	292.67
	Sub-total	141.25	4713.02	179.31	4806.18	320.56	9523.20
C.	Ministry of Environment and Forest						
	NAEP (1989-90)	0.70	47.53	0.00	0.00	0.70	47.53
	Total (A+B+C)	288.36	10441.02	220.63	8810.20	508.99	19251.22

* Includes tentative achievement of 2006-07.
Source: GOI. 2007. Report of the Working Group on Natural Resource Management, Vol. 1, Planning Commission of India.

e. Evolution of Watershed Concept

During last three decades, watershed programs have gone through a sea change. A number of modifications have been made in the watershed programs based on experiences and learnings from the implementation of different generation watershed programs. The first generation watershed programs were mainly designed for soil conservation whereas the second generation watershed programs aimed at conserving degraded land area or more specifically soils (Joshi et al. 2004). The integrated watershed development approach was adopted during mid 1980s and in early 1990s third generation watershed programs were introduced that emphasized on participatory approach. The new approach focuses on raising crop productivity and full livelihood improvement programs (Wani et al. 2006). These newly developed approaches like livelihood improvement and productivity enhancement are fairly superior to the earlier approaches but still a large number of watershed programs are yet to be graduated into holistic/integrated programs.

During evolution of watershed development programs (from compartmental to holistic) the processes and institutional arrangements also evolved. The Government of India revised the watershed guidelines and emphasized more on collective action and community participation including of primary stakeholders of community-based organizations (CBOs), non-governmental organizations (NGOs) and *panchayat raj* institutions (PRIs).

Despite, sustainability of a watershed intervention, continuation of watershed program after its withdrawal has always been a big question. Often it is seen that after withdrawal of project support the watershed developments are not looked after maintained, resulting in neglect and damage of structures and other initiatives also are not sustained in the absence of continuation of watershed activities by the beneficiaries. Negligence or inappropriate maintenance of watershed structures in absence of adequate funding instigate the reversal process and all the benefits accrued to the society get eroded overtime. It is, therefore, important to evolve mechanisms for building resilience of the CBOs to cope with the future changes including due to climate change in the watershed programs. This could be achieved by allocating additional funding as well as empowering *panchayat raj* institutions to undertake and continue these activities once the project is over. This objective can also be achieved by involving private sector in the watershed program implementation, which is emerging in many areas.

2.2 Problem Statement

a. Capacity Building of Local Institutions and Communities for Watershed Implementation

The weakest link in all watershed programs is sharing the knowledge with all the stakeholders and capacity development. To some extent, existing approaches are unable to address these issues adequately. It is important that various stakeholders of the watershed be developed as a human capital by building capacity through adequate functional training or knowledge sharing with the help of modern information and communication-based technologies (ICT) so that they may be able to undertake different activities and deliver output in a more efficient way. A consortium of technical backstopping at national and state levels will definitely be helpful in this direction. These trained personnel will be able to address their problem in a more effective manner and this will increase the performance of watershed programs.

b. More Effective Use of Technology

A number of technologies are there which can be helpful in increasing the performance of watersheds. However, evidence on use of such technologies for watersheds is rare. Many of these technologies are quite efficient and cost effective after an initial investment. There is an urgent need to promote more effective use of such technologies. Several technologies are there that can be used for planning, monitoring and implementation of watershed projects. For instance, geographical information system (GIS) and remote sensing can be used for the benchmark characterization along with for demarcation of watersheds and then effective concurrent monitoring of the natural resource-base. ICT-based technologies can be effectively used in knowledge sharing, capacity building, providing information on markets, prices, and sharing of other technical know-how. Similarly use of sprinkler/ drip method of irrigation in watershed will promote the efficient use of harvested water for supplemental irrigation as well diversification with high-value crops such as vegetables and fruit trees.

c. Compartmental Approach

As reported earlier most watershed programs became synonymous with rainwater harvesting structures and soil conservation measures and never graduated to holistic approach. The compartmental approach also could not address the sharing of benefits among the communities from the soil water conservation measures. The approach adopted in watersheds bypassed a large number of beneficiaries and skewed towards landed in general and well-to-do big farmers in particular. The augmented water availability in the watershed through soil conservation structures benefitted resource rich farmers, who can invest in bore wells and other sources. It also resulted in low water use efficiency, low productivity and low incomes resulting in lower and poor quality community participation.

d. Water Management and Productivity

Water is critical to agricultural production. It is obvious from the fact that the Green Revolution could only occur in the irrigated tracts of the country. Most of the rain-fed areas failed to witness the same level of productivity enhancement as the irrigated regions. So far the publicly funded surface irrigation and privately developed groundwater irrigation have been the main sources of irrigation. It has helped country to sail through a state of hunger to self-sufficiency. But the water productivity remains always low, and returns to public investment, specially in large-scale irrigations remains unsatisfactory. New solutions are needed, based on new management options. How to meet ever rising demand for food while at the same time increasing farmers incomes, reducing poverty, protecting the environment, all from an increasingly constrained water resource base, are the main challenge facing agricultural water management (The World Bank….Reengaging in Agril. Waters Management: Challenges and options).

It is believed that the strong demographic push to food demand will continue in future also. For the developing countries, food self-sufficiency ratio is expected to decline from 91 to 86% , and their food trade balance is expected to turn sharply negative (US$50 billion annually by 2030). The estimates further show that over 40% of the extra food will have to come from intensified rain-fed farming. And therefore, the growing water scarcity will have to be managed.

The appropriate water management is necessary to enhance the productivities of food grains, especially cereals by 40% by 2025 from the productivity level of 2002 (IFPRI/IWMI, 2002). Water remains a key element there. Therefore, a more integrated and comprehensive water management approach is required to augment the productivity with the help of judicious and efficient use of scarce water resources of the country. Nonetheless, *in-situ* moisture conservation and water harvesting will become a compulsion and this will increase the role of watershed programs by many fold.

2.3 Strengths Compared with other Government Programs

Watershed programs are considered as growth engines for agriculture development in dryland areas and have the potential to achieve inclusive growth. The rural livelihoods are dependent of natural resources and watershed programs deal with conservation and efficient use of soil, water, vegetation, livestock, aquatic life and most importantly, human resources and building community organizations. Watershed programs are in advantageous position over other government programs which generally address one or two components. These strengths of the watershed programs need to be harnessed fully for achieving inclusive growth in the country.

Watershed is logically manageable unit to bring significant impact in the communities. Watershed program addresses core issue of water, which becomes the starting point or foundation to build developmental activities. Hence watershed program forms the base or entry point for improving rural livelihoods or implementing poverty alleviation measures.

It is well known that investment in watershed program has resulted in multiple benefits in the villages like increasing crop productivity, improving groundwater, increasing ground cover and employment generation etc. Hence, watershed program benefits both directly and indirectly all the stake holders in the project. Watersheds are considered as envelope which is amenable for converging developmental programs to implement in the villages, because of the presence of readymade institutional arrangements, representing all sections of the communities. Hence, watershed becomes an important entity for the development as it has started addressing the rural development in holistic manner including vulnerable and marginal communities.

2.4 Importance of Rain-fed Agriculture and Watershed Management

Rain-fed systems dominate world food scenario and will continue to contribute the bulk of the world food production. There is close nexus between hunger, poverty and water, but investments in rain-fed agriculture have been neglected over the past 50 years. The comprehensive assessment concluded that water investments in rain-fed agriculture have large payoffs in yield improvements and poverty alleviation through income generation and environmental sustainability through huge social, economic and environmental paybacks (Rockstrom et al. 2007). The recommendation from comprehensive assessment of water management in agriculture is further elaborated that investments in water management are the entry point to unlock the potential in rain-fed agriculture, because upgrading rain-fed agriculture requires investments in soil, crop and farm management. Managing rainfall in farmer's fields through soil and water conservation cannot alone reduce the risk of frequent dry spells faced by the farmers in rain-fed agriculture, it requires investment and policy support for adding new fresh water through local management of rainfall and runoff. The comprehensive assessment shows that the potential of improving water productivity is particularly high in small holder rain-fed agriculture.

Farmers' Commission report under the Chairmanship of Dr MS Swaminathan highlighted the importance of rain-fed agriculture for rainbow revolution. Major recommendations emphasize the need for adoption of integrated community participatory watershed management approach, convergence of activities in the watersheds, adoption of innovative farmer participatory consortium for technical backstopping, soil health and most importantly enhancing investments in rain-fed areas from different ministries like Ministry of Agriculture, Ministry of Rural Development, Ministry of Water Resources and Ministry of Environment and Forest.

The report also highlighted the need to enhance the soil capital and insulating farmers from the risks, bridging the yield gaps by adopting existing technologies and connecting research and development initiatives in the country. Establishing national network of advanced soil testing laboratories, micro-nutrient amendment for increasing the crop yields and improving the soil health through vermicomposting, *in-situ* generation of organic matter, harvesting rainwater for supplementary irrigation and adopting integrated farming systems approach along with capacity building and knowledge sharing initiatives are some of the recommendations. Million well recharge programes, convergence and synergy of all agricultural programs around a watershed have been highlighted. Commission also recommended the watershed approach is the most appropriate one for lifting the economy of rain-fed areas in manner i.e, efficient, affordable and sustainable.

The commission has emphasized the need to adopt integrated water resources management approach for enhancing water use efficiency for reducing the poverty. Enhanced allocation of money per hacter basis for complete development of watersheds is recommended while in contrast the country is spending more than Rs. 100,000 per hacter for making water available through canal irrigation. They have also recommended that extending the duration of watershed projects beyond five years and appropriate mechanism to use the watershed maintenance and development funds which is accumulating in the country to the tune of Rs. 100 crores. While stressing the need for collective action for management of watersheds, great involvement of PRIs in the programs is also recommended.

The 11th Five Year Plan approach paper lays considerable emphasis on agriculture and agricultural growth. It is believed that for achieving double digit GDP growth, an inclusive agricultural growth rate over 4% is a prerequisite and unless rain-fed agriculture is promoted the condition will not improve. Of the country's 142 million hectares of arable land, 60% area is rain-fed where the natural resources have become vulnerable to a number of complex problems. Water is scarce. Lands are extremely eroded due to heavy soil erosion. Organic soil carbon and others micro-nutrients from the soil are depleting fast. The report of the Working Group on Natural Resource Management, constituted under the chairmanship of Dr RB Singh rightly points out that the stipulated overall GDP growth of 9% could not be achieved with the ongoing degraded and shrinking natural resources of the country (The Report of the Working Group on Natural Resource Management, 2007). The report further quotes "The business as usual will not do. NRM, particularly through watershed approach needs major adjustments and shifts in the strategies and approaches".

The Working Group on NRM suggests comprehensive integrated development of multiple resources on watershed basis and integrated crop-livestock-fish –biomass farming system based management of natural resources, specifically in rain-fed areas, both inside and outside watershed programs. The report further suggests to go for a differentiated and need-based approach with substantial investment in natural resource management in watershed programs, both in rain-fed and irrigated areas.

Report lays considerable emphasis on comprehensive management of natural resources and suggests to delineate, codify, and prioritize sub-watersheds and then prepare perspective plan at the state level. It also highlights the need for capacity building and suggests to separate capacity building phase from main implementation phase. The report recommends to consider sub-watershed as a geo-hydrological unit at PIA level and suggests that revenue village should be a management unit at community level, where Gram Panchayat should be involved in governance and the stakeholders like user groups/ self help groups play a role in execution of their own works and be accountable to gram sabha. The report further adds that panchayat should help to create durable assets in watersheds by linking the program with NREGS.

Preparation of state specific watershed guidelines to build upon the experiences and strengths, integration of small forest areas under watershed programs, community forest management rather than joint forest management and increasing the duration of watershed projects from 5 to 10 years for introducing the more comprehensive approach are the other critical and pertinent recommendation of the Working Group on NRM.

The report identifies degradation and erosion of natural resources as one of the fundamental reasons for agrarian crisis and aims to treat 38 million hectares of by utilizing about Rs 28,000 crores. The report reiterates the need for conserving genetic resources by integrating it with natural resource management.

2.5 Comprehensive Assessment and its Objectives

The overall project goal is to enhance the livelihoods of rural poor and conserve natural resources through efficient and sustainable management of watersheds development in India. Watershed programs are considered as a key to agricultural growth and development in rain-fed areas of India. Watershed programs in India have not yielded the desired impact in general. However, there are a number of bright spots where substantial impacts are recorded. Impact of watershed programs could be enhanced through comprehensive assessment of these initiatives by synthesizing the lessons and learnings from the successful projects as well as not so successful ones. By identifying the drivers of success and identifying appropriate enabling policies and institutions along with technological interventions and funding mechanisms based on critical evaluation of the watershed programs in India the benefits of watershed programs could be scaled out (Wani et al. 2004).

Comprehensive Assessment (CA) of Watershed Programs in India is a major step towards critical evaluation of the benefits (tangible and non-tangible) and impacts of the past 15 years, its challenges and possible solutions.

The specific objectives are:

- to critically assess the impact of various watershed development programs in India
- to identify the drivers of success from the bright spots in terms of targeted objectives, enabling policies and institutions contributing towards achieving greater impact
- to develop suitable institutional and technical recommendations, policy guidelines and a suitable database for sustainable and efficient management of the watershed programs.

It quests the plausible solutions on how could watershed programs be made more effective and manageable to increase agricultural productivity, help to enhance incomes and reduce poverty and protect environment for sustainable development. This comprehensive assessment deals with multiple, temporal and spatial scales, drivers of success, constraints and enabling policies and institutions.

3. Approach and Methods for Comprehensive Assessment

A multi-level assessment on the watershed programs were carried out for identifying and quantifying impacts of watershed programs in India along with the drivers of success, hindering bottlenecks/ constraints, enabling policy and institutions for potential impacts of watershed programs in the country. Biophysical and socio-economic constraints were identified from the analysis of assessment reports, which were further enriched by identification of potential and future options for improving impact of watershed programs in the country through technological interventions, convergence, policy options, institutional arrangements and funding and implementing guidelines.

The approach critically analyzed macro and micro-level studies that emerged from the watershed programs along with detailed analysis of secondary data from the published literature as well as primary data collection through detailed case studies. The study employed a consortium approach to undertake specific studies by the specialized institutions for specific issues, for e.g. policies and institutions, environmental services, agricultural productivity, social issues, collective actions, gender equity, etc. New science tools such as GIS and remote sensing methods along with well-tested conventional analytical tools were employed for undertaking representative case studies.

The comprehensive assessment (CA) is undertaken by a consortium of 14 organizations. The Ministry of Agriculture and Ministry of Rural Development, Government of India, supported ICRISAT to setup and lead the consortium to study and assess the impact of various watershed development programs in India. Other organizations in the consortium are NCAP, TNAU, WOTR, JAU, IEG. ISEC, GBPUAT, GIDR. CRIDA, CSWCRTI, SPWD, RRSSC, Bangalore (ISRO).

The approach includes:

- review of published and departmental reports.
- macro-level studies using meta analysis, regional impacts and using remote sensing.
- micro-level studies using detailed case studies from covering different agroecoregions.
- synthesis of results, study impact and identify drivers of success.
- culling out the impacts indicators, suitable technical, institutional policy and social options for achieving impact.
- compilation and development of reports, recommendations and policy briefs for achieving greater impact of watershed programs.
- identifying gaps: knowledge, technologies, governance, policies, funds, etc.

Review literature and departmental reports for assessing impact of watershed programs. The specific data and information covering benefit-cost ratio, productivity and cropping intensity, irrigation and groundwater availability, development of social, technical, human and physical capital, gender and equity issues, quantitative and qualitative impact indicators and exit strategies were analyzed and synthesized.

The detailed case studies were examined, covering different agroecoregions in the rain-fed areas, different watershed development programs, different implementing agencies, bright spots as well as not-so-successful watersheds covered for drawing broad impact of watershed programs besides to instill suitable institutional mechanisms and polices for the successful implementation of watershed programs.

Comprehensive assessment has identified range of best-bet options including cost efficient-water harvesting structures, *in-situ* conservation measures, improved management practices, rehabilitating wastelands, integrated nutrient management, integrated pest and disease management practices having the opportunity for widespread impact on poverty reduction, environmental improvement, agricultural productivity and resilience. The best-bet options were compiled and brought as a manual for different end-users in watershed programs.

Initially, a two-day workshop on the project was convened to discuss and finalize the strategies for undertaking the comprehensive assessment of watershed programs in India, where several participants from the Government of India's Ministry of Agriculture and Ministry of Rural Development, State Governments; ICAR institutions, agricultural universities, donor agencies, NGOs and scientists from ICRISAT deliberated and finalized strategy for the CA .

The inception workshop also identified consortium team and worked out the data needs and emphasis of assessment, responsibilities and time line for undertaking the comprehensive assessment.

Immediately, after the inception of workshop, consortium core group meeting was convened to discuss about the strategies to move forward in the project and to collect the evaluation reports on watershed programs in India. The methodologies and approaches were also finalized for comprehensive assessment.

Review workshops were organized to share the progress among the team members and experts from the watershed programs and receive the suggestions for refining the reports. The draft reports were again circulated among the team members and experts for further improvement.

Writer's workshop was held at ICRISAT to consolidate the learnings emerged from comprehensive assessment into draft report and finalize the recommendations emerged from the study.

4. Multilevel Assessment of Watershed Programs

4.1 Overall Impacts

Watershed programs are considered as engine for bringing in prosperity, enhancing income and food security, and sustainable development in the rain-fed areas. The Government of India gives considerable importance to the watershed programmmes to enhance the quality of life and augment the status of natural resources in the vulnerable regions i.e. rain-fed areas of the country. It has undertaken strategic investments through watershed development approach for the natural resources in the region with objective to bring in second green revolution in the country. Evidences indicate that watershed programs have yielded considerable dividends over time and there exists enormous untapped potentials in watershed that can be harnessed for turning the rain-fed regions into more productive and prosperous regions. However, the success of watershed programs is limited and therefore, a comprehensive assessment of these programs is needed to bring in necessary changes in approach, institutions, guidelines and implementation for enhancing the efficacy of these programs in attaining various watershed objective.

The overall objective of the watershed prgramme is to enhance the livelihoods of rural poor who suffer disproportionate pre and post production risks in the rain-fed areas that make their lives miserable. It is therefore, imperative that the impact of watershed programs be assessed at different levels (Macro & Micro) to see contributions of watershed programs and to identify some of the drivers of success. The identification and synthesis of biophysical and socio-economic constraints will enrich future options for improving watershed programs in the country through more targeted plans and policy options, technology interventions, and adequate financial resource allocations.

The study has undertaken a number of macro and micro-level impact studies to assess the impacts of watershed programs and identify drivers of success. A meta-analysis was undertaken to estimate the overall impact of watershed programs in the country. Some regional level impact studies based on the reviews of various watershed programs in the regions were also undertaken to observe the regional impacts of different watershed programs. In addition, use of remote sensing using satellite images for assessing impact was undertaken.

A few case studies were carried out to see the micro-level impacts of some of the selected successful watersheds to draw lessons on different process and innovative approaches that enabled those watersheds to emerge as the role models. The salient findings of these macro- and micro-level impact studies are presented in subsequent sub-section.

Review of Evaluation Reports of Watershed Program in India for Comprehensive Assessment Program

The objective of this study is to compile and review the monitoring evaluation reports received from various departments. ICRISAT collected 144 monitoring and evaluation reports, guidelines and miscellaneous literature of watershed projects in India and they were included in a website (http://www.icrisat.org/gt-aes/CA_watersheds/reports110.html). One hundred ten reports (93 final and remaining concurrent or mid term) are concerned with monitoring and evaluation of the projects and remaining are concerned with guidelines and other literature.

The evaluation reports for various programs and from various state departments are heterogeneous in style, content and include numerous parameters to evaluate the performance of watersheds. Some of these are discussed below:

Rainfall - Rainfall varies very widely from 385 mm in Gayatri watershed in Tumkur district to more than 7000 mm in Darugre Chicama watershed in East Garo Hills district of Meghalaya.

Base Line Characterization

Many of the reports indicate lack of base-line information. The baseline characterization of natural, physical, human, crops, livestock and socio- economic resources, etc., is important before initiation of the project, lest it will be difficult to evaluate the performance of various interventions and the project. Many reports, for example NWDPRA projects from N-E states, do not provide base line information.

Entry Point activities (EPA)

None of the evaluation reports, except Watershed in Pongalur block of Coimbatore, provides any information on entry point activity to motivate the watershed community for their active participation. These (EPAs) are construction of reading room, school compound wall, community hall, school building fencing, asbestos sheet roofing over temple, repair of approach road, drinking water supply, construction of water tank, deepening of well, etc. From watershed community perception these activities are important. However, these EPAs neither promoted community participation nor demonstrated impact of any of the new technological interventions.

Economics Data

About 30 reports provide information on benefit- cost ratio, internal rate of return and net present worth (NPV) of the project. Benefit- cost ratio varied between 1 for Phozo watershed (NWDPRA) in Mizoram to 2.75 in Sahibi river valley project in Rajasthan and Haryana. Similarly, internal rate of return averages between 10% and 43% for Khootgad in Almora district of Uttarakhand.

Conservation Measures Taken on Arable, and Non-arable area

Though the data on various measures have been listed for most of the projects, they are not of much use to draw any significant inferences or assessing impact. At most these information help in monitoring of the periodic achievements of various targets, which are also not given in many cases. It is suggested that physical and financial targets and cost norms of each type of treatment for a project need to be indicated for any purposeful evaluation and monitoring. Measurement of parameters such as rise in water table, reduction in runoff and soil erosion, increase in crop area and their yield, etc., provide indirect assessment of impact of conservation measures.

Reduction in Runoff and Soil Loss

Conservation of treatment resulted in runoff (3%) and soil loss (33%) reduction in Chahal watershed (NWDPRA) of Bharatpur district, Rajasthan. In Daulatpura watershed, runoff reduction of (40.5%) and soil loss by 60% were reported. It appears that these estimates for Daulatpura watershed are guess estimates. Only 14 watersheds provide information on reduction of runoff and soil loss. Runoff

reduction varies between 10 and 60% and soil loss reduction ranges between 3 and 70%. More information on runoff and soil loss is available for RVP & FPR projects. There was soil loss reduction of 92.5% in Ramganga, 64% in Matatila. Sahibi watershed evaluation report suggests reduction in suspended sediment load by 67%. The RVP and FPR reports suggest that there was also reduction in peak runoff rate and volume of runoff.

Green Cover

Evaluations of watershed projects carried by ISRO provide information on change in biomass cover. It ranges between 2.1% for Chamak Sayal watershed in Rudra Prayag and 25.1% for Gosthni watershed in Visakhapatnam district. Reports from other departments and evaluation provide the information on bio mass cover for only 3 watersheds namely Deoli Kala, Chahal and Sahibi watersheds, which ranged between 2 and 9%.

Rise in Groundwater Levels

As a consequence of conservation measures, generally there is rise in groundwater level in open wells and bore wells. Twenty watershed evaluation reports provided information on rise in water level. It was 0.6 m in Mdr-1 B watershed in Kheda district of Gujarat and Gosthani watershed in Visakapatnam district of AP, respectively. It was 2.5 to 3 m in Manomothuru watershed in Shivaganga district of Tamil Nadu, 2.5 m in Deoli Kala in Kota district and 1.77 m to 9 m in Daulat pura in Ajmer district of Rajasthan.

Increase in Irrigated area

Twenty-four watershed evaluation reports provided information on increased irrigated area due to rainwater conservation measures. Increase in irrigated area ranged from a low of 10 ha in Ranigad watershed of Champawat district of Uttarakhand to a high of 735 ha in a representative Karkara watershed in Chatra (Chhota Nagpur plateu) district of Jharkhand (earlier part of unified Bihar) under IGBP program which supplemented earlier work of RVP & FPR project of Damodar Valley Corporation. Some of the worth mentioning watersheds where there was significant increase in irrigated area are namely Hewat North (117.2 ha) in Pauri Gadwal district, Khootgad (27 ha) of Almora in Uttarakhand, Anthiyur (200 ha), Manimothuru (47 ha) in Shivaganga district, V-Kikothur (200 ha) all in Tamil Nadu, Sotnadi in Badaun, Chahal (150 ha) in Sultanpur district of UP. Change in irrigated area per centage was 65% in Daulatpura in Ajmer district, 14% in Saraswati –1 watershed, Banaskantha district of Gujarat and 29% in Mendhwan watershed, Ahmednagar district of Maharashtra.

Shifting (Jhoom) Cultivation

Most projects under WDPSCA are located in N-E states. There has been reduction of area under shifting cultivation and decrease in number of families practicing shifting cultivation. Area under *jhoom* decreased from 305 to 275 ha. *Jhoom* cultivation reduced from 305 to 228 in Andhacherra watershed in N Tripura district of Tripura. On Phizo watershed, in Zunheboto district of Nagaland *jhoom* cultivation reduced from 56 ha to 35 h. There was 100% reduction on Sauoru watershed in Kohima district of Nagaland.

Increase in Cropped Area and Cropping Intensity

Nineteen watersheds reported increase in cropping intensity. It ranged from 2.5% in Saihpui watershed, Kolasib district of Mizoram to 60% in Kalasur watershed in Indore district of Madhya Pradesh. Other significant increase in cropping intensity were in Nurnagar Cherra (45%), Kha- Liemkong watershed (32%), Dhani Cherra (26%), Arwanda (20%) in MP, and Kundah (20–30%) watershed in Tamil Nadu and Kerala under RVP & FPR.

Additional area under cultivation was reported in 52 watersheds. It ranged from 6 ha in Luka Nala watershed under NWDPRA program in Jhansi district of UP and 930 ha in Sahibi watershed under RVP& FPR project in Haryana and Rajasthan. Some of the prominent watersheds wherein area was brought under cultivation due to improvement and reclamations of marginal and wastelands with silt deposition in drains and other land improvement measures include Bachupally (490 ha) in Anantapur district of AP, Yerravanka (104 ha) in Kadapa district, Kurna Nala (821 ha) in Devaraia district of UP, SM-a/1 (405 ha) in Midnipur West of WB, Chandpur (403 ha) in Birbhum district, Dalkajola (575 ha) in Hoogly district of WB, Daulatpura (519 ha) in Ajmer, Chahal (422 ha), Bharatpur district in Rajasthan. Area under vegetables and fruits increased in NWDPRA watershed in N-E states.

Increase in Crop Yield

Most watersheds under various programs reported increases in yield for the crops grown in the watershed. Catchment of Matatila in UP has reported that the crop yield in case of pigeonpea, barley and mustard has increased from 5, 4 and 3 q/ha to 19.5, 12.0, 10.0 q/ha, respectively. Kundah catchment in Tamil Nadu has reported that potato yield increased from 16 to 16.8 q/ha and for tea increase from 6.9 to 8.2 t/ha because of watershed development measures. Modest yield increases were reported in Nagarjun Sagar catchment, which cover AP, Karnataka and Maharashtra. Average yield increase for millet was 6%, *kharif* sorghum 10%, rabi sorghum 9%, groundnut 8%, pigeonpea 6%, chick pea 11% and chilly 9%.

Crops yield percentage increase in Baldirai watershed (NWDPRA) in Sultanpur district of UP was 51 for paddy, 49 for wheat, 150 for chickpea, 161 for maize and 35.3 for pigeonpea, respectively. Gayatri watershed in Tumkur district of Karnataka reported 25% increase for paddy and chickpea, 25% for all pulses and 85% for vegetables. Wheat yield increase in Chahal watershed was 170.5 and 10.4% for mustard. Masthalla watershed in Bellary district reported an increase of 65% for pigeonpea, 28% for maize and 17% for groundnut. Chandra watershed in Birbhum in West Bengal reported paddy yield increase of 1500 kg/ha.

Gudhiyalatur watershed under IWDP in Erode district of Tamil Nadu reported 30% yield increase for ragi and 23% for maize. Similarly in Haripriya watershed under IWDP in Kota district of Rajasthan oil seed crops yield increased from 1.0 t/ ha to 1.6 t/ ha, pulse crops yield increased from 0.75 t/ha to 1.25 t/ha and cereal crops yield increased from 3.1 t/ha to 4.25 t/ha, fodder yield increased from 40 t/ ha to 110 t/ha and horticultural yield increased from 0.5 t/ha to 0.75 t/ha.

Wasteland Development

Under watershed programs, wastelands that are not cultivated, have been developed through soil water conservation measures and used for growing grasses as well as for the plantation of trees. Partial development of non-arable lands have been done in Uttarakand, Nagaland as well as Manipur, Uttar

Pradesh, Karnataka and Rajasthan watersheds. Similarly, even under NWDPRA watersheds, reduction in wastelands in the treated watersheds has been observed through remote sensing upto 10% of the wastelands and under river-valley projects, reduction in wasteland is more as specific efforts have been made to minimize erosion. In some cases where 1000 ha have been developed with plantation of 12 million saplings with 61% survival rate, contributed significantly in reducing the wastelands. However, detailed exact assessment of wasteland cannot be done through this study as the scope was created for assessing the impacts of watershed programs and reduction in wasteland is just one of the component studied in this report.

Pasture Development, Fodder Production, Livestock and Milk Production

Improved conservation of water results in better soil moisture environment and increased water availability, which favors increase in biomass production, increased fodder production, increased milch cattle and milk production. Very few watershed evaluation reports provided information on pasture development, fodder production, livestock management and pasture development and milk production. Pasture development on non- arable lands was done in Khootgad watershed in Almora (Uttarakhand), Tapi in Mon district (Nagaland), Chahal in Bharatpur and Daulatpur in Ajmer with development on 29, 79, 53, and 739 ha, respectively. Similarly fodder production on arable land was taken on Kha-Leimkhong, Senapati district, and Merakhong, Imphal East district of Manipur, Baldirai, Sultanpur (UP), Masthalla, Bellary district and Daulatpura, Ajmer district on 1310, 40, 82, 10 and 225 ha, respectively. Generally, the number of cows and bullocks decreased and the number of buffaloes increased in northern India. However, the number of bullocks increased in the watershed in Uttarakhand. Watersheds in Rajasthan reported decrease in the number of sheep and saw increase in the number of goats. There was about 13% increase in milk production in Deoli Kala watershed in Kota district of Rajasthan.

Increase in Employment

Large employment for local people was generated by various activities of watershed development. However, the information mostly was limited to casual employment generated during employment period of the projects.

Watershed development results in conservation of soil and water and higher water use efficiency of conserved of natural resource. Potential for increased regular employment is created due to increased on- and off-farm economic activities and it has not been estimated and reported. Masthala (Bellary), Mendhawan (Ahmednagar), MDr-1-B (Kheda), Sareaswati-1 (Banaskantha) and Raipur Rani (Panchkula) watersheds reported regular employment of 10.4 person day/ha/year, 18 person days /ha/year, 11 person days and 4 bullock days/ha/year, 39 person days and 4 bullock day/ha/year, and 1436 person days/year, respectively.

Increase in Income

Increase in on–farm productivity, production and income from other non- farm income generating activities result in increased family income. In Raipur Rani, it was Rs 17710 per year, while in Khootgad, it was Rs 13536 per year. Average family income increased due to watershed development. For e.g. in Deoli kala the average family income increased to Rs 14606 per year and in Masthala watershed to Rs 4192 per year. Increase in family income in Karkara watershed was Rs 17500/family. Sahibi

and Kundah watersheds under RVS & FPR program reported average total income of Rs 62450/ year and 140682/family for sample families. There was increase in income from sale of milk from Rs 538 to 3935 per house hold and farm income from Rs 2089/ha to Rs 4739/ha in Mendhawan watershed in Ahmednagar watershed under IGWDP. Service income increased from 0.78% to 10.5% in Mendhawan village. There was no business activity in the village earlier. As a result of watershed activities income from business was estimated at 10.91% of total family income.

Increase in Assets

Increase in number of assets such as tractors, cattle shed, pucca houses, motor cycles, tube wells and open wells, sewing machines, agricultural equipment and implements, pumping sets as a result of increased family income from various sources was reported in number of NWDPRA watersheds. Since base line information was not available at the time of evaluation of watershed development impact, it is difficult to put information in any quantitative manner.

Institution, Capacity Building and Processes of Implementation

Most of the projects have been implemented by state line departments, and non-government organizations were involved in implementation of projects under IGWDP and IGBP. In all the projects, watershed associations/*gram* resource management associations (GAREMA), wherein all members of the village/s were invoted and watershed committees and executive bodies, were formed. The project reports do not give adequate information of composition of the watershed, representation of poor and marginal farmers, women, landless and other vulnerable groups of the society. In many projects women SHG were also formed to take up non-farm economic activities. SHGs were more effective where NGOs were involved in implementation of the projects. Training program were conducted and they ranged between 2 at Peach hog in Yepia district of Arunanchal Pradesh and 78 in Chahal in Bharatpur district of Rajasthan. Kisan Mitra Mandal and Gopal were also formed in projects, under NWDPRA.

The reports do not provide information on capacity building efforts for project implementation agency (PIA) and watershed development teams (WDT). The reports also do not provide information on people's participation on selection of watershed, and the selection and planning of various interventions in the watersheds. Involvement of landless and activities to benefit them were also not very explicit in the reports.

Innovations

Voluntary ban on open grazing by cattle, ban on felling of trees, over exploitation of groundwater by deep bore wells, 16% labor contribution, Rs 100/family/year from second year of the project were some important innovations under IGWDP projects in Maharashtra. Live fencing with *Gliricidia* in Ayarkunnam watershed in Kerala, crops planted in interspaces' of mango plantation in Mavarkal watershed in Trivandrum district of Kerala, fodder yielding grasses in Khootgad in Almora, Uttaranchal, square mini ponds on 5% of the field area in Karkara watershed in Chatra district of Jharkhand and bamboo fencing in Kha- Leinmkhong watershed in Senapati district and bamboo spurs in drains in Leimkhong in East Imphal district of Manipur were some of the notable innovations introduced in watershed projects.

Constraints

Many evaluation reports mentioned frequent transfer of department personnel, lack of transfer of money to the project, insufficient training to PIA and representation of relevant disciplines in watershed development team, lack of mid-term evaluation for correction, less people's involvement, less demonstrations to motivate and convince stake holders on efficacy of technological interventions, lack of corpus fund for maintenance as some of the main constraints in implementation.

Generally watershed projects in high rainfall areas under NWDPRA and WDPSCA in N-E states and Uttarakhand have not reported base line data and therefore it was difficult to assess the performance of various treatments and also overall impact of watershed development on watershed community. Apparently the interventions in the watershed have made lesser impact on the productivity and creation of livelihood opportunities. However, the evaluating agency for NWDPRA watersheds in N-E states has rated the watershed performance on people's perception of various treatments and activities to arrive at overall ranking of the watershed impact, which are satisfactory.

Analysis of Concurrent/Mid Term Evaluation Reports

There are 17 concurrent reports. The concurrent evaluation reports of watershed under IGWDP provide details of achievements, their impact, community involvement, financial details, etc. IGWDP projects have been implemented in Maharashtra through direct involvement of NABARD and NGOs and watershed community, involvement of landless, women, etc. In Sedashi-Wavoshi watershed in Raigadh district, NABARD evaluated the watershed through stratified sampling of 48 farmers and physical verification in all reaches of the watershed. Capacity building of NGO and watershed community, community willingness for participation was initiated before initiation of planning activities for the watershed. Village Watershed Community was formed before implementation was initiated. It was observed that rise in water level in open wells ranged from 0.4 to 1.2 m, farmers started cash crops (vegetable) production, community contributed 16% of total labor, 24 ha of wasteland was developed, 1.2 million samplings were planted on 1000 ha watershed area with 61% survival, joint forest management committee was formed for protection of trees, 15 women SHGs were formed. Paddy yield increased from 17 q/ha to 25 q/ha, the net present worth of agricultural produce increased from Rs 1.733 million to Rs 39.15 million, non-recurring employment of 2.88 million person-days and recurring employment of 14500 person-days were created. Haripriya watershed under IWDP in Kota district in Rajasthan, oil seed crops yield increased from 1.0 t/ha to 1.6 t/ha, pulse crops yield increased from 0.75 t/ha to 1.25 t/ha and cereal crops yield increased from 3.1 t/ha to 4.25 t/ha, fodder yield increased from 40 t/ ha to 110 t/ha and horticultural yield increased from 0.5 t/ha to 0.75 t/ha. The rise of water column in open well was 4 m in Haripriya watershed.

Mid term evaluation of IWDP watersheds in Pongalur block of Coimbatore reported that the increase in cropping intensity ranged from 1 to 50%, and there was greater diversity in planted crops and crops yield increased. Cotton yield increase ranged between 13 and 82%, sorghum between 22 and 40%, maize 8 and 39% and onion 8 and 40%. Increase in income from on-farm, livestock and household also increased. Farmers' perception for impact of various activities was also rated and ranked. Overall performance index and ranking, based on soil and water conservation treatment, drainage line treatment, water resource development and afforestation for various watershed was also reported and recommendation for various implementation processes and component of interventions were made.

Conclusions

In general, the watershed programs have made good impact on conservation of resources and have benefited watershed community. However, there is a need to strengthen baseline characterization, community participation, linkage with mentor organization, capacity building, observation on hydrological parameter such as runoff, soil loss, periodic rise in water table, use of GPS and remote sensing tools to map physical resources such as water bodies, biomass cover, degraded lands, various land use, etc., at beginning, periodic interval and at the end of project period. This would be of immense value. With implementation of common guidelines for all watershed programs being implemented by various development departments and organizations, uniform format for computerized records of observations and report structure across programs and states would help in storage and retrieval of data and report. It would help to assess and compare the watershed programs and ecoregions.

4.2 Impact of Watershed Programs and Conditions for Success: A Meta-Analysis Approach

This study is a sequel of the earlier study "Meta-analysis to Assess Impact of watershed programs and people's participation" by Joshi et al. 2005. The meta-analysis is a powerful methodology that collates research findings from previous studies, and distils them for broad conclusions. Meta-analysis can be helpful for policymakers, who may be confronted by mountains of conflicting conclusions (Alston et al. 2000). In one sense, it takes cognizance of the collective wisdom of numerous scientists who have evaluated and reported the performance of watersheds and thus takes care of the problems of selection and reporting biases. It is an established methodology, which has been diligently applied to assess the returns to investment in education (Lockheed et. al., 1980; and Phillips 1994), understands the implications of certain medical treatments on offspring and to measure the returns to research investment (Alston et al. 2000) at global level. Joshi et al. (2005) applied meta-analysis to evaluate the impact of watershed programs in India.

This paper intends to assess the benefits and conditions for success of watershed programs in India. It also identifies conditions for larger participation of the stakeholders in the watershed activities, which is a prerequisite for successful implementation of the watershed projects. More specifically, the objectives of the study are: (i) to document the benefits of watershed programs in different regions of the country, (ii) to identify conditions for successful implementation of watershed programs and assess the role of people's participation in the success of the watershed programs; and (iii) to document conditions for greater people's participation in order to identify some of the drivers (biophysical, social and economical) for successful watersheds.

Approach and Methodology

Numerous studies are there which evaluated the performance of watershed programs. These studies were published either as research articles or research reports. These watershed studies cover the entire rain-fed regions of the country and represent a wide range of environment according to their agroecological location, size, type, source of funding, rainfall, regional prosperity or backwardness, etc. The present study evaluates the impact of watershed programs with the help of 626 micro-level studies[1] including 311 studies in the previous study to establish higher degree of confidence in the analysed results for the CA of watershed programs in India. These micro-level studies were

1 A complete bibliography of watershed studies is available with the consortium.

critically reviewed and analysed for upscaling the conclusions to stipulate the macro-level picture of the watershed programs.

Watershed programs in India are being implemented with objectives of improving production efficiency, equity and sustainability in the rain-fed areas. Sustainability of natural resources is a vital issue for the rain-fed areas. To document benefits of watershed programs on sustainability of natural resources, a few proxy indicators have been carefully chosen and analyzed. Four important indicators like (i) increased water storage capacity, which augmented the irrigated area, (ii) increased cropping intensity, (iii) reduced run-off, which enhanced groundwater recharge, and (iv) reduced soil loss have been identified to demonstrate the sustainability benefits. Management of watershed is a unique example of collective action. Active people's participation plays a decisive role in the performance and efficacy of watershed programs. The study also examines the performance of watersheds under different levels of people's participation. The people's participation has been documented as high, medium and low with respect to various activities at different stages of the watershed programs. Intensity of people's participation was related with the multiple benefits derived from the watershed programs.

Benefits of Watershed Programs

The descriptive summary of multiple benefits derived from watersheds, as indicated in numerous studies, is shown in Table 2. It is obvious that watershed programs performed well with a mean benefit-cost ratio of 1:2.03 with the benefits ranging from 0.82 to 7.30. It indicated that on an average, even in fragile and high risk rain-fed environments, watershed programs were able to generate benefits that were more than double of their costs.

In many of the watersheds benefits were even higher. About 18% watersheds generated benefit-cost ratios above 3, which is fairly modest (Figure 1). However, 68% of watersheds performed below average with B:C ratio of 1:2.03. Merely 0.6% watershed failed to commensurate with cost of the project.

The mean internal rate of return of 27.43% was significantly high and comparable with any successful government programs (Table 2). The internal rates of return in 41% watersheds were in the range of 20 to 30% whereas about 27% watersheds yielded IRR of 30 to 50% (Figure 2). The watersheds with IRR below 10% were only 1.9 per cent. It is to be noted that IRR indicates marginal efficiency of the investment and these were comparable with any government development programs in the country. These results reconfirm that watershed programs are able to meet their initial costs generate substantial economic benefits and justify the investment in watershed programs as income levels were raised within the target domains.

Another important purpose of the watershed programs was to generate employment opportunities to address the equity concerns of landless labourers, and marginal and small farmers. The results of meta-analysis indicate that watershed programs have generated significant and substantial employment opportunities in the watershed areas. The mean additional annual employment generation in the watershed area on various activities and operations was about 154 person-days/ha/year (Table 2). It was as high as 900 person- days/ha/year in those watersheds, that included multiple activities. Generating employment opportunities for the rural poor means raising their purchasing power, and in turn alleviating rural poverty and income disparities. This has an important implication that the watershed investment may be characterised as a poverty alleviation program in the fragile areas.

Table 2. Summary of benefits from the sample watersheds using meta-analysis

	Particulars	Unit	No. of studies	Mean	Mode	Median	Mini-mum	Maxi-mum	t-value
Efficiency	B:C ratio	ratio	311	2.01	1.70	1.70	0.82	7.30	35.09
	IRR	%	162	27.43	25.90	25.00	2.03	102.70	21.75
Equity	Employment	person days/ha/ year	99	154.53	286.67	56.50	0.05	900.00	8.13
Sustainability	Increase in irrigated area	%	93	51.55	34.00	63.43	1.28	204	10.94
	Increase in cropping intensity	%	339	35.51	5.00	21.00	3.00	283.00	14.96
	Runoff reduced	%	83	45.72	43.30	42.53	0.38	96.00	9.36
	Soil loss saved	tons/ha/ year	72	1.12	0.91	0.99	0.11	2.05	47.21

The important objective of the watershed program is to improve the livelihood of poor rural households, who encounter disproportionate uncertainties in rain-fed agriculture due to precarious environment, acute degradation of soil, and water-scarcity. The estimates show that watershed programs were quite effective in addressing the problems of land degradation due to soil erosion and loss of water due to excessive runoff. Soil loss of about 1.12 tons per ha per year was saved due to interventions in the watershed framework. Conserving soil means raising farm productivity and transferring good soils to the next generation. It was noted that on an average about 38 ha m additional water storage capacity was created in a watershed as a result of watershed program. Augmenting water storage capacity contributed in (i) reducing rate of runoff, and (ii) increasing groundwater recharge. On an average, 46% runoff loss was reduced because of various watershed interventions and the groundwater table was also augmented by 3.6 meters in the watershed areas. These have direct impact in expanding the irrigated area and increasing cropping intensity. On an average, the irrigated area increased by about 52 per cent, while the cropping intensity increased by 35.5 per cent. In some cases the irrigated area increased upto 204% while the cropping intensity increased by 283 per cent. Such an impressive increase in the cropping intensity was not realized in many surface irrigated areas in the country. These benefits confirm that the watershed programs perform as a viable strategy to overcome several externalities arising due to soil and water degradation.

The above evidences suggest that watershed programs, which have been specifically launched in the rain-fed areas with the sole objective to improve the livelihood of poor rural households in a sustainable manner, have paid rich dividends and were successful in raising income levels, generating employment opportunities and augmenting natural resources in the rain-fed areas. These benefits have far reaching implications for rural masses in the rain-fed environment.

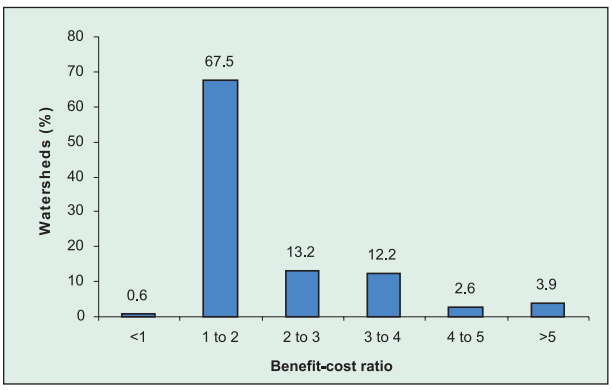

Figure 1. Distribution (%) of watersheds according to benefit-cost ratio (BCR).

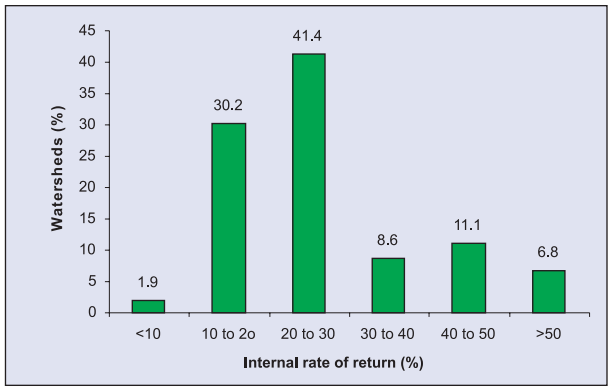

Figure 2. Distribution (%) of watersheds according to internal rate of return (IRR).

Results of Meta-Analysis Regression

The results of meta-analysis regression further showed that the benefits vary depending upon the location, size, type, rainfall, implementing agency, and people's participation, among others. These results are presented in Table 3. The coefficient of multiple determination (R^2) shows the variables included in the model and explained more than 56% variation in the benefit: cost ratio. The positive value of intercept also indicated a positive impact of watershed programs on augmentation of income. A number of factors determine the economic efficiencies of watershed programs. Geographical location, rainfall pattern, focus of watershed program, implementing agency, status of target population and people's participation are some of the critical factors that play a deterministic role in the performance and efficiency of watersheds. Consideration of time gap between implementation and evaluation of the program is also important. However, the effect of time gap between implementation and evaluation could not be captured, as the variable was statistically non-significant. However, a positive sign of the variable indicates a larger benefit associated with intervention with time and suggests that performance of the watershed program should not be judged immediately after the implementation. The impact of other variables on the watershed efficiency is discussed here.

Geographical Location of the Watershed

The present study groups all watersheds into seven agro-climatic zones viz. (i) Trans-Gangetic Plain zone, (ii) Western Himalayan zone, (iii) Western Plateau & Hill zone, (iv) Gujarat Plains & Hill zone, (v) Southern zone (vi) Central Plateau and Hill zone, and (vii) North Eastern zone. These zones have hetrogenous agroclimatic conditions, divergent potentials, unique opportunities and very distinct socio-economic characteristics. The analysis indicated that economic benefits over investment on watershed programs were positive and significant in all the zones, which established the efficacy and utility of watershed programs for enhancing the income in the rain-fed areas across the country. However, the results indicated that economic benefits on initial investment were the highest in Western Himalayan regions, Southern zone, Trans-Gangetic Plains, Western Plateau and Hill zone, Eastern Himalayan zone and Gujarat Plain and Hill zone. The Western Himalayan region attained 12% higher B:CR than the base level of Gujarat Plain & Hill zone. The positive and significant coefficients obtained for all the zones have important implications for investment priorities for watershed programs. To maximize returns to investment on watershed programs, the highest priority must be accorded to the Western Himalayan zones followed by Southern zone, Trans-Gangetic zone, Western Plateau and Hill zone,

Central Plateau and Hill zone and Eastern Himalayan zone. In earlier study efficiency of watersheds in Eastern Himalayan zone and Central Plateau zone could not be captured due to non-availability of sufficient studies from these two regions.

Rainfall

The results of present meta-analysis confirm that the rainfall in the region largely influenced performance of watersheds. The study classified rainfall into five rainfall zones: (i) less than 500 mm, (ii) 501-700 mm, (iii) 701-900 mm, (iv) 901-1100 mm, and (v) more than 1101 mm to capture the effect of rainfall on the efficiency of watersheds. The results indicated that the performance of current watershed program was best in the rainfall ranging between 901 mm and 1100 mm, followed by 701 mm and 900 mm. It was noted that the B:CR was 30% higher in the rainfall, ranging between 901 mm and 1100 mm in comparison to base level of less than 500 mm. Rainfall lower than 700 mm and higher than 1100 mm were poor performers due to scanty and excessive water availability in these regions along with inappropriate rainwater management strategies.

The results clearly infer that current watershed management options performed better, indicating the need to adopt different interventions to manage where rainfall ranges between <500 mm and >1100 mm. The other rainfall regions call for increased R&D allocation in watershed programs to undertake strategic research and design innovative strategies to enhance the efficiency of watershed programs. The current approach of one size fits all did not work well and could be one of the important factors along with others for 2/3rd watersheds performing below average performance in terms of B: C ratios.

Size of Watershed

Size of watersheds does play a critical role. Depending upon the size of the watersheds, these are broadly divided into micro (≤1200 ha) and macro (>1200 ha) watersheds. The results showed superiority of macro-watersheds over micro-watersheds with respect to the returns to investment. The performance of macro watersheds was 34% better than the micro-watersheds. This is contrary to general belief that micro watersheds perform better. It may be due to economies of scale and more externalities through diverse activities in large watersheds.

Focus of Watershed

The watersheds mainly focused in three broad areas: (i) rehabilitation of degraded lands, (ii) soil and water conservation, and (iii) both rehabilitation of degraded lands as well as soil and water conservation. Results indicated that investment on rehabilitation of degraded lands along with soil and water conservation was more rewarding than mere rehabilitation of degraded lands.

Implementing Agency

Watershed programs involve several organizations in implementing watershed programs. Results indicated that the watershed programs jointly planned and implemented by the central and state agencies gave higher returns. The returns from such watersheds were 34% higher than the watersheds controlled by other agencies. Since agriculture is a state subject, support flowing from the Central Government has a synergetic effect in the performance of watersheds. The independent programs

Table 3. Determinants of the performance of watershed: regression coefficients on meta-analysis.

Variable	Default category	Variable name	Estimated coefficients	t-ratio
		Intercept	0.0721	0.1097
Geographical location	Gujarat Plains & Hills	Western Himalyan Zone	0.7525	2.5553**
	All other observations	Southern Zone	0.5950	2.3521**
	All other observations	Trans-Gangetic Plains	0.4345	1.8584*
	All other observations	Western Plateau & Hills Zone	0.4215	1.4052@
	All other observations	Central Plateau And Hills Zone	0.3514	1.1743
	All other observations	Eastern Zone	0.3408	1.0536
Rainfall	Rainfall < 500mm	Rainfall between 901 to 1100mm	0.9252	5.1494***
	All other observations	Rainfall between 701 to 900mm	0.3891	2.5887**
	All other observations	Rainfall between 501to 700mm	0.1024	0.6494
		Rainfall above1100mm	-0.0010	-0.0051
Size of watershed	Micro-watersheds	Macro-watersheds	0.2282	2.4297**
Focus of watershed	Land degradation	Degraded land with soil and waters conservation	0.1195	1.4414@
	All other observations	Soil & water conservation	-0.0938	-1.0359
Implementing agency	Other implementing agencies	Implemented by Centre and state	0.8376	4.1621***
	All other observations	Implemented by the Centre only	0.2051	1.4239
	All other observations	Implemented by Centre, states and others	0.0639	0.3131
People's participation	Low peoples participation	High people's participation	0.7777	5.9220***
	All other observations	Medium people's participation	0.1510	1.3168@
Per capita income in the region	Location in low income group states	Location in medium income group states Medium	0.0906	0.5743
	All other observations	Location in high income group states	0.0733	0.4289
Activities performed under watershed	Only Agriculture	Agriculture and livestock	0.3574	2.6192***
	All other observations	Agriculture and forestry	-0.2817	-1.4428@
	All other observations	Agriculture livestock and forestry	-0.1743	-1.1481
Soil type	Clay soils	Red soils	0.3688	1.8918*
	All other observations	Alluvial soils	0.0744	0.4308
	All other observations	Black cotton soils	-0.0720	-0.3782
	All other observations	Sandy loam soils	-0.0462	-0.2673
R2				0.5629
Number of observations				636

@, ***, **, and* are significant at 20, 10, 5 and 1% of probabilities, respectively.

of the Central Government generated less returns to investment mainly because of lack of effective monitoring. This suggests that the Central Government should play a catalytic role with the state government, in implementing and managing the watershed programs. The role of non-governmental organizations and other agencies were though positive but insignificant. It could probably be because the Government of India has a major role in watershed programs and in its comparison the roles of others are insignificant.

Target Population

The study attempted to estimate the effect of target population on the performance of watershed and based on the average income level of the targeted population it was delineated into: (i) high income group states, (ii) medium-income states, and (iii) low-income states. High-income group states had a per capita agricultural gross domestic product greater than Rs 4000 as in Joshi et al 2005. Medium and low income groups had per capita incomes between Rs 2000 and 4000 and below Rs 2000, respectively. Though the estimated regression coefficients were statistically insignificant, these indicated that the returns from watershed programs were comparatively higher in medium and low income states. States having high income were not showing attractive returns to investment on watershed programs. The B:CR of watersheds in low, medium and high income states were 2.26 and 2.1 and 1.78, respectively. These results reiterated that low and medium income group people participated better in watershed programs as it met their need of increasing incomes. In low income states, beneficiaries offer their labour to supplement the investment made in various activities. Such an interface of public-private partnership has a multiplier effect on returns to investment. These results have strong bearing on investment priorities for watershed programs. The medium income groups of states have comparative advantage because beneficiaries supplement private investment to the public resources allocated for watershed activities. Therefore, states falling in medium and low income states should be accorded higher investment priority for watershed program.

People's participation

Watershed development is a community approach. Active people's participation is, therefore, highly critical in the success of the watershed program. The results of the study showed that the benefits were the highest from the watersheds where people's participation was high. Summary results of people's participation and benefits from watersheds are given in Table 4. The available evidences confirm that there exists a positive relationship between people's participation and benefits from watershed program. The benefit-cost ratio was much more (2.63) in watersheds where people's participation was high in comparison to the watersheds with low participation (1.42). The other impact indicators except runoff reduction were also far ahead in watersheds having greater people's participation. These results call for devising innovative ways for increasing as well as improving quality of community participation in watershed programs.

People's Participation and Benefits from Watersheds

Watershed programs always calls for community participation and collective action. It is necessary because individual choices have collective consequences in the watershed framework. Action of one group of farmers in one location affects adversely (or favourably) to other group of farmers in different location. Often the different groups and locations have conflicting objectives with respect to their investment priorities and enterprise choices. These need to be converted into opportunities. To

achieve this, some innovative mechanisms need to be developed with the involvement of community or stakeholders, which could resolve their conflicting objectives to sustain the objectives of watershed programs.

It is interesting to note that benefits from watershed programs were conspicuously more in the low-income regions as compared to the high-income regions (Table 5). The benefit-cost ratio was 2.25

Table 4. Summary of benefits from the sample watersheds according to people's participation.

			People's participation		
Indicator	Particulars	Unit	High	Medium	Low
Efficiency	B:C ratio	ratio	2.63 (16.01)	1.60 (29.72)	1.42 (16.36)
	IRR	%	38.28 (10.21)	22.26 (4.74)	17.30 (8.21)
Equity	Employment	person days/ha/year	165.17 (5.29)	118.73 (4.31)	105.42 (9.97)
Sustainability	Increase in irrigated area	%	77.43 (8.23)	56.17 (8.07)	29.43 (10.32)
	Increase in cropping intensity	%	44.60 (9.37)	24.96 (10.21)	32.03 (14.21)
	Runoff reduced	%	43.24 (6.03)	40.41 (4.22)	69.00 (7.19)
	Soil loss reduced	tons/ha/year	1.18 (43.21)	1.1 (18.21)	0.87 (22.33)

1= Figures in parentheses indicate t-values More about people's participation is discussed in the following section.

Table 5. Summary of benefits from the sample watersheds according to income status of the region.

			Per capita income of the region*		
Indicator	Particulars	Unit	High*	Medium**	Low**
Efficiency	B:C ratio	ratio	1.75 (15.34)	1.96 (28.21)	2.25 (9.36)
	IRR	%	24.55 (7.23)	27.9 (6.89)	30.64 (6.02)
Equity	Employment	person days/ha/year	91.05 (7.27)	159.7 (9.16)	164.3 (6.76)
Sustainability	Increase in irrigated area	%	48.48 (12.50)	45.83 (8.09)	76.02 (6.71)
	Increase in cropping intensity	%	31.4 (10.82)	34.09 (14.41)	43.75 (10.27)
	Runoff reduced	%	43.21 (9.32)	43.27 (6.81)	49.32 (5.28)
	Soil loss reduced	tons/ha/year	1.18 (36.23)	1.1 (41.11)	0.87 (12.26)
Extent of people's participation			High	High	Low

Figures in parentheses indicate t-values. *, **, and *** include the states having per capita AgGDP greater than Rs. 4000, between Rs 2000 and Rs. 4000, and below Rs. 2000 per annum, as in Joshi et al. 2005.

in low-income regions as compared to 1.75 in high-income regions. The corresponding figures for annual employment generation were 164 and 91 person-days per ha, respectively. The low-income regions call for such investments to enhance income levels of rural poor. This suggests that watershed program should receive higher priority by the government in medium and low-income regions. Such investments will not only raise income and employment opportunities in the backward regions but also contribute in conserving soil and water resources. Farmers in these regions could not invest due to low income and limited opportunities. Government intervention through watershed programs would benefit the rural poor in the low-income regions.

Activities Performed

Benefits always depend on the nature of activities that performed in the watersheds. Watersheds often include different activities pertaining to agriculture, livestock, forestry, etc., as the livelihood options. It is interesting to note that the contribution through integrated agriculture and livestock activities was significantly better than that of agriculture alone (Table 3). Perhaps the complementarity between these two enterprises helped the beneficiaries in diversifying their activities more favourably. It is plausible that negative coefficient that encompassed agriculture and forestry simultaneously was due to the effect of practicing *jhoom* (shifting) cultivation in most of the hilly tracts of eastern region. Shifting cultivation affects the forest as well as the watersheds in the area. Besides, most of the forests fall in the areas where rainfall is above 1100 mm and the best regions that yield higher benefit-cost ratios fall within the rainfall range of 701 to 1100 mm.

Soil Type

Soil types, structure and properties are critical in determining the performance of watersheds. The best way to capture the effect of soil should have been to include their intrinsic physical and chemical properties. In the absence of such information, a broad classification of soil type viz. clay, sandy loam, black cotton, alluvium and red soils was fitted in the model. The results indicated that under the present circumstances the most ideal soils for the watersheds were alluvial and red soils. Since the same soil behave differently in different rainfall zones, these results need to be to considered judiciously and further analysis with soil types and rainfall combinations need to be studied.

4.3 Regional Impact Assessment Reports

a. Impact Assessment of Watershed Development in Southern India: A Review

The present study intended to review the impacts of various watershed treatment activities performed in the major Southern states covering Karnataka, Andhra Pradesh Kerala and Tamil Nadu. The watershed development programs are being implemented by different ministries through various development programs like DPAP, RLEGP, HADP, IGWDP, IWDP, NWDPRA, TAP, SGRY, Sujala watershed program, and ORP. These watershed development programs were implemented by different departments such as government line departments (Agricultural Engineering, Agriculture, District Rural Development Agency), village *panchayats*, Indian Council of Agricultural Research institutes, state agricultural universities and NGOs like MYRADA and others. In the study states, over the years, different regions were treated on a micro watershed basis. For the purpose, a total of 65 impact assessment studies were reviewed. The studies covered 343 micro watersheds that

were treated, covering an area about 0.17 million hectares. The major watershed program in Andhra Pradesh is Andhra Pradesh Rural Livelihoods Program (APRLP) and impact of APRLP is also covered in this section.

Impact of Watershed programs

Reddy (2000) reviewed 22 impact assessment studies conducted across the country from 1967 to 1997 and found that watershed development projects over the years have shown positive impacts on crop yields, cropping intensity and cropping pattern changes. He found that all the studies have shown that net incomes have increased significantly and the mean B:CR was stable at 1.75, implying positive impacts produced by the watershed development programs in the country.

Many other studies (Palanisami et al. 2002; Venkatesa Palanichamy et. al, 2002 ; Sreedharan 2002 ; Sastry et al 2002 ; Ramaswamy and Palanisami 2002; Ramasamy et al. 2002; Wani et al. 2003, 2006; Chandrakanth and Nagaraj, 2006; Zomer et al. 2006; Palanisami et al. 2006; Shiferaw et al. 2006; Palanisami and Suresh Kumar, 2006; Jeyabalakrishnan 2006 ; Osman et al. 2006; Malaisamy et al. 2006; Radhamani et al. 2006; Sai Maheshwari, 2006) employed before and after approaches to assess the impact of watershed development activities. Many researchers (Alemu et al. 2002; Lokesh et al. 2006; Ramakishna et al. 2006, Sreedevi et al. 2007) adopted with and without approaches to asses the impact.

These studies focused the impact of various watershed treatment activities on various impact domains like soil and moisture conservation, water resources development, impact of cropping pattern and yield, and overall economic impacts. These impacts on different domains are discussed hereunder.

Bio-physical Impacts

Watershed treatment activities have produced significant changes in the bio-physical aspects of the watershed. These include improved conservation of soil and moisture, improvement and maintenance of fertility status of the soil (Sikka et al. 2000; Sastry et al. 2002; Ramasamy and Palanisami, 2002; Palanisami and Suresh Kumar, 2002; AFC, 2001; Sreedevi et al. 2007; Pathak et al. 2006), reduced soil and water erosion. The organic carbon increased by 37% due to watershed intervention (Sikka et al. 2000) and most studies revealed that there was significant reduction in soil and water erosion. Significant reduction in soil and water erosion (77.78% reduction) was observed by Wakjira, 2003.

Evidences show that soil conservation had positive impact on retention of moisture, reduced soil erosion, change in land use pattern and yield. Soil loss reduced from 18.8 t/ha to 6.37 t/ha from 1988 to 1989. Between 1985-86 and 1989-90 the yield rate of all the crops increased with an annual CGR from 3.94% to 16.40% (Evaluation and Applied Research Department. 1991).

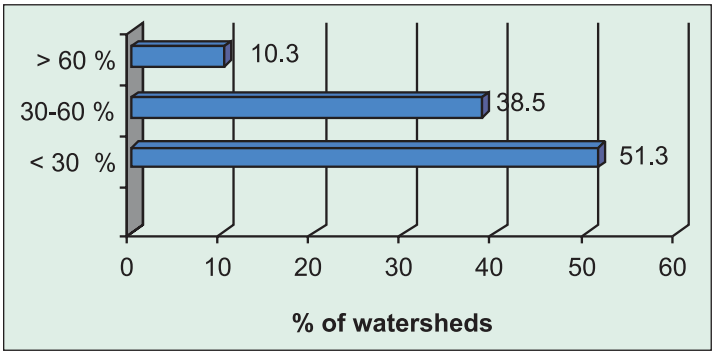

Fig.3. Percentage of watersheds by increased in cropped area.

Most of the studies found that there is significant increase in cropped area and it increased from 6.84% (Sreedharan, 2002) to 52% (Sastry et al. 2002). The increase in cropped area further helped in increased production and productivity. The productivity enhancement due to

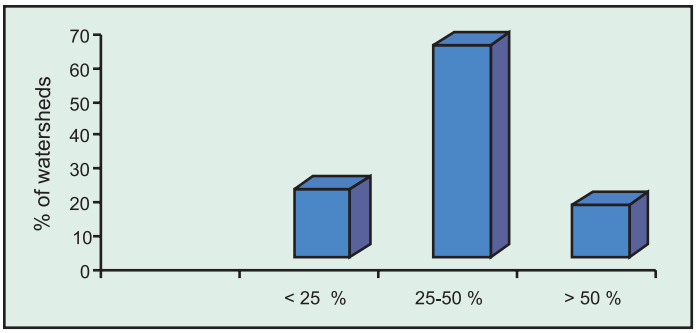

Fig. 4. Percentage of watersheds by water level in the wells

watershed development is a common phenomenon in most of the watersheds. The increase in yield of crops ranged from 5% (Shobarani, 2001) in Karnataka to 91.11% (Wakjira, 2003) and 100-300% in Andhra Pradesh (Wani et al. 2003, 2006, Sreedevi et al. 2007).

The cropping pattern changes have taken place both in additional area brought under well irrigation from the fallow lands and in area under rain-fed cultivation. The area under high water consuming crops increased by 25.3% in first crop and 29.4% in second crop period (Evaluation and Applied Research Department, 1990). Similarly, the evidence shows that the cropping intensity is increased from 120% to 147% in Kattampatti watershed and 102% to 112% in Kodangipalayam watershed (Palanisami and Suresh Kumar, 2004). Increase in crop productivity index, fertilizer application index, and crop diversification index was also observed (Sikka et al. 2000 and 2001).

Socio-Economic Impacts

Evidence indicated that the watershed development programs also produced substantial socio-economic impacts. The watershed interventions helped the rural farm and non-farm households to enhance their income level. Evidences show that the rural labour households in the treated villages derived Rs.28732 when compared to Rs.22320 in control village. It was 28.73% higher in Kattampatti watershed. Similarly, the per capita income was also relatively higher among households of watershed treated villages. The percentage difference among households across villages worked out to 13.17% in Kattampatti and 70.44% in Kodangipalayam watershed (Palanisami and Suresh Kumar, 2004). Increase in per capita income and household income helps the rural households to enhance their asset position. The asset position of the households increased significantly and it varied from 13% (Agricultural Finance Corporation, 2001) to 50% (Nalatawadmath et al. 1997). In addition, the increased income helps the households to ensure quality foods and achieve nutritional security in many cases.

Impact assessment carried out by TARU in APRLP implemented watersheds showed that about 90% of the households reported increase in income due to watershed interventions, where 37% of the respondents agreed that annual income increased more than Rs. 10000 after the implementation of the program. Similarly, more than 85% of the farmers belonging to all categories (marginal, small, medium and large) reported increased returns from the agriculture after the implementation of the program. During the survey, 71% of the respondents reported increased returns from productivity enhancement initiatives taken up through APRLP program (Santhi Kumari, 2007).

Case study was undertaken in Adarsha watershed (Kothapally, DPAP watershed) and non watershed villages for the distribution of income from the various sources during 2001 and 2002, which revealed that income from crop husbandry was 44% in non watershed implemented village, whereas it was 36% in Adarsha watershed during normal rainfall year (2001). However, the income from farming drastically was reduced to 12% in non watershed village during drought year (2002), while the income contribution from the farming remained unchanged (37%) in Adarsha watershed, showing the resilience effect of the interventions made in the watershed. During the same period, share to

agricultural income in total family declined to 12% and income from non farm activities was more through migration in non watershed village compared to watershed implemented villages (Shiferaw et al. 2006).

Watershed interventions through Sujala program in Karnataka state has increased household income by 20 per cent, resulting in the reduction in number of families below poverty line by 42% in the watershed villages. Crop productivity in Sujala watershed villages has increased by 24% and similarly cropping intensity has increased to 134% from 98% after the implementation of watershed program (Dave, 2007).

One of the objectives of watershed development program is to generate adequate employment to the local people. Review indicates that a sizable number of casual employment was created during the implementation of works such as bunding, leveling, construction of check dams, percolation ponds, summer ploughing, crop demonstration, retaining wall, plantation etc. This in turn helped reduction in out migration. Evidences show that the out migration has been reduced by 20-50% in many watersheds (Sastry et al. 2002). In some watersheds the reduction was noticed upto a higher level of 43% (Ramakrishna, 2006).

People's participation from planning to execution of watershed programs is critical. Evidences from evaluation study of 15 Drought Prone Area program (DPAP) watersheds conducted in Coimbatore district of Tamil Nadu, India, show that the overall community participation was found to be at 42 per cent. The participation was found to be 55, 44 and 27%, respectively, at planning, implementation and maintenance stages. This suggests community participation in watershed development program is yet to reach more. Similarly, overall contribution for works on private land was found to be 14.71 per cent. It varied from a low of 7% for fodder plots to a maximum of 22% for horticulture and farm pond. However, contribution in terms of cash/or kind towards development of structures at common lands such as percolation ponds, check dams etc., was found to be nil. Level of adoption of various soil and moisture conservation measures and their maintenance indicate that there is a wide variation in level of adoption, with a low of 2.4% in farm pond, 30.40% in summer ploughing, 36.80% in land leveling, 44% in contour bunding. Follow up by farmers is also found to be poor in most of the technologies and it account for 5.23% in farm ponds, 21.58% for contour bunding etc (Sikka et al. 2000).

The Water Technology Centre, Tamil Nadu Agricultural University, carried out mid-term evaluation of 18 watersheds under Integrated Wasteland Development program (IWDP) in Pongalur block of Coimbatore district, Tamil Nadu. The results reveal that peoples' participation index at planning stage was 52.69%, followed by implementation stage (39.28 per cent). This shows low level of peoples' participation at both the stages of the project (Palanisami et al. 2002). In several watersheds, the structures are not maintained due to lack of funds as well as lack of co-ordination among beneficiaries. Also because of the local (panchayat) elections, many of the presidents of the watershed associations have not been re-elected, resulting in lack of co-ordination, particularly during the post-project management. There is a decline in interest in watershed structures during the post-implementation phase and this can be attributed to (i) failure or collapse of the new institutions set up to manage watersheds; and (ii) lack of clear norms on how to operate watershed development funds (Suresh Kumar 2007). Thus ensuring peoples' participation in different stages of watershed implementation and management is crucial, which would help in achieving the objectives of watershed development in a sustained manner.

Environmental Impacts

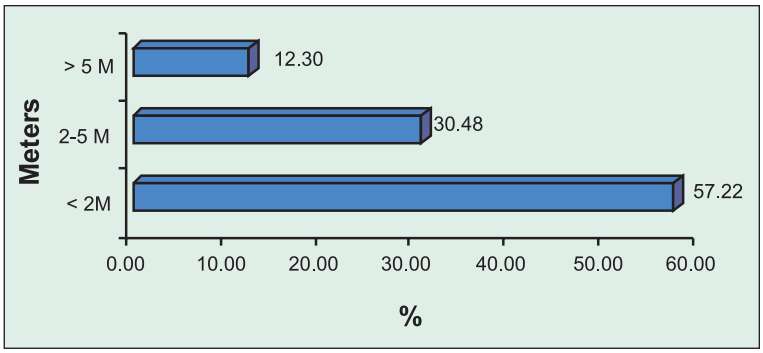

Fig. 5. Percentage of watersheds by water level in the wells

The impact assessment studies conducted by different agencies and scientists across regions over a period of time imply that watershed development activities generated significant positive impacts in the environment. One of the important objectives of watershed development is *in-situ* water and soil conservation. It was observed that because of watershed interventions water tables increased. The increase in water level in the wells is varied from 0.1 meter to 3.5 meters and this varied across seasons. Similarly, the expansion in irrigated area due to watershed development activities varied from 5.6% to 68% across regions and seasons. Experiences show that the increase in water level in the wells was less than 2 meters (57% of watersheds). About 30% of watersheds witnessed an increase of 2-5 meters and only 12% of watersheds showed an increase of more than 5 meters increase in water level in the wells.

The rainwater harvesting structures constructed in the watershed help in enhancing the surface water storage capacity. The structures like minor and major check dams, percolation ponds, farm ponds, renovation of irrigation tanks activities help in a big way to enhance the surface water storage capacity. Evidences show that on an average about 92 ha cm additional capacity was created and it varied from 63 ha cm to 136 ha cm. In addition to the fixed capacity, repeated storage will be available for different fillings once already stored water is percolated. Maximum additional storage capacity of 359 ha cm was created in Tiruppur block of Coimbatore district of Tamil Nadu. This has helped in groundwater recharge. The analysis of recuperation rate before and after watersheds indicates that recharge rate has now increased in the range of 16 to 39 per cent.

Impact of percolation ponds reveals increase in water columns of wells from 1.2 to 1.8 mtrs. The gross irrigated area (GIA) increased by 13.6% by the pond intervention. Increase in GIA per well is 0.27 ha. Palanisami and Suresh Kumar (2004) estimated that the additional surface water storage capacity created was worked out to 9299 m^3 in Kattampatti watershed, comprising 4245 m^3 from renovation of tanks, 4924 m^3 from percolation of ponds, 130 m^3 from construction of major and minor check dams. In Kodangipalayam watershed, the additional water storage capacity created worked out to 12943 m^3. This additional storage capacity further helped in improving groundwater recharge and water availability for livestock and other non-domestic uses in the village. The water level in the open dug wells had risen in the range of 2.5 to 3.5 meters in Kattampatti and 2.0 to 3.0 meters in Kodangipalayam watersheds. The groundwater recuperation in the near by wells was increased. The area irrigated increased, thus the irrigation intensity increased from 115.74% to 122.73% in Kattampatti watershed and 101.45% to 102.01% in Kodangipalayam watershed.

Watershed development activities produced significant positive impacts on water table, perenniality of water in the wells and pumping hours that resulted in an increased irrigated area and crop diversification (Sikka et al. 2000 and 2001, Sreedevi et al. 2004, Pathak et al. 2007, Wani et al. 2001). Madhu et al. 2006 found that the conservation and water harvesting measures in the watershed helped in improving the groundwater recharge, water availability for cattle and other domestic uses, increased

perenniality of water in the streams, rise in water table in the wells, sediment trapping behind the conservation measures/structures and stabilization of gully bed. The productivity of crops increased from 6.65% to 16.59% in the watershed village.

Planting trees in private farm lands and common lands was also being undertaken as part of the watershed development. This created additional green cover and thus improving the environment. The watershed eco-index which reflects the addition green cover created varied from 1.8% to 43 per cent. Thus it is lucid from the analysis that watershed development activities generate sufficient positive externalities and have significant impacts on the environment.

Overall Economic Impacts

Experiences show that watershed development activities have overall positive impacts on the village economy. The benefit cost ratio, which shows the return per rupee of investment, ranged from 1.27 to 3.7. The size of BCR also depends on the magnitude of benefits accrued due to the watershed development activities which in turn critically depend up on the rainfall. The watersheds have high BCR when the two annual rainfall received is between 700 mm and 900 mm. Similarly, the watersheds receive rainfall less than 700 mm and 700-900 mm have relatively higher IRR. The analysis also revealed that the BCR worked out to more than 2 in around 12% of watersheds. About 88% of watersheds have the BCR less than 2. Similarly, about 41.67% of watersheds exhibit 41.67% of IRR, 54.17% of watersheds have IRR between 15 and 30% and only 4.17% of watersheds have IRR more than 30 per cent.

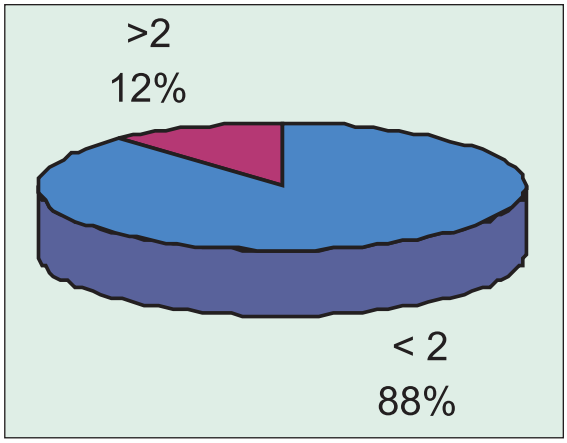

Fig.6. Distribution (%) of watersheds by BCR category.

The IRR, worked out for Kattampatti and Kodangipalayam watersheds, was 26% and 24%, respectively, which is higher than the long-term loan interest rate by commercial banks (12.75 per cent), indicating the worthiness of the government investment on watershed development (Palanisami and Suresh Kumar, 2004). Lokesh, et.al, 2006 found even higher benefit-cost ratio of 3.5 and fairly a high internal rate of return of 38% (Ramaswamy and Palanisami, 2002).

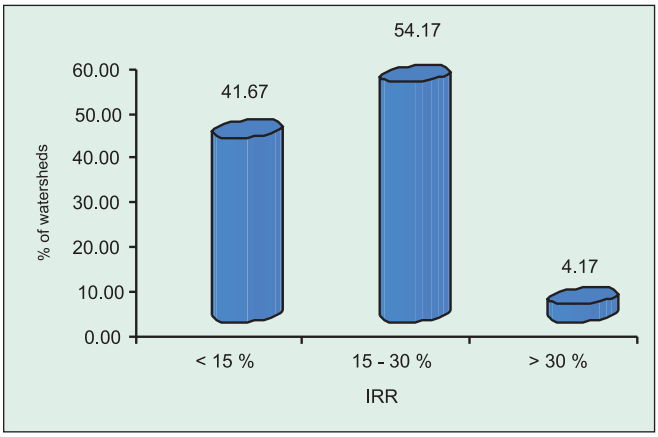

Fig. 7. Distribution (%) of watersheds by IRR category.

The net returns per rupee of irrigation cost are worked out to 1.4 to 16.32. This also varies across types of watersheds and seasons. The watershed development activities have increased the net returns per rupee of irrigation cost. The net returns have increased from 6.52 to 16.32 after the implementation of watershed development activities Similarly, the watershed development has differential impacts and varied across size groups. It is also found that the net return per acre inch

of groundwater increased by 3% and 30%, respectively for small and large farmers after WDP implementation. Water use and net returns per acre of GIA for farmers in the upstream increased by 68% and 66%, respectively and in down stream by 48% and 110%, respectively (Mengesha, 2000).

The net present value indicates that the watershed development activities produced desired results as evidenced from positive NPV. The net present value of the benefits derived from various watershed treatment activities is worked out to Rs. 1.236 million (Milkesha Wakjira, 2003). As these indicators - NPV (positive), BCR (greater than one) and IRR are greater than the opportunity cost of capital, one can speculate that the watershed development activities are financially feasible and economically viable.

Conclusion

The future strategy should therefore be a movement towards a balanced approach of matching the supply-driven menu with a set of demand-driven activities. People's participation, involvement of *panchayati raj* institutions, local user groups and NGOs along side institutional support from different levels, viz. the Union Government, state, districts and blocks should be ensured to make the program more participatory interactive and cost effective. Convergence of various rural development programs in around the watershed could be ensured to promote holistic development of watersheds. For its continued success, the program should be economically efficient, financially viable, technically feasible and socially acceptable while ensuring equity. For, sustainable development, regular and routine monitoring of environmental parameters is important as environmental enhancement increases the credibility and acceptability of the program.

b. Andhra Pradesh Rural Livelihoods Project; Insights and Impacts

The Andhra Pradesh Rural Livelihoods Project (APRLP), an initiative of the Government of Andhra Pradesh, Department for International Development (UK Government) and the Government of India, was started in 1999. This project has joined the on-going state-wide watershed program to promote a change in focus so that the livelihoods of the poorest people in rain-fed areas take centre stage.

The project has fully financed all activities for 500 watersheds in five districts *viz.*, Anantapur, Kurnool, Mahbubnagar, Nalgonda and Prakasam in Andhra Pradesh, which are semi-arid, drought-prone and among the poorest in the State. The project also provided extra finance to the Government of Andhra Pradesh for 'watershed plus' activities such as capacity building, productivity enhancement, livelihood support and convergence with other schemes and services, in more than 2,000 watersheds. In 2004-05 the APRLP approach was extended to all the watersheds in all 22 rural districts of Andhra Pradesh.

APRLP Approach

The convergence system forms the strategy of APRLP for maximizing the efforts so as to meet strategic and practical livelihood concerns of the poor, small and marginal farmers and women in the communities. APRLP has chosen watershed as a logical unit for implementing the program with efficient management of existing natural resources and convergence of activities and thereby sustaining rural livelihoods.

A hydrological watershed is a delineated area from which the runoff drains through a particular point in the drainage system, where watershed is considered as ideal unit for managing the vital resources of soil, water, and vegetation. Watershed management is the integration of technologies within the natural boundaries of a drainage area for optimum development of land, water, and plant resources to meet the basic needs of people and livestock in a sustainable manner (Sreedevi et al. 2006). Watershed management is used as an entry point to increase cropping intensity and also to rehabilitate degraded lands in the catchments with the aim of increasing productivity, enhancing biodiversity, increasing incomes and improving livelihoods. Such an approach demands integrated and holistic solutions from seed to final produce with involvement of various institutions and actors with divergent expertise varying from technical, social, financial, market, human resource development and so on (Wani et al. 2003a; Wani and Sreedevi 2007 and Sreedevi et al. 2006). The program outputs are tuned to reduce poverty, minimize land degradation, increase productivity and production, building communities' resilience to shocks due to natural calamities such as drought and flooding as well as the climate variability due to global warming.

Integrated Watershed Management Approach

Adarsha watershed, (Kothapally, Ranga Reddy district in Andhra Pradesh) is an example where a more holistic vision that brings the concept of sustainability and eco-regionality, and focuses on increased productivity and profitability of complex farming systems at the smallholder level has been adopted. The integrated watershed approach adopted by the consortium at Adarsha watershed encompasses the new science tools and technologies for harvesting and managing natural resources on a watershed scale without undermining the natural resources. Adarsha watershed team led by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in partnership with National Agricultural Research Systems (NARSs) has conceived, developed and successfully evaluated an innovative farmers' participatory consortium model for integrated watershed management. The new integrated watershed model provides technological options for management of runoff water, *in-situ* conservation of rainwater, appropriate nutrient, and soil management practices, waterway system, crop production technology, and appropriate farming systems. The model includes the consortium approach and adopts the concept of convergence in every activity in the watershed. ICRISAT has clearly demonstrated increased productivity from rain-fed systems through integrated watershed approach, which further helped in improving the soil quality and reducing the land degradation. Farmers adopted improved management practices such as sowing on broad-bed and furrows (BBF) landform, *Gliricidia* planting along bunds, integrated nutrient management treatment including inoculation with *Rhizobium* or *Azospirillum sp*, environment-friendly integrated pest management, using improved bullock-drawn tropicultor for sowing and interculture operations, and *in-situ* conservation, harvesting of excess rainwater and storage for use as supplemental irrigation, and for increased groundwater recharge. These innovations have been scaled up by APRLP in all the districts of Andhra Pradesh.

APRLP has also adopted the path with technical backstopping from research organizations like ICRISAT, Central Research Institute for Dryland Agriculture (CRIDA), and Acharya N G Ranga Agricultural University (ANGRAU) for improving the rural livelihoods in the state. The concept of consortium is an integral part of the new integrated watershed management model. A consortium approach of institutions is adopted for technical backstopping of the watersheds, where expertise from different international, national, government and non-government organizations (NGOs) is utilized for operationalizing the project. Establishment of consortium mechanism helps to expand the effectiveness of the various watershed initiatives.

Selection of Watersheds and Unique Features in APRLP

APRLP devised a nine point selection criteria for watersheds integrating natural resource degradation criteria with multiple deprivation criteria (social and material deprivation) in order to arrive at reliable indicators for both technical and social features. Micro- and macro-watersheds were identified and prioritized, based on the sediment yield index, indicating land degradation due to erosion and the dependability of precipitation and evapo-transpiration, which depends on the variability and deviation of rainfall. Habitations were ranked according to the levels of degradation and the categories renamed as natural resource deprivation typologies.

Multiple deprivation criteria are indices of poverty, considering the multiple dimensions of poverty as reflected in deprivations of income, accessibility to services and social status. Since APRLP takes a holistic view of people towards their livelihoods and opportunities, it sought to integrate the indices of natural resource degradation and multiple deprivation, and a matrix was drawn up where each was given equal importance, while selecting watersheds.

A probation period of up to 18 months was made mandatory in watersheds, during which the major activities were the preparation of capacity building plans for primary and secondary stakeholders and the preparation of strategic (perspective plan for five years) and annual action plans. In each watershed 50 hectares was selected as an entry point, out of which 20 – 30 ha of land belonging to small and marginal communities were selected for the treatment during the probation phase. The success of the probation phase was assessed by the community themselves that was empowered by the project and were instilled with a sense of ownership of the project, leading to its sustainability. APRLP adopted site-specific and farmer-friendly participatory net planning (PNP) approach for preparing action plans for the individual farm holdings. Similarly, the poorest of the poor were identified through participatory situational analysis, and wealth ranking of different households was based on their social and economic conditions.

Operationalizing APRLP-DFID-ICRISAT Watersheds

A coalition of partners consisting of CRIDA, ANGRAU, National Remote Sensing Agency (NRSA), Drought Prone Area program (DPAP) [now District Water Management Agency (DWMA], Department of Agriculture (DoA), project implementing agencies (PIAs), APRLP program Support Unit (PSU) and ICRISAT was operationalized through set of roles and shared responsibilities with common vision. The emphasis was on empowerment of the community and gender equity through knowledge-based technological and institutional interventions, targeting multiple development constraints. The representative benchmark watersheds were identified for testing the technological findings, where, in the three target districts (Mahabubnagar, Kurnool, and Nalgonda) fifty watersheds (10 nucleus and 40 satellite) were selected as the test sites for implementing the project activities. An additional 100 watersheds were added later. The nucleus watersheds served as the sites for undertaking action research for development, critical monitoring and also as sites of learning where farmers conduct experiments with improved soil, water, crop, nutrient, and pest management options with technical backstopping from the consortium partners.

The empowered farmers were encouraged to undertake convergence of various activities to increase productivity and employment opportunities for enhanced incomes. The farmers from nucleus watersheds when empowered became trainers to fellow farmers in both nucleus and satellite watersheds while the PIAs empowered and developed as master PIAs and trained other PIAs in the districts. A

detailed baseline socio-economic household survey was conducted in selected nucleus watersheds through participatory rural appraisal, structured questionnaire and secondary data to study major socio-economic and biophysical constraints for sustainable crop production and to document detailed baseline data for impact monitoring at the end of APRLP in each village.

Equity issues were addressed appropriately while preparing action plans for sharing benefits from the interventions. Similarly, micro enterprises had been promoted under plus activities to generate income for the communities during the off season. It also aimed at reducing migration of rural people during non-agricultural season to urban areas. Micro finance component had given priority to poor communities (self help groups) by linking local micro credit institutions for generating their revolving funds and for sustainability.

Impacts of APRLP: Assessment from Benchmark Watersheds

Crop Productivity

Continuous cropping without adequate nutrient supply, erosion of top fertile soil and cropping on marginal lands are some of the main causes for declining soil fertility in farmlands in the semi-arid tropics. Soil test-based nutrients and micro-nutrients dosage application, *in-situ* generation of N-rich organic matter through planting *Gliricidia sepium* on contour and property bunds to produce N-rich organic matter and generation and application of vermicompost are some of the practices adopted for integrated nutrient management in nucleus watersheds of Kurnool, Mahabubnagar and Nalgonda. The farmers recorded 17 to 125% increase in greengram yield from the micronutrient-amended plots as compared to their normal practice. Maize yields increased by 13 to 230% with an average increase of 72% over the base yield of 2980 kg ha^{-1}; the increase in castor yields was 21 to 70% with an average increase of 60% over the base yield of 470 kg ha^{-1}. Similarly, groundnut yield increased by 28% over the base yield of 1430 kg ha^{-1}.

Increasing crop productivity is common in all the watersheds and evident in a short period from the inception of watershed interventions. Adoption of improved practices like use of high-yielding cultivars and integrated nutrient and pest management by the farmers resulted in increased crop productivity and profitability. The productivity of maize increased 2 to 2.5 times with an average yield of 3640 kg ha^{-1} under sole maize and upto four-fold under maize/pigeonpea intercropping system.

With adoption of best-bet options (improved seed, integrated nutrient and pest management and improved crop husbandry practices) in benchmark watersheds, farmers recorded spectacular yield advantages in sorghum (35-257%), maize (30-174%), pearl millet (72-242%), groundnut (28-179%), pigeonpea (97-204% in sole and 40-110% in intercropping) and mung bean (42-111%) crops.

System Diversification and Resilience due to Watershed Interventions

Most farmers are practicing single cropping (either rainy season in *Alfisols* or post-rainy season in *Vertisols*) in the target ecoregions. Double cropping (sorghum-chickpea; maize-chickpea) introduced in the traditionally *rabi* (post rainy) season in Vertisol areas of Kurnool and Nalgonda districts (850 ha) and intercropping (sorghum/pigeonpea; castor/pigeonpea; groundnut/pigeonpea; groundnut/pearl millet and cotton/pigeonpea) in the Alfisol regions (2500 ha) of Mahabubnagar, Nalgonda and Kurnool districts. Similarly case study was undertaken in Adarsha watershed (Kothapally) and non watershed implemented village for the distribution of income from the various sources during 2001

and 2002, which revealed that income from crop husbandry was 44% in non watershed implemented village, whereas it was 36% in Adarsha watershed during normal rainfall year (2001). However, the income from farming has drastically reduced to 12% in non watershed village during drought year (2002), while the income contribution from the farming was unchanged (37%) in Adarsha watershed showing the resilience effect of the interventions made in the watershed (Fig 8). During the same period, income from non farm activities was more in non watershed village compared to watershed implemented villages.

Soil Loss and Runoff

The implementation of soil and water conservation interventions resulted in reduction in runoff and rise in the groundwater level in the benchmark watersheds. The mean of 7 years runoff in treated sub watershed was 40% and in untreated sub watershed was 70% of seasonal rainfall in Adarsha watershed. The mean of 7 years data reveals that about 44% of runoff and 69% of soil loss were reduced in the treated sub watershed compared to the untreated sub watershed. There is a significant reduction in peak runoff rate as observed in the treated sub watershed, which is responsible for the soil erosion

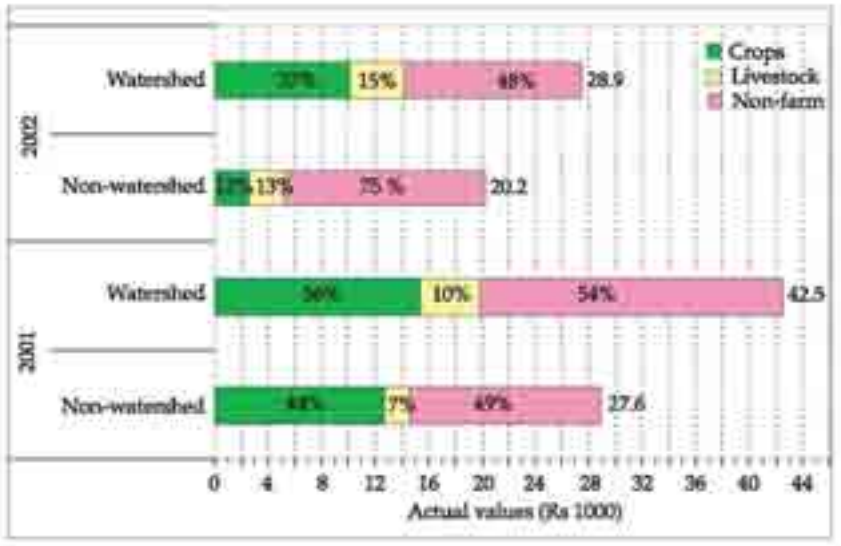

Fig. 8. Income stability and resilience effects during drought year (2002) in Adarsha watershed, Kothapally, AP, India.

Household Income

The impact evaluation in APRLP Watersheds by TARU (2007) has indicated that the average household incomes have risen by 76% over a period of four years ever since the project was initiated. The incremental income increases are high for medium (93 per cent), followed by large farmer households. Landless and marginal farmer households have experienced 84 and 65% income increases, respectively.

It is reported that the APRLP revolving funds have played a critical role in income increases of the poorest households. In middle and higher income households, income increases are attributable to loans taken from revolving funds established both by APRLP and from IKP. But income increases are mainly attributed to APRLP among the poorest of the poor, landless and marginal farmers. As many as 65% of APRLP beneficiaries attribute to household income increase to the loans from PE and EP revolving funds.

Capacity Building and Social Capital

Promotion of livelihoods through enterprise development is one of the major emphases of APRLP. Several capacity building programs and training to strengthen the livelihood activities were undertaken for initiating various income generation activities. Considering the importance of both agriculture and

animal husbandry in providing income to the households, particularly in the dryland areas, the program has provided services for enhanced productivity in agriculture and livestock through trials, trainings, creating assets and infrastructures in the villages. Revolving funds were provided for members to undertake various income-generation activities in both enterprise and productivity enhancement areas. In Prakasam district (Anonymous 2000), the households have undertaken a number of activities through the revolving fund. A majority of members (51%) have taken up milch cattle units for income generation through selling of milk in the village or nearby areas. In setting up grocery shops, 8% of members have utilized the loan amount, followed by 9% for sheep and goat and 3% for agricultural purposes. Interestingly, 28% of the members reported to have invested the amount in miscellaneous activities like tea stalls, cloth shops, STD booths, cable business, tailoring, hotels, etc. However, majority of members have gone for milk cattle investments. ICRISAT encouraged income-generation activities like village seed bank (SHG in Nemikkal watershed in Nalgonda district, Karivemula and Devanakonda watersheds in Kurnool district), vermicomposting and *dal* mills (SHG in Karivemul watershed in Kurnool district) among the marginal communities for their income generation.

Many village level institutions have been developed to undertake the watershed program. There is a tremendous involvement of members in the process and participation in various activities of capacity building and livelihood-generation activities. It was also overwhelmingly found that the involvement of women members was there in various activities of APRLP. The building up of social capital among the communities is one of the outcomes of APRLP that helped to sustain the institutions even after the exit of program in the watershed villages.

Conclusion

The scaling up of integrated community watershed management interventions through APRLP has shown that a vast potential of rain-fed agriculture remains untapped as current rain-fed crop yields range between 1 and 1.5 t ha^{-1}, which can be easily more than doubled with improved management. Current rainwater use efficiency of 35-45% can be substantially increased by adopting integrated water resources management approach along with improved soil health and crop management options. The paradigm shift from soil water conservation to rural livelihoods in APRLP approach have paved the way for watershed plus activities, which helped to address the communities in holistic manner for improving livelihoods.

c. Impact of Watershed Program in North Eastern Regions

Various watershed projects are being implemented under different watershed programs in NER. Some of these watershed projects were evaluated by a few independent and capable institutes like NERI, WALMI, ICAR Research Complex for NEH Region, Agricultural Finance Corporation (AFC) Assam, by National Productivity Council (NPC), New Delhi, etc. The watershed evaluation reports, prepared by these agencies present, assessed and quantified impacts of watershed projects in NER but due to certain obvious reasons like lack of benchmark information and poor record keeping these reports, on many counts have just talked about the indicative impacts rather than their actual quantification. Though all watershed evaluation reports pertaining to various watershed development projects under different watershed programs in NER clearly establish an affirmative and conducive role of watersheds in augmenting income, equity and sustainability in the NER, it appears from the review that impacts of different watersheds in NER have been somewhat mixed and mild. Some of the indicated impacts of watershed projects have been discussed in the subsequent paragraphs.

Bio-Physical Indicators

Degradation of land due to removal of fertile top soils from the hilly tracts has become a serious threat for the sustainability of agriculture and ecology in NER. Heavy soil erosion often found to be suffocating for the drainage systems, leading to the problem of water stagnation in low-lying areas. In addition, it causes serious sedimentation in different bodies in the NER. On an average, a huge amount (83.8 tonnes/ha/annum) of soil sediments were found to be draining away from a barren fallow land having 65% slope, if no measures were taken to check the water run-off (Annual Reports of ICAR NEH, various years). The average losses of plant nutrient per ha per annum in the sloppy lands were also substantial. Annually, 1118 kg organic carbon, 14 kg potassium, 649 kg magnesium, 407 kg zinc and 17 kg copper drained away due to soil erosion induced by shifting cultivation. The studies further reveal that soil erosion from hilly slopes (60-70%) under first, second and abandoned shifting land could be as high as 147 tonnes, 170 tonnes and 30 tonnes per hectare per annum, respectively. In total, it is estimated that annually 181 million tonnes of soil were lost in NER (ICAR NEH, Soil Div, 2004). However, watersheds have been extremely beneficial in mitigating the problem of soil erosion. Available watershed evaluation reports indicate that the soil and water conservation measures like dug out sunken ponds, brush wood check dams, loose boulders' dams, live check dams, etc., were constructed in the upper, middle and lower reaches of the watersheds. Upper reaches often experienced high erosion problem and needed some specific conservation measure to check the heavy loss of soils. Forest plantation, taken up under watersheds helped a lot in minimizing the erosion problem. Introduction of horticultural crops like jackfruit, litchi, guava, mango, citrus fruits, etc, on the lower portion of the hillock not only helped in reducing erosion but also provided sustainable source of income in the watersheds like Umlangiong. However, giving absolute quantitative values for the erosion control potentials of various conservation measures or watersheds is difficult because despite the indication that watersheds have contributed positively in minimizing the problem of soil erosion none of these reports come up with any quantified estimate about the extent of reduction in soil loss.

Increase in Net Sown Area

The watersheds in NER have also been successful in increasing net sown area. The reports indicate that the extents of increase in net sown area of watersheds were between 13.7 (Sidibo, Dhani Cherra watersheds) and 40% (Pipla-Cherra watershed). On an average, net sown area in watersheds increased by 21.4 per cent. One of the most important contributions of watershed is intensification of cropping. Due to increased availability of water, gross cropped areas in watersheds increased up to 37.5 per cent. In Peach Hoj watershed, 57 ha of *rabi* crop area was developed. This implied that due to watersheds farmers were able to allocate more area under sowing and even area sown more than once was on increasing path.

Increase in Cropping Intensity

This fact is fairly qualified by the increased cropping intensity in the watershed areas. For example, increase in cropping intensity in Sidibo and Dhani Cherra watersheds was 22% and 24 per cent, respectively. Nurang Cherra watershed observed an increase in cropping intensity by 45 per cent, which was above the average. On an average, cropping intensity in watersheds in NER increased by 40 per cent.

Increase in Productivity

Productivities of most of the agricultural and horticultural crops also rose substantially. Productivity of cereals has gone up by 2-6 quintals/ha in Sidibo watershed of Arunachal Pradesh. Productivity of rice, which is a leading crop in NER, increased by 2.7% to 25 per cent. Interestingly, productivity of paddy in shifting cultivation area also increased substantially.

In Meghalaya, about 9% productivity enhancement had been reported in the shifting cultivation area, whereas productivity gains in the transplanted area was only 3% after implementation of the watershed. Due to lack of baseline information most of the watersheds for different states were unable to focus such kind of impact. In Sidibo watershed, 2-6 qtl. of yield gain in cereals was reported after the implementation of watershed program. In Sanouru watershed, paddy yield increased by 11 qtl (from 15qtl before watershed to 26 qtl after start of watershed). State wise productivity gains from different crops are given in Figure 9.

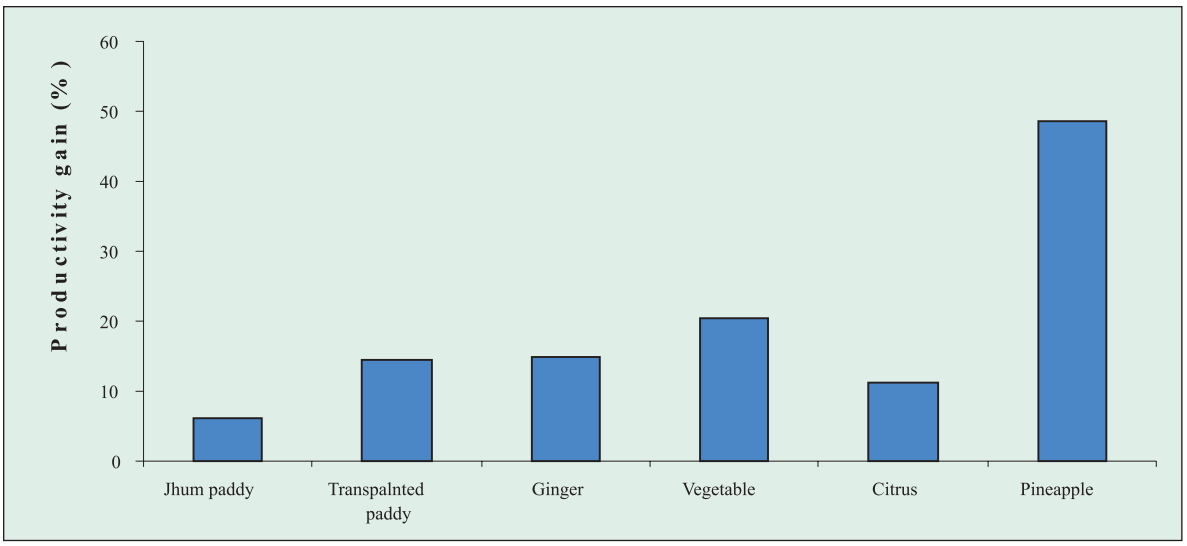

Figure 9 . Average increase in productivity of important crops in watersheds in NER.

Besides a few exceptions, there was substantial improvement in the productivities of cultivated crops. Yields of different horticultural crops (fruits and vegetable) also increased substantially between 11% (citrus) to 118% (pineapple). However, the most significant contribution of watershed program is transformation of cropping pattern.

Cropping Pattern Change

Watersheds have brought in significant cropping pattern changes in the watershed areas. Most of the regions in NER used to practice mono-cropping. Implementation of watershed programs has made substantial changes in the cropping pattern. Conserved soil moisture and stored water enabled farmers to take double or multiple crops. Cultivation of *rabi* crops were reported in the watershed areas. In consequence, many new crops like wheat, tomato, cabbage, cauliflowers, radish, oilseeds and pulse were being taken in watershed areas. Farmers were willing to switch over to wet terrace cultivation if water was made available through diversion of streams. Of course, rice was the prime choice for wet terrace cultivation (Pani Kheti). Under shifting cultivation, *jhumia* families adopted mixed crops like maize, millets, paddy, colocasia, etc. However, significant decrease (30%) in shifting cultivation area

due to adoption of permanent/settled cultivation has been noticed. Out of 1.908 million ha of shifting cultivation area in North Eastern states, only 0.351 million hectare was developed till 2005-06. About 27% *jhumia* abounded *jhum* practice. In 2000, the unit cost of treatment of shifting cultivation area was Rs. 10,000/ha. Jhum area per family reduced from 0.84 ha to 0.56 ha

Area under fruits and vegetable was on increasing spree in various watersheds. It is difficult to provide estimates of areas under fruit crops like banana, citrus fruits, pineapple, mango, litchi, etc., but it has been reported in many of the watershed reports that plantation of these crops were on progressive modes. For example, in Phijo watershed, vegetable area increased by 25 per cent. The area of potato also increased about 12 per cent. Similarly, in Andhra Cherra watershed, more than 24% area increase was reported for the vegetable crops. In Sanouru watershed, a 10 ha orchard was developed during the project period and seedlings of peach, pears and orange were distributed among the farmers that would have added even more area under fruit orchard thereafter. Twenty five hectares horticultural orchard for banana, pineapple and orange plantation was developed in Tapi watershed. In addition, 25 ha of tea plantation was also taken up. Tapi watershed also undertook forest plantation on 100 ha of land. Sixty five hectares of land under forestry and bamboo plantation was in Peach Hoj watershed. As a matter of fact farmers were able to have 20 qtl firewood and 100 numbers of bamboos. However, to develop systems like agro forestry, forestry, orchards, soil conservation structures, dairy, land reclamation, and fisheries asked for substantial establishment cost and higher labour and other external inputs. The most concerning feature is high establishment cost and negative net returns in the initial years of watershed development.

Economic Evaluation of Watersheds

Economic considerations are probably the most important element behind performance of any activity that involves investment and labour. Economic evaluations of watersheds in NER indicate that people have derived significant economic benefits from various watershed projects. Out of 17 watersheds, for which benefit cost ratios (B:CR) were reported, 24% yielded B:CR between 1.0 and 1.25 and their mean was 1.12 (Figure 10). Benefit cost ratios for 29% watersheds were found to be varying between 1.25 and 1.5 with a mean of 1.39. Nearly 24.0% watersheds had an average B:CR of 1.64. Twelve%

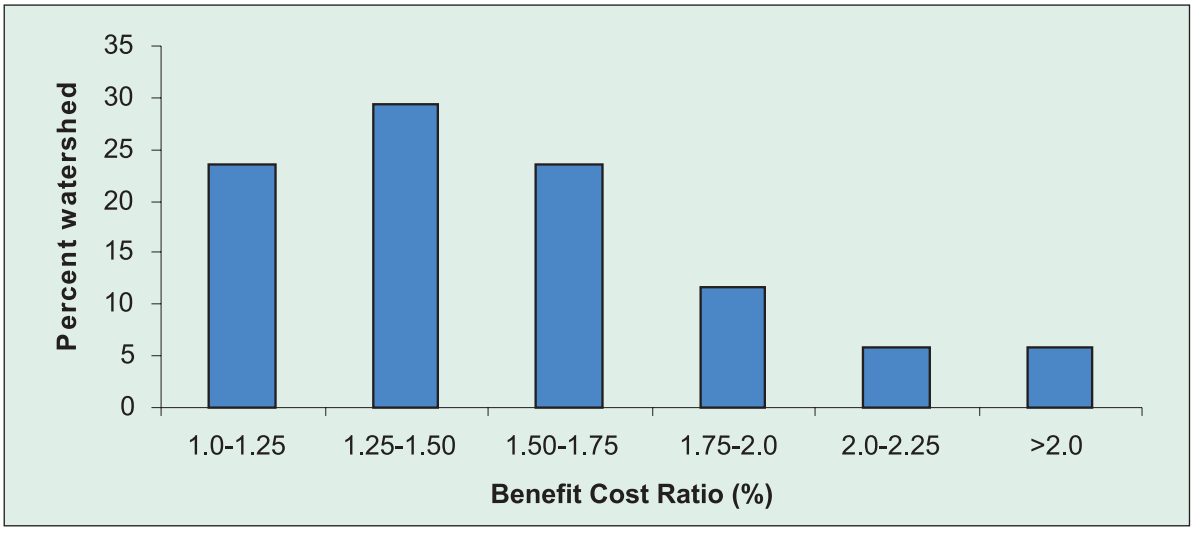

Figure 10. Performance of different watersheds with regards to benefit cost ratio.

Figure 11. Performance of different watersheds with regards to internal rates return.

watersheds had an average B:CR of 1.88. Merely two watersheds (12%) crossed B:CR of 2.0. Average B:CR for all watersheds was 1.65, which indicates that every rupee invested on watersheds in NER generated 1.65 times benefit in monetary terms.

Internal rate of returns (IRR), which is an indicator of the efficiency of an investment, is widely used to take an investment decision. It is the annualized effective compounded return rate that can be generated from an investment. Obviously, higher IRR from an investment is always desirable and it is assumed that greater is the IRR better would be the chances of solvency of the project. It was observed that IRR of the watersheds were fairly moderate, which indicate the financial feasibility of watershed projects in NER (Figure 11). The IRR for Sidibo, Umalangiong, Kupli watersheds were more than 14 per cent, which was the lowest. Among all reviewed projects, the mean IRR, obtained from 13 watershed projects was 19.6 per cent. IRR for about 85% watersheds was more than 14 per cent, which indicates the financial soundness of most of the watersheds.

The ex-ante evaluation of investment from Upper Shipra watershed project of Meghalaya, clearly indicate that the project was financially feasible with the internal rate of return (IRR) of 14 per cent, the benefit cost ratio (B:C) was Rs. 1.77 and net present value (NPV) was about Rs. 77789/ha. The income inequalities at ex-ante level indicated that overall Gini index from total households income were higher (0.323) at higher altitude as compared to lower altitude (0.204). Among the different sources of income, the share of agricultural income is the highest (62% and 36% respectively) in both higher and lower altitudes. Also its% contribution in total inequality is the highest in both higher and lower altitudes (62 and 55%, respectively).

Using the technique (Lerman and Yitzhaki, 1985) of source decomposition of the Gini index, clearly indicated that the marginal effect of agricultural income was negative (Table 6) at higher altitude and positive at lower altitude. The negative marginal effect implied that additional increase in agricultural income would reduce the total inequality, which is socially desirable. Whereas positive marginal effect in agricultural income would lead to increase in inequality. The positive marginal effect at lower altitude may be due to better utilization of land resources by particular group of farmers. This may also have positive impact on development of farmers well being in long term as the present growth of income (under some category of farmers) may percolate to other farmers through 'tickle down effect'. The above findings clearly indicate that through adoption of scientific method of farming in

watershed, agriculture will be crucial, both for enhancing the income level of the households as well as to take care the equitable aspects of the welfare being of the society.

It is interesting to note (Table 7) that income from livestock component is contributing positively towards the reduction of household income inequality. The negative marginal effects for livestock component strongly suggest that the incorporation of this component is to make watershed area development in equitable manner.

The contribution of income from labour services source indicate that it plays a vital role in total income share in lower altitude than that of at higher altitude, as their respective share is 30 and 5 per cent, respectively. The marginal effect is negative in both location and suggests that through additional manpower requirements in watersheds can stimulate to raise in family incomes and can help to reduce the inequalities of income distribution which is one of the implicit goal of the watersheds.

Employment Generation

A few evaluation reports have indicated that employment opportunities also increased in different watersheds due to adoption of improved production practices and diversification towards high value enterprises like fruits and vegetables, dairy, goatry, poultry and piggery. Various watershed related activities such as construction of check dams, fencing, terrace bunding, dug and sunken ponds, etc. have also augmented the employment opportunities in watersheds. Generally, two types of arrangements

Table 6. Decomposition of household's existing income (at ex-ante level). Inequality at lower altitude

Source of Income	Correlation on with rank of total income	Gini of sources	Income share	Share of income inequality	Per cent age contribution of total inequality	Marginal effects
Agriculture	0.841	0.375	0.356	0.113	0.554	+ 0.197
Livestock	0.920	0.183	0.064	0.011	0.054	- 0.010
On & off-farm employment	0.712	0.163	0.296	0.034	0.167	- 0.0129
Business	0.933	0.245	0.167	0.038	0.187	+ 0.020
Others	0.634	0.102	0.116	0.008	0.039	- 0.077

Table 7. Decomposition of household's existing income (at *ex-ante* level). Inequality at higher altitude

Source of income	Correlation on with rank of total income	Gini of sources	Income share	Share of income inequality	Per cent age contribution of total inequality	Marginal effects
Agriculture	0.998	0.320	0.618	0.198	0.617	- 0.001
Livestock	0.822	0.932	0.158	0.121	0.038	- 0.120
On & off-farm employment	0.215	0.176	0.051	0.002	0.006	- 0.045
Business	0.711	0.798	0.097	0.055	0.170	+ 0.073

were made to meet various labour requirements in watersheds. In watershed like Umlangiong, one member from each household contributed at least one day in a month as *shramdan* to perform various activities of watershed. But in many watersheds considerable employment (between 104-498 person days/year) were generated. The average figure for annual employment generation was 393 person-days/ year. In terms of percentage, annually 4% to 24% more employment was generated in the watersheds, which was certainly helpful in controlling migration of labour from NER.

Income Generation

Watershed projects had a very positive role in raising income of its participants. Many of the watershed evaluation reports showed gains in income from different watershed activities. In case of shifting cultivation, on an average 25% increase in income of the *jhumia* families was reported. Possibilities of additional income worth Rs. 2500-5000 per hectare were reported due to inclusion of *rabi* crops in watersheds. In Umalangiong watershed, total annual income increased by 48.5 per cent. Income from paddy and maize also increased by 39% and 60 per cent, respectively.

Livestock, Poultry and Fish Production

It appears that considerable efforts have been made to integrate livestock, poultry and fish production with other farming activities. Scrub bulls were castrated to naturally control the livestock population and breed improvement. Fish fingerlings, chicks and piglets were also distributed in many of the watersheds. However, the result was mixed. In some cases, livestock and poultry production contributed significantly in income augmentation. For instance, in Nurang Cherra watershed, farmers earned 94% more income from cattle, 83% from goat, 82% from pig and 60% from poultry (Table 8). However, it was an irony that in many cases the tribal farmers in watershed slaughtered and consumed the animals.

Table 8. Average increase in income due to livestock and poultry in Nurang Cherra watershed

	Average income (Rs./month)		Average income increase	
Livestock	Before watershed	After watershed	(Rs. Per month)	(% per month)
Cattle	340	760	320	94.1
Goat	300	550	250	83.3
Pig	330	600	270	81.8
Poultry	250	400	150	60.0

Non-Farm Ancillary Activities

Watershed projects do aim to improve the skills of the farmers in different non-farm ancillary activities. Many people were trained in black smithy, carpentry, bamboo mat making, and other handicrafts. However, most of the report rate this component (non-farm ancillary activities) of watersheds weak and calls for strengthening this component.

d. Impact of Watershed Development in Central-Western Region:

Evidence and Way Forward

This report is based on the state level reports prepared for the four states in Central-Western region in India. The states are: Madhya Pradesh (M. P.), Maharashtra, Gujarat, and Rajasthan[2]. The main focus of the reports is to present major findings pertaining to the impact of watershed development project (WDPs) as evidenced in the existing studies.

In all, the four states cover approximately 50,000 micro watersheds initiated under the major programs in the states. The study tried to focus mainly on the impact assessment/evaluation studies conducted after the completion of the project rather than capturing the evidence during the mid-term evaluation.

Overall Observations:

The summaries of the major findings of impact assessment in the four states in Central Western region in India suggested an overall positive impact of watershed projects in the region. The impact, however, is highly variable.

Notwithstanding the methodological difficulties as well as limitations of the approaches actually adopted by different scholars/agencies, there is overwhelming evidence that the projects have yielded benefits as per some of the key parameters viz; increase in cropped and irrigated area, increase in agriculture production owing mainly to the increased availability of water, shift to high value crops requiring more water, enhanced availability of fodder (especially from crops), and increased availability (if not security) of drinking water.

There are also positive benefits in terms of institution development and participation of the marginalized community in the public spheres created by watershed development. The study, however, does not focus on these aspects.

The bio-physical and economic impact, captured in this chapter however, remains limited to a sub-set of households (30-35 per village in the case of increased irrigation) and is also selective in terms of time frame depending on rainfall profile on the one hand and the lapse of time since the structures were created. Equity and sustainability thus emerge as the major concerns at this stage of watershed development. The evidence on productivity is at best mixed. This may be because either the crops are non-comparable (in a pre-post scenario) and/or the yield levels are compared across irrigated crops (in a with-without scenario). A more careful analysis carried out by scientific institutions do suggest increased yield (given the irrigation level) resulting from increased use of fertilizer or improved cultivars, etc. Such studies, however, are fairly scanty. Apart form technology adoption, efficient use of groundwater is yet another issue, which remains to be addressed especially when the impact of WDPs is mainly centered round increased availability of water through various water harvesting measures.

There is little evidence on improvement of common property land resources (CPLRs), livestock, and plantation related activities though, the studies based on RS-data do provide evidence on increased vegetative cover and reduced fallow/degraded land. To what extent, the increased vegetation may

2 The report for M. P. has been prepared by Amita Shah (at GIDR); for Maharashtra by Abraham Samuel, K. J. Joy, and Suhas Paranjape at SOPPECOM; for Gujarat by Sachin Oza and Suvendu at DSC; and for Rajasthan by Viren Lobo at SPWD.

provide direct benefit to the landless/poor households is difficult to discern. For, the trajectory is neither automatic nor, sustainable in absence of appropriate institutional mechanisms for managing such resources. Equity in sharing of the augmented water is also equally crucial if the expanse of watershed benefits is to be enlarged substantially.

There are of course, examples of good practices in each of the four states. These examples come from both-the NGOs as well as the GO-implemented projects. How to move from limited and selective benefits to a more comprehensive impact on agriculture and rural livelihood is an issue, which needs to be addressed in the next round of watershed projects in the region. There are a number of steps that are essential for tapping the full potential of watershed projects given the policy framework. Learning from the varied experiences is useful; this would necessitate adequate material from impact assessment studies, carried out by using appropriate and comparable methodology; covering a fairly representative sample; and put in public domain for bringing better transparency and engagement of the various stake holders.

The statewise impacts of watersheds are presented in subsequent paragraphs.

WDPs in Madhya Pradesh: The Impact[3]

Based on the response obtained from both the PIA as well as group of villagers, the impact of DPAP (349 micro WDPs across 21 districts; and 23 Micro-WDPs in 12 districts) was estimated. It was found that : (i) soil-moisture conservation was reported to be satisfactory in the case of 13 (out of 21) districts in the case of DPAP and 4 (out of 12) districts in IWDP, (ii) the impact on increase in cropped area was mixed in both the projects. In fact, there was a decline in the area in Jhabua and West Nimar due to decrease in irrigated area, perhaps due to sub-normal rainfall, (iii) increase in cropping intensity in several districts, especially where irrigation facility was developed under the project. Average agricultural income increased in most of the districts, (vi) impact on reduced out-migration was limited, (vii) sustenance of community asset was very poor (almost non-existent) in Jhabua, West Nimar, East Nimar, Ratlam, Dhar, Shajapur, Betul, Chhindwada and Dewas. In fact some of these districts are high-concentration areas for watershed projects as noted earlier.

RGMWM - 43 Micro-WDPs with 443 Households in Raisen District

The study is based on a detailed investigation into the impact of micro-WDPs by comparing households in the project and non-project villages, covering 11 and 3 out of the total of 14 villages under the study. Using the propensity score matching method, the study found that majority of farmers growing k*harif c*rops were no better after WDPs in income terms; for r*abi* crops the scenario was worse and also more variable, perceived positive impacts were mainly in terms of time saved (17 minutes per day) for fetching drinking water, short term gains and direct employment, and long term gains in access to water was not visible. The study thus highlighted the fact that these results do not match with the self-assessment where the increase in yield was of the order of 60-80 per cent. While these are not strictly comparable results, it is noted that the issue of the timing for impact evaluation and the selection of criteria for impact assessment by creating counter factual is very important.

Deashpand and Naryanmoorthy, 1999 while assessing the impact of NWDPRA found that the increase in crop yield was moderate, increase in employment – significant, increase in net income-low, shift

3 The report draws heavily on two studies undertaken by Sen, Shah, and Kumar (2007) and Shah, Joshi and Desai (2008) as part of the larger initiative of Forum for watershed Research and Policy Dialogue (ForWaRD).

towards high value crops-high, moisture conservation-moderate, repletion of groundwater-high, and biomass generation-high. It is important to note that high increase in groundwater use is the main source of a moderate increase in yield, which despite high shift towards high value crops have brought low increase in farm-income.

In the result of a rapid assessment (A sample of 346 micro-WDPs in 18 districts; 5% of the completed WDPs) it was found that:

over 80% of the villages had reported increase in water table as a major benefit from the watershed project, followed closely by impact on reduced soil erosion (77%), and employment opportunity on the project work-sites (57%). Increased in vegetation/tree cover was reported by about 8% of the villages whereas improvement in drinking water was reported by 11% of the study villages. However, the extent of benefits from irrigation and soil-moisture was confined to a sub-set of households in villages. About 63% of the villages reported no or less than 20% of the households benefiting from irrigation; the proportion is 50% in the case of increased soil moisture.

Examples of Good Practices

Notwithstanding the mixed impact, there are a number of examples of good practices with respect to project-implementation and impacts. Some of these include:

i) DANIDA-supported projects with emphasis on low-cost technology and equity

ii) Action for Social Advancement (ASA)with focus on irrigation and credit support

iii) CHSE-implementing the projects of RGMWM with appropriate thrust on technology and participatory institutions

iv) Samaj Pragati Sahyog (SPS) facilitating NGOs to implement project supported by CAPART and also promoting equitable use of water among tribal households

v) XIDS special emphasis on gender and equity.

While most of the above examples represent NGO-implemented projects, there are a number of good practices that have been adopted by the government implemented projects, especially the policy level innovations adopted by RGMWM in the past few years.

Impact Assessment in Maharashtra

The study by ISRO in six WDPs indicated that agriculture land increased between 2-5 per cent. Increase in cropping intensity was from 111-113 in as per the state level study of NWDPRA-projects; from 106-117 in Khed; and from 99-138 in Kanhur Mesai (NWDPRA).

Increase in yield was reported in most of the above studies. The increase varied significantly from 10% in *kharif*, 20% in *rabi* and 25% in summer as reported in NWDPRA-projects to some thing like 60-70% in other cases.

There has been a significant increase in area under irrigation in the case of the WDPs covered by the studies noted above. Most of the increase in irrigated area has been attained through increased number of open/tube/bore wells.

Reduced soil erosion in RVP-supported by GTZ, the cost-benefit ratio for reduced silt was 0.66: 1.The increase in income per households ranged between 8-19% in Kundawale and Khandas (NWDPRA).

Cost-benefit ratio in Kamini watershed was 1:1.3 (excluding secondary benefits); and 1:1.28 for water reservoir in Western Plateau and Hills. In NWDPRA, the increased on-farm employment was found to be in the range of 7-25% per household. It is noted that increase in crop productivity per se, does not increase labour absorption.

Impact of WDPs in Gujarat:

The studies undertaken for impact assessment of watershed projects in Gujarat are a few and far between the evaluation of MoRD and World Bank projects reports increase in cultivated area. According to a study conducted (by Shah and Memon) in four micro watershed projects covering 120 sample households, the cultivated area had increased by 2. 8%.

Increase in irrigated Area: The study of four micro watersheds indicated an increase of about 17% in irrigated area; much of the increase in irrigated area was during the *kharif* season. The increase in irrigated area ranged from 55 to 107 ha. in the sample micro watersheds. There has been a significant increase in number of farmers growing irrigated cotton, which is a long duration crop.

Crop Productivity and Income: In the four micro watersheds crop productivity increased especially in irrigated crops. This has resulted in average net returns by Rs.15,000/ per landed household. This works out to be 63% as compared to the pre-project situation. Findings from the WB-study indicated only marginal increase in crop productivity.

Observations from Rapid Assessment of 25 Micro WDPs in Four Villages: The sample consisted of 21 WDPs, implemented by some of the leading NGOs; the remaining five were implemented by the Forest Department, Government of Gujarat.

The households reporting benefits from soil-moisture conservation is 33% whereas the coverage of irrigation benefit is 36% among the sample villages.

The proportion of wells that are functioning as source of irrigation has increased from 34 to 88% after the project interventions.

There has been significant increase in the area under irrigation intensive crops such as cotton and paddy. Whereas 17% of the sample villages reported increase in the number of buffaloes, 12% of villages reported in the number of goats in the post-project period.

Overall benefits were reported to be high in the case of 12 villages, the level of benefits was medium in the case of 13 villages. Low level of benefits was not reported by any of the sample villages. Detailed on-site and off-site impact of fully treated watershed in Rajasamadhiyala in Rajkot district in Gujarat is reported in a separate case study by Sreedevi et al. 2006a under case studies section.

Impact of Watershed Projects in Rajasthan

A total of approximately 8,000 watersheds have been implemented in the State covering over 50,00,000 ha land. These include about 1500 WDPs under NWDPRA since the 6th Five Year Plan. We have tried to summarise major findings from some of the impact evaluation studies conducted at the time of completion of the project period.

One of the major suggestions of the evaluation team was that project formulation is weak. The watershed development planning does not seem to be based on sound database/information.

Community participation at the planning stage needs to be substantiated so that its commitment for sustaining the assets created is obtained. The involvement of PRIs is essential right from the project formulation stage.

The agriculture in eastern Rajasthan is characterized by high risks from drought, degraded natural resources and pervasive poverty. At Gokulpura-Goverdhanpura village in Bundi Rajasthan, ICRISAT along with partners implemented integrated watershed project using holistic system approach with integrated genetic and natural resource management (IGNRM) strategy. This report discusses the multi-faceted impact of this watershed program. It has been found that the science-led participatory watershed program at Gokulpura-Goverdhanpura had made positive impacts on natural resources, rural livelihoods and environment. The major impact of watershed interventions was seen in improving the surface and groundwater availability. Increased water availability resulted in increased cropping intensity and diversification to more remunerative landuse systems, involving livestock, horticultural and vegetable production. Overall the watershed program has reduced land degradation, enhanced agricultural productivity and incomes, decreased poverty of rural poor, reduced labor migration and improved environment quality (Pathak et al. 2007).

e. Impact of Watershed Programs in Central India

This section presents experiences of impacts of watersheds from the Central India. Impact evaluation of soil and water conservation measures adopted in any watershed area is essential to know an overall assessment of the technical results. It also helps in knowing the appropriateness of the method employed in carrying out the project activities and also to estimate the medium and long term social and economic benefits of the activities, efficiencies and impact of the project in the context of its stated objectives. Keeping in view the importance of the post project evaluation, it attempts to assess the impact of different soil and water conservation measures adopted in hot arid zone of Rajasthan under different watershed projects under taken by CAZRI and State Government.

CAZRI Experience

Central Arid Zone Research Institute (CAZRI), Jodhpur, has conducted several studies on hydrological behavior of different process in the arid zone and developed techniques for development of arid watersheds. CAZRI has effectively developed more than 6000 ha area under Jhanwar, Sar, Baorali-Bambore, Kalyanpur and Kukma watersheds.

For rainwater management, institute has designed underground tanka of 10 m3 to 600 m3 capacities for different rainfall and catchment conditions. These tankas were successfully constructed in Jhanwar, Sar, and Baorali-Bambore watersheds. Harvested water of these tankas have been used to provide life saving irrigation to plants. The benefit cost ratio of tanka ranged from 1.25 to 1.40 under different uses.

About 60 ha area were covered under contour bunding in Jhanwar, and Baorali-Bambore watersheds. Bunding helped in increase in yield of pearl millet by 40% over control (3 q/ha) in Jhanwar watershed. Contour vegetative barriers of perennial grasses or shrubs were constructed for conserving soil and water in sloping lands. Rooted slips of local eight species of perennial grasses (*Cenchrus ciliaris*, *Cenchrus setigerus*, *Cymbopogon jwarancusa*, *Lasiurus sindicus*, *Panicum antidotale*, *Panicum turgidum*, *Saccharum bengalense and Vetiveria zizanioides*) and seedling of six species of shrubs (*Agave americana*, *Aloe barbadensis*, *Barleria prionitis*, *Euphorbia antisyphylitica*, *Ipomoea carnea*

and Leptadenia pyrotechnica) were transplanted at 1 m vertical interval on contours across the slope.

Result indicated that perennial grass species performed the best and formed effective barrier against soil erosion. Runoff volume and specific peak discharge were reduced by 28 to 97% and 22 to 96% respectively (Sharma et al. 1997). In another study conducted at Kalyanpur (Distt. Barmer) during 1998, vegetative barrier of *Lasiurus sindicus, Saccharum munja and Cassia angustifolia* were established at horizontal interval of 30 m. The moisture data revealed 36.5%, 72% and 54.2% higher moisture storage as compared to control in C*assia angustifolia, Lasiurus sindicus* and *Saccharum munja* respectively.

Under ex-situ rainwater management a Khadin of 20 ha areas was developed in Baorali-Bambore watershed with surplussing arrangements. Before construction of Khadin, uncontrolled runoff from upper catchment used to wash away seeds, fertilizers, and standing crops besides loss of valuable water. After construction of Khadin, farmer could take excellent *kharif* and *rabi* crops.

For farm water management, a farm pond of 20,000 m3 capacity was constructed at Kukma watershed at Bhuj in Gujarat. Construction of this farm pond resulted in assured availability of 20,000 m3 water even in as small as 150 mm rainfall region. The collected water was used to provide irrigation to datepalm, *ber, aonla* and other fruits plants in nearby area. For individual household roofwater harvesting system was designed and demonstrated at many places in watershed areas.

For *in-situ* rainwater management circular micro-catchment of 5% inward slope with LDPE lining was successfully demonstrated in watershed area for establishment of *ber* and other trees. For severally eroded and gullied catchment loose stone check dams (LSCD) at 1 m V.I. were constructed in Jhanwar watershed area on 17 gullies. Regular observation on these gullies indicate that LSCD proved to be very effective in controlling further extension of gullies and all these gullies got stabilized with adoption of LSCD.

For channel treatment three masonry anicuts and two loose stone anicuts were constructed on main streams in Jhanwar and Baorali-Bambore watershed, respectively. Construction of these barriers resulted in substantial reduction in velocity of water, thereby causing reduction in erosion at downstream and precipitation of suspended sediments at upstream. Temporary inundation of water at upstream helped in regeneration of vegetation in upstream beside recharge of groundwater. In Sar watershed, artificial recharge of groundwater was superimposed in a 2.8 ha m pond with three infiltration wells to improve water availability for conjunctive uses. For moisture conservation, soil, straw and plastic mulch were tried in Baorali-Bambore watershed. The grain yield of pearl millet was 32.67 and 28.12% higher for plastic and straw mulch, respectively over no mulch.

In alternative land use system, various systems like agro-horticulture with pearlmillet/mung/moth + *ber/aonla*/pomegranate, silvi-pastoral system with C*enchrus ciliaris* + *Prosopis cineraria/ Colophospermum mopane/Harwickia binata* were successfully established in watershed areas. Ditch-cum-mound fencing and cut and carry system were adopted for pasture development in Jhanwar watershed. For wastelands alternative crops like C*assia angustifolia* and *Lawsonia alba* were successfully raised at appropriate locations in the watershed. For arable farming improved varieties of Pearlmillet, clusterbean, mungbean, mothbean, etc., were introduced in the watershed areas.

State Government Experience

As a result of watershed management activities in degraded Aravallis at Siha, Rewari (Haryana), the number of electrified wells increased from 67 to 205, sprinkler set 2 to 70 and irrigated area 260 to 420 ha. The livestock population increased from 882 to 1396. Consequently, milk production increased from 2997 to 5724 litres/day and overall income increased from 400 to 500 per cent. With proper soil and water conservation measures in watershed in Aravallis, soil loss was reduced from 150 t/ha to less than 5 t/ha. Development of water resource resulted in the increase of net irrigated area to 28 ha and cropping intensity from 128 to 210 per cent. Food grain and fodder production also increased substantially.

Likewise, adoption of graded bunds, gully control structures, contour cultivation, inter cropping, use of cover crop in rotation along with other improved package of practices have been found sustainable in semi-arid region of Rajasthan. Graded bund has reduced the run-off from 20 to 4.8% and soil loss from 24 to 4.12 t/ha/yr. Besides other benefits intercropping on contour resulted in 48% higher grain yield. By adoption of various development activities in Osian index catchment during a five-year period, cropping intensity increased by 31.4% and forage yield by 1.97 1/ha. Construction of water harvesting structures helped to increase the groundwater recharge as indicated by rise in static water level. Sediment deposition against loose stone check dam was 3.86 m/ha/yr.

4.4 Impact Evaluation of NWDPRA Watersheds Implemented During 8th and 9th Five Year Plans using Satellite Images

Ministry of Agriculture, Government of India, has accorded high priority to the sustainable integrated farming systems of rain-fed areas on watershed basis through National Watershed Development Project for Rain-fed Areas (NWDPRA). Watershed development involves diversified activities on the field for land and water resources development, varieties of activities leading to socio-economic development, involvement of villagers, financial resources, etc. Hence, monitoring and evaluation in addition to impact assessment becomes important to assess long-term and short term effects at watershed level. Remote sensing provides multi-temporal spatial and synoptic view of large areas that facilitate a good opportunity to identify and monitor changes in natural resources before and after taking up of developmental activities. Such methods have been found to be useful in the past to bring out impacts in a cost-effective manner and hence the same was evaluated in selected watersheds implemented during 8th and 9th Five Year Plans

Satellite Images for Impact Assessment

The remotely sensed data has the advantages of providing synoptic view and large area coverage which helps in obtaining the proverbial "birds eye view" of the features. Satellites, which orbit around the earth, provide a vantage point to find, measure, map and monitor the earth's natural resources. Remotely sensed data potentially offer a rich source of information about conditions on the earth surface that change over time. Measuring and evaluating changes in a landscape over time is an important application of remote sensing. With the launch of Indian Remote Sensing Satellites (IRS), data availability both in the multipsectral and panchromatic domains with varieties of spatial resolution are assured for user community. The repetitive coverage of the same area over a period of time provides a good opportunity to monitor the land resources and evaluate the land cover changes through a comparison of multi-temporal images acquired for the same area at different points of time.

Changes like increased area under cultivation, conversion of annual crop land to horticulture, change in surface water body, afforestation, soil reclamation, etc., could be monitored through satellite remote sensing. Due to large area coverage at different point of time, the technology facilitates for evaluating the ground realities at any given point of time.

The satellite images from different space platforms have varieties of sensors in the visible and infrared region and are good for assessing the dynamics of watershed development, type of vegetation, crop vigor, growth monitoring, green biomass, soil and water characteristics of a watershed. However, these sensors have a constraint of not being able to sense the earth's surface during cloud cover conditions. This is particularly a constraint while imaging in the optical region of the electromagnetic spectrum during the *kharif* season.

Monitoring and Evaluation of NWDPRA using Remote Sensing

During first phase of the project, 60 watersheds were identified for impact evaluation from Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu and Uttar Pradesh and similarly 62 NWDPRA watersheds treated during 9th Five Year Plan period was taken up during second phase from Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttaranchal, Uttar Pradesh and West Bengal. Evaluation of identified watersheds was carried out using remote sensing technique by considering the parameters like cropped area: change in area extent of agricultural crops, cropping pattern, extent of wetland and irrigated crops; *plantations*: increase in agricultural and forest plantations; *wastelands*: change in areal extent; *alternate land use*: switching over from marginal cropland to agro-horticulture and agro-forestry; *water body*: change in number and areal spread and *biomass*: overall changes in biomass or canopy cover or productivity.

Methodology Used

Satellite remote sensing data of the identified watersheds pertaining to pre and post treatment periods are analyzed. The analysis involves geometric corrections, digitization and extraction of the study area, preparation of landuse/landcover maps of two time data, preparation of normalized difference vegetation index (NDVI) images for both data sets, quantification of improvements in the arable and non- arable lands using time-series analysis of both data sets. The digital analysis of satellite data was carried out at the Regional Remote Sensing Service Centre (RRSSCs), Indian Satellite Research Organization. The analysis involves geometric correction of image data with respect to reference map to start with, digitization of watershed boundary, land use / land cover mapping, NDVI generation and image comparisons (Fig 12). Geometric correction of IRS LISS sensor data covering the study area was done through acquisition of ground control points (GCPs) from 1:50,000 reference map with respect to corresponding satellite images followed by computation of polynomial transformation model with two-way relationship, followed by output image generation through resampling techniques to obtain rectified final image. Image-to-image registration of two time satellite data was done by identifying accurate common GCPs on both images for computing yet another transformation model followed by re-sampling, resulting in co-registered images for comparative analysis.

Change detection is a process of determining and evaluating difference in a variety of surface phenomena over time while using geospatial data sets of multiple dates. Changes can be determined by comparing spectral responses at the same spatial location amongst a set of two or more multi-spectral data acquired at different points of time. There are many change detection algorithms using digital

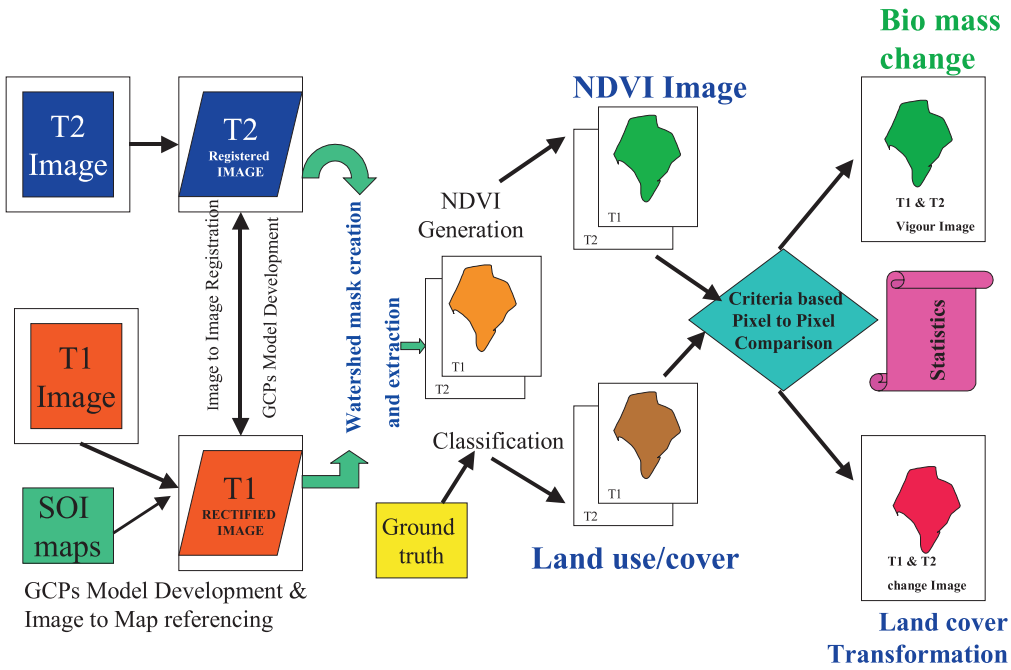

Fig 12. Impact evaluation pathways using remote sensing on watershed program.

techniques like image differencing, image rationing, principal component analysis and comparison of classified images.

Findings from the Study on Watershed Implemented during 8th and 9th Five Year Plans

- There is substantial improvement in the cropped area (upto 16.1% in Jagner block, Agra dist.) during 1990 to 1999 as evidenced from corresponding IRS 1B LISS 2 data of *rabi* season and processed land use/land cover information. During the period, fallow lands have decreased (maximum observed in Babina block, Jhansi dist. i.e., 10.7%).
- During the period (1990-1999), wastelands have decreased (maximum observed in Jagner clock, Agra dist. i.e., 10.4%). Some of these wastelands have been put to cultivation and some of these wastelands have been put under plantation in the watersheds.
- Bundhis constructed by Minor Irrigation department in Jagner block, Agra dist. are contributing towards surface water retention and groundwater recharge. This is evident from change in cropped area in the vicinity of such structure and large increase in number of tube wells in upstream of the structures. Therefore, such structures could be brought under purview of NDWPRA program.
- Saccharum munja plantation is offering alternate employment opportunity as it is useful for rope making.
- The vegetation vigor analysis for the watersheds has signified that nearly 50% of land (maximum 70.2% in Jogia, Siddhartha nagar and minimum 38.1% in Ghatampur block Kanpur) within the watersheds does not bear any significant change in their biomass status. These areas belong to arable land being cultivated (where cropping pattern remains same), fallow, rocky and bare regions.
- Biomass has moderately increased on almost 30% geographical area of the watersheds (maximum 57.2%) in Ghatampur block, Kanpur and minimum 14.9% in Jogia block, Siddarth nagar). These lands belong to wastelands put to plantation, changes in cropping pattern etc. It has also been

observed that group of crops under cropland 1 are relatively mature as compared to cropland 2 during satellite data acquisition and therefore exhibits relatively higher NDVI value. In Ghatampur block, Kanpur district ,changes in Yamuna river course has increased area under dry river sand and therefore NDVI value has increased.

- Biomass has increased largely on almost 1-3% of land which was earlier wastelands and then turned for cultivation as observed especially in Badaun where wastelands are put to cultivation and increase in dry river course as observed in Ghatampur block, Kanpur district.
- On almost 10% of land (maximum 16.1% in Baldirai block, Sultanpur and minimum 1.2% in Ghatampur block, Kanpur), biomass has moderately decreased. These areas belong to cultivated land where cropping pattern has changed or the specific cases e.g., in Baldirai block large area of ravinous tract has been put to *Saccharum munja* grass cover. This grass is relatively mature during February-March when the satellite data has been acquired and therefore NDVI values are relatively less as compared to pre-treatment period. In Jogia block, Siddarth Nagar area under seasonal waterlogging has got increased due to shallow bed level of Banganga river and therefore it has affected the NDVI values.
- Upward trend has been noticed in irrigated crops in all watersheds. There is also increase in area under agro-horticulture/agro-forestry (maximum 0.7% in Jagner block, Agra and minimum 0.05% in Bamaur block, Jhansi).

Remote Sensing for Monitoring and Evaluation of Watershed Development Programs

Remote sensing technology has made great strides and contributed significantly in the management of natural resources, disaster management, environmental monitoring, etc. Operational use in many of the application areas including watershed management has been achieved using Indian Remote Sensing satellite data. The remarkable developments in space technology currently offers satellites which provide better spatial and spectral resolutions, more frequent revisits, stereo viewing and on board recording capabilities. The Indian Remote Sensing satellites IRS-1C and 1D provide multispectral data with 23 m resolution and panchromatic data with 5.8 m resolution. This high-resolution satellite data not only improves identification of different features but also helps in mapping at cadastral level, providing detailed information on 1:12,500 scale. The composite data of LISS-III and PAN generated for sample areas of southern and northern Karnataka clearly showed that various features like agro-horticulture, orchards, irrigated crops, wastelands, forest plantations both young and matured could be interpreted more accurately. Thus, the potential of high-resolution satellite data could be effectively used for watershed management and monitoring activities at land ownership level with reference to survey numbers. Now, the availability of high-resolution satellite data has further opened up new vistas in the area of watershed development. The satellite data along with conventional data could be effectively used for watershed developmental and management activities, such as inventory and assessment of natural resources, viz., soil, land use or land cover, geology, groundwater prospects; watershed characterization; watershed prioritization; water balance studies and run off estimation; groundwater targeting; land capability classification; identification of existing or potential erosion prone areas and monitoring and evaluation of developmental activities.

Geographical Information System (GIS) for Integrated Watershed Management

The information derived from satellite data, reference maps, and other socio-economic data could be stored in Geographical Information System as a database. GIS is an effective tool for development of a

watershed, as information derived from remotely sensed data can be integrated with the conventional database. GIS also facilitates modeling to arrive at locale specific solutions by integrating spatial and non-spatial data such as thematic layers and socioeconomic data. The database generated will also help the authorities in planning and change monitoring and assist in understanding the effect of developmental activities undertaken by incorporating the data derived from-the repetitive coverage of the satellite.

Conclusion

The availability of high resolution data through remote sensing opens the new era in watershed development program in terms of planning and monitoring of activities. However, it is necessary to put down institutional mechanisms between ISRO and implementing agency at national level for using the technology. The cost of operation and success of the project can be enhanced through remote sensing and GIS through appropriate planning and concurrent monitoring of the processes.

4.5 Micro-Level Case Studies

a. Socioeconomic and Policy Research on Watershed Management in India: Synthesis of Past Experiences and Needs for Future Research: ICRISAT- IWMI Study

A large portion of the rain-fed areas (60% of arable land) in India is characterized by low productivity, high risk and uncertainty, low level of technological change and vulnerability to degradation of natural resources. Water is critical in these areas because of scarcity and also lack of proper management that accelerates shortages. Heavy and intense rainfall and surface runoff during the monsoons lead to soil erosion and siltation or pollution of water bodies downstream; and severe drought in the summer season lead to acute scarcity of water for postrainy season crops, which are two extreme eventualities that need to be managed for enhancing agricultural productivity, augmenting income and preventing degradation of soil and water. The watershed program was initiated in India with the basic promise to overcome such anomalies in rain-fed areas. The nature and scope of the watershed programs were modified over different plan periods and recently tuned to encourage people's participation. The purpose of the study is to review past experiences in watershed research and development in India with emphasis on policy and institutional constraints to sustainable watershed management in the rain-fed drought-prone regions, synthesize lessons from diverse experiences, identify knowledge gaps, and develop recommendations for future research. The study will provide useful insight into the importance of economic, policy and institutional issues and constraints, and suggest options for watershed management.

The study is based on review of literature and earlier empirical analysis in different watershed areas complemented by field study of six watershed development programs in India. These programs covered different agroecological regions and are managed and funded by different agencies: Mysore Resettlement and Development Agency (MYRADA) in Karnataka, Rajiv Gandhi Watershed Mission (RGWM) in Madhya Pradesh, Adarsh Gaon Yojana (AGY) in Maharashtra, Sukhomajri and Logarh watersheds in Haryana, Fakot watershed in Uttarakhand and Adarsha watershed in Kothapally, Andhra Pradesh. The basic criteria for selection of the case studies are based on the functioning, processes and approach of the different watershed programs in

the country. The main purpose of the case studies was to examine the commonalities among watersheds located in different agroecoregions, developed through various approaches to watershed management by different agencies, and identify factors that contribute to the success or failure of different watershed development interventions. The focus was to understand if there were some common forces, processes and factors, which lead to their short term success and long-term sustainability. The six watershed programs from six different states were selected considering biophysical factors, socioeconomic conditions, organizational affiliation (NGO, state governments, Central Government, and international institution) and institutional approaches in managing the programs. The selected watersheds fall in a range of agroecoregions managed by the government, ICAR, NGOs and a consortium of institutions consisting of various agencies and led by ICRISAT.

Analysis of Selected Case Studies

Adarsh Gaon Yojana (AGY)

The State Government of Maharashtra launched the AGY (Adarsh Gaon Yojana meaning model village program) in 1992. The aim of the program was to create one model village in each *taluk* of the state, using Ralegaon Siddhi as a model, with an emphasis on the development and regeneration of land and water resources. The five principles of Ralegaon Siddhi were *nasbandi* (restriction of family size), *nashabandi* (ban on alcohol), *charaibandi* (ban on free grazing), *kurhadbandi* (ban on tree felling), and *shramdan* (donation of voluntary labor for community welfare). These have evolved out of the philosophy of conservation and sustainable development. Villages that were selected for funding under the AGY program had the following characteristics: (i) located in a drought-prone area; (ii) scarcity of water was the key problem; (iii) irrigated area was less than 30%; and (iv) population was less than 4000. Villages had to apply for participation in the program through *gram sabha* of the village abiding by the principles and fulfilling the criteria laid down by the AGY. Once the villagers had made this resolution, they sought the support and approval of the *gram panchayat* and identified an NGO to monitor and assist them in implementation of the program. After the NGO had been identified, the villages approached the state level committee for participating in the AGY. Some villages formed their own NGO and hired technical and social staff for implementing the program. AGY aimed to demonstrate how the convergence of various government programs at the village level could bring about social and economic change along with regeneration of land and water resources. The strategy necessitated a high degree of cooperation between various departments that usually do not interact with each other. The funds sanctioned under the AGY were made available to the villages for two main types of activities: (1) watershed development as the core activity; and (2) other non-core development activities.

Over the past few years, the groundwater table has increased from a depth of 35-50 feet to 10-15 feet in Hiwre Bazar village, which is recognized as one of the best villages under the AGY. Prior to project implementation, water was available in the village at a depth of 35 to 50 feet during the monsoons and about 55 to 60 feet during summer. The number of wells in the village increased from 97 in 1993 to 217 in 2000. About 98% of soil erosion has been checked effectively through the construction of structures on the slopes, combined with controlled grazing.

Lessons Drawn from the AGY Examples

- The AGY placed great emphasis on peoples' participation and expected community institutions or the local village-level NGOs to drive the project. However, it cannot be assumed that formation of local institutions will ensure peoples' participation.

- A high degree of motivation needs to be maintained through incentives and benefits that are visible to sustain motivation for participation. Strong leadership is essential that can motivate people to participate in the project activities. A committed leader can bind the community for a common purpose.
- Political support is required to ensure regular flow of funds to the projects. Since the AGY was a completely state-funded program, it was expected that the government would dedicate funds to the program so as to ensure that implementation at the village level would not be affected. Benefits were not always visible on the ground because funds were released sporadically, which had a negative impact on the motivation of the people to work together.
- *Shramdan* or contribution of voluntary labor is an effective cost-sharing mechanism that helps to establish peoples' ownership of the project, although in some cases, cash contributions by households might be even more effective.

Rajiv Gandhi Watershed Mission (RGWM)

The RGWM, launched on 20 August 1994 by the Government of Madhya Pradesh, has become India's largest watershed management program targeting to cover nearly 3.5 million ha. The objectives of the mission are to: (i) augment and conserve soil and water resources (both surface and groundwater) for sustaining livelihoods and reducing vulnerability to droughts; (ii) develop an easily accessible repository of scientific and technological inputs for planning and implementation; (iii) maximize people's participation for sustainable resources development; and (iv) improve the environmental resource base. The watersheds under the RGWM were classified into three zones: recharge zone, which usually has lands having high gradients; transition zone, which has gradients requiring *in-situ* moisture conservation and discharge zone, which has flat lands requiring efficient water spreading techniques. Key tasks of the mission were to integrate concerns of poverty reduction and environmental regeneration through participatory watershed management; focus action on degraded areas and dryland areas to build environmental security and food security; and improve agricultural production and incomes. The Common Guidelines for Watershed Management of the Ministry for Rural Development were followed. A mission director with a mission office at the state level was appointed to oversee the mission activities. The project implementing agencies (PIA) are both government departments and NGOs. The program at the local level was planned and implemented by the watershed committees, which control about 85% of the total program funds. The work is executed through watershed committees consisting of user groups (UGs), SHGs and women thrift and credit groups, while the State Government provides technical and financial support through the mission. For the purpose of planning and implementation the watersheds are divided into project areas covering an area of 5000 to 10000 ha, which are known as Milli Watersheds.

The mission has introduced a system of participatory evaluation by the community itself, where villages, which has undergone more than three years of work under the Watershed Management Mission, a public display board is maintained in a central place in the village regarding the progress of activities. External evaluations have also been commissioned through agencies such as UNICEF. The main impact of RGWM was observed in increased in groundwater, improved area under irrigation and fodder production besides decreased land area under degradation. Improved area under winter cropping has improved significantly, thereby improving cropping intensity.

Lessons Drawn from Rajiv Gandhi Watershed Mission

- The mission approach, backed by political will and support, has resulted in intensification of implementation of centrally sponsored watershed development programs and ensured a regular flow of funds to the projects.

- The effective representation of the village population on watershed committees and their functioning depends upon the quality of facilitation and support provided by the PIA. Since efforts at community mobilization have been inadequate, people are less willing to cooperate and resolve conflicts.
- Benefit sharing mechanisms have not been put in place between various strata of communities. Therefore, it was found that some farmers benefited more than others. However, the landless have benefited from the increased demand for labor in the village.
- The upstream-downstream impacts are evident because the whole Milli watershed is being treated through micro-watershed projects. However, no areas of conflict have as yet emerged.
- Villagers do not have a feeling of ownership for the project because more emphasis has been given on the formation and capacity building of the watershed committee as against the village community. There is a general feeling that the committee is responsible for the project and hence capacity building is required at all levels.
- Sustainable institutions at local level are lacking to take this work forward, although physical impact of the watershed interventions is evident. Emphasis on achievement of physical targets has compromised the developing sustainable institutions and collective action.
- The coordination between government departments takes place through the state-level mission office, but there is no similar structure at the district levels. At the district level, the collector influences the implementation strategy of the project. A mechanism is required through which people's views can be taken into account.

Mysore resettlement and development agency (MYRADA)

MYRADA is a non-governmental organization working for rural poor through building and strengthening grassroots' level institutions to address developmental issues. It seems that the organization works in a decentralized manner and each project has an identity of its own, with flexibility to make decisions and plans for implementation. MYRADA's micro-watershed development program is based on the philosophy that local-level institutions manage the watershed development activities through evolving the model of the self-help affinity groups (SAGs). The process of formation of SAGs is through three phases: (i) identification of appropriate members or group having common affinity that bind them together, where the group decides the modalities of the savings and credit and rules and regulations for group functioning (ii) group stabilization phase involving imparting managerial skills and (iii) withdrawal phase comprising linking and internalizing external agencies for moving forward.

The basis of institutions managing the watershed resources was the credit groups (SAGs). Further, SAGs are graduated into micro-watershed development associations (MWDA) involving all interested farmers, particularly those whose lands were within the boundary of the particular association. The process through which an MWDA emerges differs in each watershed. Poorer people need time and space to build up their skills and confidence to join others. For example, some groups with lands having potential for immediate returns may come together more quickly than others. The MWDAs are different in structure and function compared to the SAGs although they are established on the base formed by the SAGs. As against the SAGs that grant loans for any type of credit need of the member, the MWDAs give loans only for treatment of private lands as well as for agricultural inputs, ie, for any land-related activities. The MWDA members participate in the whole process of development and designing the plan for natural resource management and watershed development. MWDA gets grant from MYRADA for developing both common and private lands. The association converted the grant to a soft loan for activities on private lands. The loan amount was repaid to the

association by the farmers and is being revolved on a loan basis, with interest, for upgrading and maintenance of private lands. On measuring commitment and willingness of the members to invest in their own lands, MYRADA introduced the concept of contributions ranging from 30 to 50% of the costs in cash for activities taken up on individually owned lands. To ensure sustainability of the MWDAs, linkages are developed with financial institutions, agricultural extension services and other government departments. Members of the MWDA are encouraged to interact with the different departments so as to build their confidence and capacity to negotiate for accessing better services.

The treatment plan for each micro-watershed is completed by the members of the MWDA with the help of a team of a civil engineer, agriculture specialist, soil engineers and training personnel. Men and women users of common property resources such as livestock owners participate in the planning and become members of the MWDA deciding on the control of grazing, prevention of tree felling, plantation activities and selection of species.

The physical interventions made under MYRADA's watershed development program can be understood through its key slogans: (i) make water 'walk'; and (ii) bring soil back to life. MYRADA also believes that unless watershed activities are accompanied by agriculture development strategies, food security and protective livelihood systems, improvement in the quality of life for the poor cannot be ensured. Hence, through different awareness programs, training courses and credit facilities, a holistic program consisting of integrated agricultural development, off-farm livelihood activities, afforestation and use of non-conventional energy are undertaken in the micro-watershed. The improved crop productivity and water availability has been reported in the watershed besides implementation of controlled grazing in common lands and forbidding of bore wells in the watershed.

Lessons Learnt from MYRADA Implemented Watershed Programs

- The MWDA and MYRADA are partners in planning, implementation, management, monitoring and evaluation of the project, where smaller homogeneous MWDAs are more viable and sustainable than large and heterogeneous ones. The interests of marginalized groups are better represented in smaller groups. Equity can best be achieved through smaller interest groups.
- The funds received from donors like German Agro Action are not intended for targets, giving the organization the flexibility to achieve their objectives of building and strengthening MWDAs.
- It is true that plans need to be developed for the entire watershed area, but implementation is more effective when the watershed is divided into smaller micro-units. MYRADA puts in a considerable amount of time and energy in capacity building of the MWDAs making them sustainable.
- Upstream vs. downstream: MYRADA looks at 'coverage vs intensity'; water harvested in the upper reaches through treatments is not used for irrigation. It is used only for recharge, and therefore as yet there have been no conflicts between upstream and downstream farmers.

Sukhomajri Watershed

Sukhomajri is one of the first model watersheds in the country, which is well acclaimed for its success on several fronts. This provided foundation for developing key innovative processes (planning, implementation and monitoring), benefits derived and their distribution among the communities and people's participation. The watershed project covering an area of 135 ha was started in 1975, when Sukhana Lake, a public recreation site located in Chandigarh was seriously confronted with the problem of upstream soil siltation. The investigations carried out by Central Soil and Water Conservation Research and Training Institute (CSWCRTI) suggested that the problem originated from the village Sukhomajri located 15 km upstream from the lake.

The village Sukhomajri is located in the northwest part of India, near Chandigarh. The village had a population of 538 in 1976; most of them belonged to the *Gujjar* community, which is generally engaged in livestock activities. Crop and livestock production was the main source of livelihood, where goat rearing is common in the village. These contribute about 58% of total income from all sources. The average size of landholding was small (0.57 ha), with majority (71%) having land below 1 ha. The individual farmers owned about half of the land in the village and the other half was common property land.

A watershed initiative was jointly developed by the CSWCRTI and the Government of Haryana to stop the siltation into the Sukhana Lake. The project was fully funded by the Ford Foundation and the CSWCRTI, Dehradun took the lead in planning, execution, monitoring and evaluation of the project. The major components of the watershed program were: (i) rainwater harvesting and recycling, construction of three earthen dams with a total storage capacity of 20 ha-m, and underground PVC pipe to irrigate winter crop; (ii) demonstration of improved crop production technologies; and (iii) rehabilitation of hilly catchment area with mechanical (gully plugs, trench, etc) and vegetative measures like planting of trees and grasses. The unique feature of the project was that the villagers were involved in locating appropriate sites for check-dams and gully plugs. The watershed witnessed complete transformation through concerted efforts to involve effective participation of local community for managing common property resources besides physical construction for conserving soil and water.

The benefits were substantial in different forms. The foremost was soil conservation. The siltation in the Sukhana Lake declined by 95% in 1980; it saved Chandigarh US$200,000, annually used for regular repair and maintenance. The effective people's participation came as a consequence of numerous private benefits to the villagers due to conservation measures. Within the village, the regeneration of grasses and trees contributed in improving the irrigation water availability, which intensified cropping patterns, and expanded the livestock enterprise. The regeneration of grasses increased from 40 kg ha^{-1} in 1976 to 3 t ha^{-1} in 1992. Similarly, the number of trees also increased from mere 13 Nos.ha^{-1} in 1976 to 1292 Nos. ha^{-1} during 1992 in the watershed (Arya and Samra 2001).

'Water Users' Association' was initially formed involving communities in the village, which was later converted to 'Hill Resource Management Society' (HRMS) to enhance crop and livestock productivity; promote equitable distribution of benefits; and conserve resource effectively. The harvested rainwater through suitable structures, was shared equally by all families (including landless laborers), irrespective of the land ownership. All the members were given the right to sell water at a specific rate to any farmer in the village developing suitable mechanisms among communities. A good network of irrigation pipes was developed for water distribution. Similarly, each family was allowed to collect grass and fodder from the community land. Income of villagers has improved significantly through selling *bhabher* grass (*Euloliopsis binata*) and increased milk production by feeding *Mungri* grass drawn from common lands. However, the profit of the HRMS has substantially fallen under new profit sharing system implemented by Government of Haryana and hence the investment in repair of the dams and other structures has virtually stopped, which has adversely affected rainwater conservation in the reservoirs. The ultimate effect was non availability of water to the members for irrigation. Such a policy change by the State Government has affected the sustainability of not only the Sukhomajri watershed but also all Sukhomajri model watersheds developed in Haryana.

Lessons Drawn from the Success of Sukhomajri Watershed

- Community participation in planning, execution and management is a precondition for the success of the watershed. The entire village society was empowered to take decision on various aspects, including that of sharing benefits.

- The watershed activities must be backed by assured prices and appropriate market arrangements for the resulting goods and services produced. The flexibility in changing enterprise portfolio should be quick with changing technology in primary and secondary sectors. The government policies need to be favorable and induce society to conserve natural resources.

ICAR Model Watershed

Indian Council Agricultural Research (ICAR) launched a few watersheds as action and research project under its Operation Research Program. The aim was to test and demonstrate the improved technologies in actual farm conditions. The main focus was dissemination of new information to the farming community. The purpose was to demonstrate the technologies that raise farm income through conserving soil, water and biodiversity and involving the beneficiaries. Fakot watershed implemented under ICAR model is in Dehradun district, which is located in the western lower and middle Himalayas of Uttaranchal. It has an area of 370 ha, covering eight hamlets with a population of 912 in 1975. The baseline information revealed that the region was severely prone to the degradation of ecosystem, dominated by the resource-poor and poverty-stricken inhabitants and deprived of basic minimum infrastructure, like road, markets, power, etc. Agriculture was largely dominated by women folk as the men were forced to migrate in search of jobs to other parts of the country. The project was conceived, developed, executed, monitored and evaluated by CSWCRTI, Dehradun. In the agricultural lands, the bio-engineering structures included construction of checkdams, *guhls* (water channels), bench terraces and vegetative barriers. In the rain-fed areas, the farmers did not consider terracing profitable; therefore, these were leveled gradually. In the non-agricultural land, the measures included diversion drains, contour trenches, gully or *nala* plugs, retention of walls and vegetative cover to check roadside erosion. Besides these measures, improved cropping systems, agricultural technologies (including high-yielding varieties of crops and fertilizer application) and management practices were developed and demonstrated by CSWCRTI to the farmers.

In this watershed, common interest points among the beneficiaries were identified and asked to form groups with their own rules and regulations to manage the resource effectively. Water harvesting and distribution was the entry point in the watershed. The common interest groups were for water harvesting, recycling, fodder supply, fruit and vegetable cultivation, etc., and were formed after the financial withdrawal from the project. The success of the watershed has induced adoption of similar models in surrounding areas. The whole region has been converted into a vegetable and fruit belt with surplus milk due to market access and proximity to urban centre. Water is a binding force for the farmers to work together for regular repair and maintenance of the check-dams. The watershed witnessed sea change from a high subsistence-based system into a commercial and market-responsive system. The millets (*mandua* and *jhingora*) were gradually replaced by rice, wheat and maize with the availability of irrigation water. The transformation continued and the watershed area was converted into a vegetable production region with tomato, cauliflower, cabbage, capsicum, chili, ginger, potato, onion, beans, etc (Dhyani et al. 1997).

Lessons Learnt from ICAR Model Watershed

- Confluence of interest stimulated community to participate in managing natural resources, where water and pasture brought the community together.
- Regular flow of technology has substantially raised the farm income through diversification in favor of high-value commodities. Initially, the availability of improved technology of rice, wheat, maize and pulses, and later of vegetables and floriculture augmented the income from agriculture.

- Easy access of market stimulated farmers to diversify agriculture in favor of high-value commodities. The nearest markets for vegetables in Dehradun and Haridwar, and market for floriculture in Delhi led farmers to harness the potential of soil and water conservation measures.

Consortium Model Watershed: Adarsha Watershed

Andhra Pradesh has accorded high priority to the watershed program. A major program for development of all the degraded lands in the State over 10 years was launched during 1997 as the 10th Year Perspective Plan aimed at improving rain-fed agricultural production through watershed development, and reducing rural poverty by increasing systems' productivity through sustainable use of natural resources. Adarsha watershed, Kothapally is one among the watersheds selected for the development program by Government of Andhra Pradesh.

The Adarsha watershed is an innovative farmer participatory integrated watershed management model. It is located in Kothapally village, Shankarpally mandal in Rangareddy district of Andhra Pradesh. It has been in operation since 1998. It covers about 465 ha and has medium to shallow black soils, with a depth of 30–90 cm. The slope is 2–2.2%. Rainfall is intermediate (800 mm). There are 274 families in the watershed with a population of 1492 (Shiferaw et al. 2002). The unique feature of this watershed is that it follows the consortium approach. The purpose of developing a consortium is to provide technical backstopping of the on-farm watersheds, and draw expertise from different international, national, government organizations and NGOs. The consortium members are: International Crops Research Institute for Semi-Arid Tropics (ICRISAT), Central Research Institute for Dryland Agriculture (CRIDA), National Remote Sensing Agency (NRSA), M Venkatarangaiah Foundation (MVF), an NGO, DPAP of the State Government, and community in the watershed. ICRISAT and CRIDA provided technical support, DPAP provided financial support, and the NGO mobilized the community for collective action. Several forms of technological interventions were made. These were related to: (i) soil and water conservation; (ii) integrated nutrient management; (iii) integrated pest management; (iv) improved cropping system; and (v) wasteland development.

The watershed activities yielded promising results despite drought conditions during 2002-03. The benefits were documented in the form of: (i) improved groundwater levels; (ii) reduced runoff from 12% to 6%; (iii) reduced soil loss to <1 t ha^{-1}; (iv) increased crop yields; (v) higher income from new cropping systems; and (vi) improved greenery in the watershed area (Wani et al. 2002b). Availability of water induced adoption of improved varieties and technologies. Availability of water has also led to the adoption and spread of value-added activities such as horticulture. Area under vegetables increased from 40 ha in 1998 to 60 ha in 2001. Area under maize increased three times from 60 ha in 1998 to 180 ha in 2001.

Maize/pigeonpea and sorghum/ pigeonpea have emerged as new cropping systems, which utilized the land for a longer time period most effectively. Cotton crop area in the watershed reduced to 100 ha in 2001 as compared to 200 ha in 1998. Wani et al. 2003 reported that despite drought conditions in 1999, yield of maize increased to 3.25 t ha^{-1} in 1999 and 3.75 t ha^{-1} in 2000 from 1.5 t ha^{-1} in 1998 (Table 14). Similarly, yield of intercropped pigeonpea went up to 0.64 t ha^{-1} in 1999 and 0.94 t ha^{-1} in 2000 from only 0.19 t ha^{-1} in 1998. Sole sorghum yield went up from 1.07 t ha^{-1} in 1998 to 3.05 t ha^{-1} in 1999 and 3.17 t ha^{-1} in 2000. Both availability of water and improved technologies contributed to such an impressive increase in the yield of different crops

New Integrated Watershed Management Model

The concept of the new integrated watershed management model was adopted in Adarsha watershed, Kothapally. The important features of this model are revealed by Wani SP. 2002 and listed as following:

- the model involves participation of beneficiaries through cooperative mode, and not through contractual mode
- instead of replicating different components, it uses new science tools for management and monitoring of the watershed
- the focus is to improve the livelihoods of the people through a holistic system's approach rather than merely addressing soil and water conservation
- a consortium of various institutions is formed for facilitating technical backstopping, motivating beneficiaries, and arranging inputs and output markets
- the model minimizes free supply of inputs for undertaking evaluation of technologies. It is based on farmers' participatory research principle
- it recommends low-cost soil and water conservation measures and structures and amalgamates traditional indigenous knowledge with the new knowledge for efficient management of natural resources
- it takes care of maximizing private benefits by emphasizing more use of individual farmer-based conservation measures for raising productivity in individual farms along with community-based soil and water conservation measures
- it evolves a dynamic framework of continuous monitoring and evaluation by the stakeholders
- it empowers individuals in the watershed and strengthens village institutions for managing the watershed program.

Lessons Learnt from Adarsha Watershed

- Consortium approach consisting of research organizations, NGO, government departments and farmers used synergies from each other to effectively plan, implement and monitor the watershed.
- The program resulted in tangible economic benefits to individual farmers through improved soil, water and nutrient management options on their lands.
- Participatory planning with the community for deciding the location of the check-dams benefited more number of farmers.
- Adoption of improved technologies (varieties, machines, vermicomposting, water management, etc) substantially raised crop yields and augmented farm income. Improved varieties were sold to the farmers and machine (tropicultor) was available on rent in the village, which was extensively used by the farmers. The farmers expressed that row-sowing and fertilizer application with tropicultor contributed to higher crop yields.
- The principle of 'No free rides' for new technology evaluations changed farmers' attitude towards the project and increased their attention and participation over time.

Conclusion

Success in attaining the livelihood and environmental objectives through watershed management relies on multiple factors, including access to markets, technology and equitable access to the conserved water and other economic goods and services generating tangible benefits to the poor. Equity in sharing the benefits is a vital consideration for effective community participation (collective action). A few important gaps in policy issues like developing suitable methods for the assessment

of the impact of watershed development programs; formulating investment strategies; developing policy options for sustainability of watershed investments and improving collective action by the community; evolving policy options, ensuring equitable sharing of watershed management benefits across sections of the watershed community; identifying policy options for introducing high-value commodities and marketing strategies in the watershed; and developing strategies for strengthening crop-livestock integration have emerged from case studies, which need to be addressed through appropriate policy arrangements.

Developing more effective and transparent institutional framework for enhancing people's participation and institutionalizing mechanisms for strengthening partnership between the government, private sector, non-government agencies and research institutions are important while addressing to improve the performance of watershed programs.

There is a need to develop watershed management technologies that would conserve the resource base and provide short-term economic benefits to the land users for improving community participation and sustainability of the watersheds. Similarly, technology options may be explored to realize multiple benefits of conserved water through watershed development programs. There is a need to quantify social benefits including the various on-site and off-site economic impacts and environmental services provided by the watershed interventions and identify the long-term tangible and intangible benefits of such programs to undertake individual (private) and collective investment in the program. Suitable approaches and dissemination strategies need to be developed to scale up/out successful approaches that encourage collective action and generate attractive socioeconomic and environmental benefits to the community.

b. Adarsha Watershed in Kothapally: Understanding the Drivers of Higher Impact

Adarsha Watershed, Kothapally
Adarsha watershed is located in Kothapally village (longitude 78°5' to 78°8' E and latitude 17°20' to 17°24' N) in Rangareddy district, Andhra Pradesh, India. It is nearly 35 km from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru. It covers 465 ha of which 430 ha are cultivated and the remaining area is wasteland. The watershed is characterized by an undulating topography with an average slope of about 2.5%. Soils are predominantly Vertisols and associated soils (90%). The soil depth ranges from 30 to 90 cm and has medium to low water-holding capacities. The total population in Adarsha watershed is 1,492, belonging to about 270 cultivating and 4 non-cultivating families. The average landholding per household is 1.4 ha.

A new farmer participatory consortium model led by ICRISAT and national partners was evaluated in Adarsha watershed, Kothapally, for implementing watershed program under the initiative of Government of Andhra Pradesh. The new model is distinctly different as it has brought the farmer in the center of the initiative. This farmer-centric integrated watershed management model has the components of use of new science tools for development, holistic farming systems approach and diversified livelihood opportunities for socially marginalized and landless communities. The interventions are so designed recognizing the needs of individual farmers that enhances the scope of participation. Consortium comprising research organizations, university, development workers, policy makers and farmers embedded in the model to provide the required technical backstopping converging various expertise for the initiative.

The salient impacts that resulted due to the implementation of this model were substantial reductions in runoff and soil loss, improvement in groundwater levels, reduction in pesticide usage, improvement

in land cover, increase in productivity and high incomes to the farmers. Compared to the pre-project situation, average household incomes from crop production doubled. ICRISAT and consortium partners attempted to understand the factors that contributed to the transformation of people's lives in Adarsha watershed through dialogue and consultation, several field visits to listen and learn from the local beneficiaries and community members in the watershed. The study helped to identify the potential drivers of success in Adarsha watershed and understand the shortcomings contributing to sustainability of the benefits.

Drivers of Higher Impact in Adarsha Watershed

Acute water stress and high community demand for watershed management: More than 80% of the cultivated land was totally rain-fed in the watershed. Lower crop yields and non-existence of water harvesting structures for conserving water urge the community to show their interest in participating watershed program, which came out clearly from the community in early meetings for collective action. Their enthusiasm was triggered and reinforced by frequent droughts and declining productivity of the land.

Pre-disposition to work collectively for community development: The villagers have a pro-active attitude towards the watershed program and are willing to cooperate with the consortium partners to gain mutual benefit. They have volunteered to abide by the collectively agreed terms (rules and norms) and work as equal partners for accomplishing the goal of the experiment.

G*ood local leadership:* The local s*arpanch* (chief of PRI) has been actively involved in the watershed program as an office bearer of watershed association. His good offices enabled initial community mobilization

Tangible economic benefits to individuals: The watershed development program provided tangible economic benefits to individuals through an integrated approach. The benefits of conserving soil moisture, augmenting soil fertility through soil management, etc., show immediate visible gains to farmers in the form of higher yields and reduced input costs (Wani et al. 2002). For example, the BBF system of land preparation conserved soil and retained soil moisture *in-situ*, thereby benefiting the farmers in the watershed.

Equal partnership, trust and shared vision among the consortium partners: Several rounds of free and frank discussions among the consortium partners regarding stake and ownership of the program brought mutual trust among partners. Team building within the consortium partners enhanced the team spirit. Farmers were approached with sufficient preparedness. Consortium model added various expertise and experience in the watershed and continuous presence of any one of the partner help the communities for easy access and timely advice in holistic manner. The presence of various expertises facilitated the communities to consult right people for their problems.

Transparency and social vigilance in the financial dealings: The model enabled a transparent and vibrant environment wherein the fund utilization is open to community scrutiny and audit, which ensured that financial dealings are fair and within the awareness of all concerned. This was seen in one of the instances where the chairman of the watershed committee tried to embezzle small funds but was immediately tracked and discharged of his responsibilities by the vigilant community. Under strong pressure from the community the ex-chairman was forced to resign. This shows high level of awareness and social vigilance prevalent in the village.

High confidence of the farmers: On-farm trials revealed that traditional crops through improved practices can bring substantial incremental income, which proved cash crops such as cotton as less attractive even under improved management in terms of risk reduction and input costs. These successful on farm trials have built up the confidence of other dryland farmers.

Low-cost structures and equitable sharing of benefits: Adoption of low-cost water storage and harvesting structures ensured that more check-dams were built, which in turn helped to distribute benefits more equitably for farmers located across watershed landscape.

Knowledge-based entry point activity: Interventions that provide immediate resource conservation and livelihood (economic) benefits to the individual farmers were taken as entry point activity. For example on farm trials on micronutrient application based soil testing results and introduction wilt resistant pigeonpea variety (Fusarium wilt in endemic in Kothapally before intervention).

C*apacity building:* Landless households and women groups were trained in the production of biopesticides, nursery raising, vermicomposting and biofertilizers with forward and backward linkages. Thus, even the poor and landless SHGs have developed a stake in the watershed program. Farmers were also trained in the use of tropicultors for land preparation, in the construction of low-cost soil and water conservation methods and in the use of micronutrients for soil fertility management. The enhanced accessibility of new technologies and the sharing of knowledge had significant effects in the development of the local capacity of the communities.

c. On-Site and Off-Site Impact of Watershed Development: A Case Study of Rajasamadhiyala, Gujarat, India

Rajasamadhiyala micro-watershed at latitude 22° 8' 15"N to 22° 13' 15"N, and longitude 70° 54' 30"E to 70° 59' 15"E, covering over an area of 1090 ha is situated in semi-arid Saurashtra region of Rajkot district of Gujarat. The mean annual rainfall at Rajasamadhiyala is 539 mm. Soils in the watershed are shallow to medium deep black soils (inceptisols) with soil depth ranging from 0.15 m to 1.25 m. The physiography of watershed is gentle to moderate sloping with an average slope of 1–2%. Groundnut and cotton are the predominant crops grown in the watershed. Some of the other crops are wheat, pearl millet, sorghum, vegetables, maize, pigeonpea, sugarcane, cumin and lucerne fodder crop. Rajasamadhiyala has a population of 1747 (male 872: 875 female) with 300 households and an average family size of 5.8 members Forty four% among these households are marginal with <1 ha land holding, 38% are large with 74 ha land and 2% households are landless in Rajasamadhiyala. Watershed project covered 80% marginal, 81% small and medium, 80% large and 100% landless households.

A comprehensive assessment of Rajasamadhiyala watershed was taken up to assess the on-site impact of watershed development program, where substantial investment of Rs 16.25 million were invested in rainwater harvesting in one village. The study was aimed to evaluate off-site impacts on two downstream watersheds. The primary data was collected through investigation of farmers with pre-tested questionnaires and about 20% households/farmers were selected by stratified random sampling method in order to collect data in Rajasamadhiyala watershed for on-site impact assessment and two down stream villages to assess the off-site impact. The secondary data were collected from various sources like reports prepared by BAIF, an NGO, project implementing agency (PIA) for the watershed program, Government of Gujarat

On-Site Impact of Watershed Development

Water Harvesting and Recharging Structures

Total storage capacity of all the water harvesting structures in the watershed is 855461 m^3 or 79 mm or about 16% of mean annual rainfall (mean of 20 years rainfall is 503 mm). An investment has been made of Rs 1.55 million since 1995. This is equivalent to the potential runoff during a normal rainfall year in the watershed with an average unit cost of construction of Rs 19 per m^3. During normal rainfall years, 2–3 times overflow takes place from the structures in the watershed. In addition, down stream watersheds get water through seepage/base flow from these structures; hence they are not affected by reduction in surface runoff to their watershed due to the construction of water harvesting structures in the upstream watershed. Indian Space Research Organization (ISRO), Vadodara, advised the farmers to excavate pits at the spots where the lineaments and dyke intersected to open up the aquifers to recharge the groundwater. Due to this, the recharging potential increased by 125% (Government of Gujarat, 2004).

The data revealed that the overall production (food and fodder crops) of 6.5 kg m^{-3} of storage capacity with an average yield of 5124 kg ha^{-1} was observed during 2004, which is about 33% increase in production (kg) per unit storage capacity (m^3), but it is revealed that there was only 15% increase in yield (kg) per unit area irrigated (ha) in 2004 over 1995.

Groundwater Recharge and Availability

Significant improvement in water yield in wells after the implementation of watershed program was reported in the watershed as evident by the duration of pumping hours per day for irrigation. The average pumping duration of 5.25 hours per day in 1995 increased to 10.4 hours per day in 2004. This reveals that there has been a net increase of 5.2 hours per day of pumping. The increase in pumping duration in rainy season was 9.5 h day-1, postrainy season 5.25 h day-1, and summer 0.75 h day^{-1}. The increase in area under irrigation in 2003 over 1995 during rainy season, postrainy season and summer were 60, 55 and 118%, respectively. The overall total area increased by 58% under irrigation in the Rajasamadhiyala micro-watershed. The density of open wells (number of wells per ha) in 1995, 1999 and 2003 was 0.23, 0.26, and 0.28, respectively, whereas bore wells was 0.09, 0.15, 0.18, respectively; and cumulative density of both open wells and bore wells was 0.38, 0.41, and 0.47, respectively over a period of time.

Cropping Pattern, Area, Production and Productivity

Considerable area increase under double cropping was observed from 33 to 171 ha between 1995 and 2004 owing to the availability of additional water and 25 ha of wasteland was also brought under cultivation in the Rajasamadhiyala micro-watershed. Significant gains in crop productivity ranging from 15.72% in vegetables to 119% in groundnut crop were recorded in the watershed. The productivity of crops grown in rainy and postrainy seasons was increased along with the area under cultivation. The cropping intensity in 1995, 1999 and 2003 were 114%, 130% and 164%, respectively.

Crop Diversification

Crop diversification over a period of time in Rajasamadhiyala micro-watershed revealed that diversification index (DI) declined continuously from 1995–96 to 2003–04, which indicates higher concentration of mixed crops in production system rather than diversification. The results revealed that crops like vegetables and fodder are grown instead of cereal crops due to availability of water and thus diversifying the crops.

Socio-Economic Indicators

The socio-economic status of the people improved sharply because of watershed interventions within a short span of time in the village. The per capita income of population increased by 38.52% during project period. The village exhibits a fairly good sex ratio of 1003 female for every 1000 male, which is worth noting that the sex ratio in the village is above the average of the state and the nation. The literacy rates amongst male as well as female were found higher in 2004. There has been 100% enrollment in primary education with children below the age of five years going to *anganbadi*.

Off-Site Impacts in Downstream Villages

Increased water availability in downstream Aniyala village has changed the cropping pattern with high level of crop productivity as base flows from water harvesting structures get water from Rajasamadhiayala structures and in addition to catchment's runoff in the watershed. The higher level of water productivity has transformed the livelihood of farmers in the village.

Conclusion

Huge investment of Rs 16.25 million was made in rainwater harvesting structures in Rajasamadhiyala micro-watershed, which is nine folds more than the normal watershed investments in India. The internal rate of return was 9.4% with the cost benefit ratio of 1: 1.24 on such a large investment. Public investments through watershed programs improved water availability and increased productivity and incomes which in turn triggered private investment in the watershed. However, over-exploitation of groundwater such as doubling the number of bore wells as well as pumping hours in Rajasamadhiyala will jeopardize the development unless suitable legal or social mechanisms for sustainable use of groundwater use are put in place by the community.

d. Institutional Arrangements in Watershed Development Projects: A Comparative Analysis of Different Approaches

Watershed programs faced paradigm shift towards involving local village communities or institutions for implementing the projects. But village level institutions, in most cases, do not have relevant capacities to deal with complexities involved in natural resources management, which need necessary guidance initially to handle the responsibilities. Suitable institutional mechanisms should be placed to manage the dilemmas while implementing the project, which ultimately play an important role in determining efficiency and sustainability of the watershed development programs. The study aimed at institutional arrangements in a watershed development project referring to the organisational structures evolved in the project and their mutual interaction mechanism while implementing the project. The outcome of the study will identify specific components of institutional arrangements having the potential to contribute towards efficiency and sustainability of the project initiatives in watershed development programs in India Watershed programs that were selected for the study are Andhra Pradesh Rural Livelihoods program in Andhra Pradesh (APRLP); Sujala Watershed program in Karnataka (Sujala); Indo-German Watershed program in Maharastra (IGWP); DPAP Watershed program following Hariyali guidelines in Rajasthan (Hariyali). Watershed programs were selected for the study from different geographical regions with innovative institutional arrangements.

Key Observations and Learnings

It is observed that social organisation in Hariyali watersheds seems to be inadequate because there are no functional user group (UG) and both primary stakeholders and secondary stakeholders are not

able to recognise any such institutional structures in the program. It is also emerged from the exercise that SHGs are considered to have no major role in watershed program, while in APRLP, SHGs are considered important and influential owing to their institutional set up of apex body of SHGs being the Watershed Implementation Agency (WIA). Similarly, SHGs apex body is influential in IGWP and in case of Sujala watersheds SHGs are considered as highly important but with less influence on the program.

Labour in watersheds are organised into groups only in APRLP and IGWP. However, in IGWP these groups are considered high important with low influence while in APRLP they are considered less important with low influence on the program. This situation is due to the fact that in the institutional arrangements followed in the IGWP, more importance is built for these vulnerable sections by making payments directly to labour groups (LGs); promoting thrift and credit activity for these groups and providing some revolving fund, whereas in APRLP, no such activities were found during the study.

In Sujala program, farmer groups (Area Groups) are considered as both important and influential, while in others, UGs are considered important but not influential. During associated discussions, it was expressed that UG are not performing their intended role due to poor organisation; while the opposite is true in case of AGs.

The independent monitoring and evaluation agency in Sujala watersheds is a unique institutional arrangement, whose contribution in the program through continuous and concurrent monitoring of the program and highlighting pitfalls, if any, was appreciated during associated discussions.

The *gram panchayat* (GP) in Hariyali watersheds is enjoying high importance and influence owing to the fact that they are WIA, while in IGWP, GP is considered less important with low influence. In case of Sujala watersheds, contradicting opinions were expressed. Both primary and secondary stakeholder groups opined that GP is less important in the program but in one watershed they are found influential while in the other watersheds they are less influential. It is true that, when there are no formal structural and functional linkages created between watershed institutions and GP, relationships between them seems to depend on the local dynamics.

The institutional structure of watershed development team (WDT) is considered important in all the programs but in APRLP and IGWP they are less influential, indicating their intensive involvement in the program. In Sujala program, WDT plays a facilitator's role giving more role for field staff to support community-based organizations (CBOs) in the watershed. In case of Hariyali watersheds WDT appears to be a more downgraded structure with regards to influence, which is evident from the discussions

Line departments are considered important with low influence in all the programs except Hariyali watersheds. In APRLP and IGWP watersheds, their involvement in the program is not sufficient.

The institutional structure of WIA in Sujala program ensures participation of farmers and women in the program, while in APRLP and IGWP participation of women in WIA activities is higher due to their significant representation in the managing body. In Hariyali watersheds, WIA does not ensure participation of women or farmers in program management. None of the WIA structures ensures participation of landless and labourers in program management.

Women members of the watershed participate more pronouncedly because of their representation in the WIA. Primary role of women members in the WIA is considered as negotiating for their share of project funds for income-generating activities.

Post project sustainability – forward/backward linkages created, wherein all the programs linkage with banks are established: Linkages with GP are strongly established with watershed CBOs in Hariyali watersheds; while in Sujala program, structural linkages are created but functional linkages depend on local dynamics. In APRLP and IGWP linkages between GP and CBOs are not effective. Sujala program has better arrangements of linking all relevant line departments with watershed CBOs. In case of Hariyali, the line department is PIA and has strong linkages with watershed stakeholders; however, linkages with other line departments depend on local dynamics. In APRLP and IGWP, linkages with line departments are not efficient.

Post-project sustainability – sustainability of CBO: Among the entire watershed CBOs, SHG show the potential to be sustainable in all the programs. WIA is more sustainable in APRLP and Hariyali programs. FGs seems to be sustainable in Sujala program but not in APRLP and IGWP watersheds. LGs are more sustainable in IGWP than APRLP watersheds.

Post-project sustainability – participation of different sections of watershed community: Sujala program gets higher ranking as different sections of watershed community is involved in program management from the inception of the program. The Hariyali watersheds are ranked least; while APRLP and IGWP watersheds fall between these two extremes with the latter ranked higher than the former.

Conclusion

Institutional mechanisms installed in Sujala program seems to be effective in many fronts due to the functional linkages between the elements involved in the project addressing post project sustainability. The study showed the importance of GP linkage and role in the watershed program for the success of the project. Hence, suitable institutional arrangements and linkages within the institutions are necessary to put in place, when the responsibility of managing natural resources is given to local communities to promote inclusiveness among the communities.

e. Socioeconomic Profiles, Production and Resource Use Patterns in Selected Semi-arid Indian Watershed Villages

Millennium Development Goals (1996–2015) include eradication of extreme poverty and hunger while ensuring environmental sustainability. The growing scarcity and competition for water, however, stands as a major threat to poverty alleviation in future. Watershed program offers a unique approach to address these issues to attain rural development. Many studies revealed that rain-fed areas (less favored areas) offer greater growth for a unit of investment apart from having a much larger impact on poverty alleviation compared to irrigated areas. As growth opportunities in more favorable zones are exhausted, the need to improve the productivity of less favored regions has become more compelling on the grounds of equity, efficiency and sustainability (Shiferaw et al. 2003). However, inequalities in the distribution of land, water and access to other natural resources in the rural settings have significant effect on poverty alleviation strategies and understanding insights of the situation is necessary when designing programs like watershed development. In fact, livelihood strategies of households vary depending on the extent of inequalities in a village. For example, tenant farmers and landless laborers are more in areas with more concentrated landholdings, resulting in complementary livelihood activities such as livestock production and seasonal migration. The study was to characterize and assess the baseline biophysical and socio-economic conditions in selected

watersheds documenting the socioeconomic conditions and resource endowment patterns of the watershed farmers, along with net incomes for different household groups from alternative income sources (cropping, livestock and off-farm). The document forms suitable benchmark to prioritize issues to be concentrated in the concentrate and strata of community that needs to be addressed in the watershed. The baseline document can be used for monitoring changes in the watershed both in biophysical and socio-economic characteristics and to assess the impacts of watershed activities in the future.

Materials and Methodology

Detailed baseline socio-economic farm household survey was conducted using a pre-tested structured questionnaire in selected nucleus watershed villages of Mahabubnagar, Nalgonda and Kurnool districts of Andhra Pradesh to identify the major socio-economic, biophysical constraints for sustainable crop production in each village. A random sampling procedure was used to select the households in two watershed villages from each of the three districts. Apart from the household survey, additional information was also collected through participatory methods such as focus group discussions, key informants and transect walks within the village.

Summary of Results

Biophysical and Socio-economic Factors

The baseline analysis of the watershed villages provide information on the major income-generating activities in the villages, land ownership and distribution aspects, cropping patterns, agricultural practices, livestock holdings, water availability for irrigation and other constraints or problems in the villages. This serves as a baseline in the process of monitoring and evaluation of socio-economic and environmental impacts of the watershed interventions. A thorough understanding of the village social structure ensures the realization of watershed development goals especially the equity and sustainability objectives. The caste structure in the village is closely associated with landholdings, livestock holdings, assets and livelihood strategies. Even though agriculture is an important occupation, the majority of farmers supplement their livelihoods through other activities such as hired labor and off-farm activities. A larger percentage of household members combined on-farm activities with one or more income-generating activities to sustain the household needs and to overcome the drought conditions during previous cropping season. For example in Malleboinpally, regular employment in neighboring towns is one of the major livelihood strategies during drought years, similarly in Mentapally, migration is an important livelihood avenue. Therefore, there is always a possibility that short-term strategies to cope with drought such as migration might as well become an adaptive strategy in the long run that could undermine the role of agriculture as a sustainable livelihood strategy. In such a scenario, watershed development that enhances land and water productivity as well as sustainability will have a greater significance.

The baseline characterization on the gender issue revealed the role played by women in supporting their households. Women performed multiple tasks that include working on own farm, working in local labor markets apart from the usual household activities. Household survey also brought out the alternate sources of income of the communities besides agriculture and status on sources of irrigation and groundwater in the watershed.

Social Profiles in the Watershed

Social profile studies revealed that there is distinct differences among the villages that could have an impact on the implementation process of watershed activities. For example, Tirumalapuram is a relatively smaller village with a more homogenous social structure and endowed with groundwater resources. There is less diversification in the type of crops grown and less number of non-farm activities in Tirumalapuram. Hence, any technological intervention is expected to have a better chance to succeed in Tirumalapuram for crop productivity enhancement through increased water use efficiency. But a single caste dominates the political and economic aspects of the Tirumalapuram village and involvement of this community in any program process becomes imperative for its success. However, there should be a proper balance by including the community without alienating other weaker communities in the decision-making process to achieve the equity objectives.

Income Inequality and its Decomposition by Source in the Watersheds

Benefits of the watershed program can be enhanced through a better understanding of the inequalities prevalent in the watersheds and the major sources of these inequalities by using decomposition techniques. Theil index is used to decompose the overall increase in inequality occurring due to changes between and within different social groups. Income shares involve arranging the income of households from the lowest to the highest, then dividing the distribution into equal parts (fifths or quantiles). Then, the percentage of total income received by each quantile or fifth is calculated. Gini decomposition and coefficient is used for measuring the inequality decomposition in the watershed between sources of income.

Disaggregated analysis of the income sources consists of income from dryland cereals, pulses, paddy, commercial crops, milk sales, other livestock income, employment, business and other non-farm sources. The analysis revealed that he average per capita total income for the combined dataset of 420 households across the six watershed villages was Rs 9269. Among the different categories of income sources, employment (which includes regular employment and casual village labor) had the highest per capita income of Rs 2731 and accounted for 29% of the total per capita household income. This was followed by commercial crops (that included cotton, castor, vegetables and other high value crops) with a mean per capita income of Rs 1990 and accounted for 21% of the average per capita total income of the household. Dryland cereals (sorghum, pearl millet, etc) had the lowest per capita income among all the categories (Rs 248), accounting for only 3% of the total income of the household.

The source of income *Gini correlations* (Gi) show that income from crops (dryland cereals, pulses and paddy) and livestock were more unequally distributed than most of the non-farm income sources. Income from employment category (regular employment and casual village labor) had a more equal distribution. Even though the source *Gini coefficients* were high for income from some sources, their contribution to overall inequality was not significant. For example, the contribution of dryland cereals to total income inequality was not much even though its source Gini was high whereas employment category had a relatively low source Gini but its contribution towards total inequality was high.

Conclusions

The baseline survey provides a suitable benchmark for monitoring changes and to assess the impacts of watershed activities in the future. The analysis of survey data gives a comprehensive snapshot of the socioeconomic conditions, social and political networks, cropping patterns, crop and livestock production, land characteristics, constraints and potential for increased productivity in the watershed

areas. It offers careful insights into the existing production systems, resource use patterns, major livelihood strategies and the prevailing socio-economic inequalities and distributional issues in the watershed communities. It helps program implementing agencies to understand the constraints, potential opportunities, farmer perceptions and priorities in the watersheds.

Income inequality decomposition techniques quantify the contribution of different sources of household income towards the total income inequality. The analysis on the effect of various income sources on household income inequalities in all the watersheds showed that income from crop cultivation had an inequality increasing effect on overall income inequality since profits accrue to households owning large extent of arable land. The increase in inequality is more predominant in Nandavaram where income from crop cultivation accounted for a major share of the total household income.

Livestock income was an inequality increasing source in some watersheds (Malleboinpally, Mentapally and Kacharam) and was an inequality decreasing source in Tirumalapuram, Nandavaram and Devanakonda. The effect was more pronounced in Kacharam as income from livestock was an important contributor to the total household income. Non-farm income was an inequality decreasing source in all the watershed areas. The non-farm income accounts for a significant share of overall inequality in the watersheds of Malleboinpally, Mentapally and Tirumalapuram (65–72%, 43–52% and 41–42%, respectively). Therefore, when land and livestock resources are unequally distributed, land and livestock based watershed interventions may not necessarily generate equitable benefits to all households. For example, dairy is an important component of livestock income but it is mainly involved by large landowners. Most of the small landowners and landless cannot afford to maintain milch animals and rely more on small ruminants. In such situations, technology interventions (appropriate feed and fodder management) should aim to increase the productivity of small ruminants which inturn may contribute to income of these communities. The kind of strategy will reduce any inequality increasing effect due to livestock income in the watershed.

The analysis reveals major livelihood strategies for different household groups, level of inequality, social heterogeneity and access to resources in the community and implications for the project and helps to draw plan of activities under watershed program besides its usefulness in monitoring changes in watershed level.

4.6 Thematic Impacts

a. Potential to Enhance Productivity and Rainfall Use Efficiency in Watersheds of India

The net cultivated area in India is reported to be 142 M ha, which is about 43% of the total geographical area. Rain-fed ecosystem constitutes about 60% of the net cultivated area falling across arid, semi-arid and sub-humid climatic zones. Due to greater geographical spread of the rain-fed agro-ecosystem in the country compared to other agro-ecosystems, any improvement in the system productivity has direct impact on the quality of life of diverse group of farmers including small and marginal communities of the country (Singh et al. 2000).

Agroecologies and Production Systems under Rain-fed Areas

The rain-fed agroecologies are diverse in terms of climate, soils, crops grown and livestock production. Rain-fed agriculture extends over 85 m ha of cultivated area. In the rain-fed areas about 90% of coarse cereals and pulses, 80% of oilseeds and 65% of cotton are grown. Arid areas, constituting about 19.6% of the total geographical area (329 m ha), are characterized by low and erratic rainfall (< 500 mm) and light textured soils. The growing season is very short (up to 75 days) with millets, short-duration pulses and hardy perennials dominating the cropping systems and farmers' dependence on animal husbandry as source of income is very high. The semi-arid areas are further classified into dry and wet. Dry semi-arid areas form 12% of the geographical area and receive a mean annual rainfall ranging from 500 mm to 700 mm with a growing season of 75-100 days. The soils in the northern part of the country are loamy sands, light sandy loams and medium black soils, while in peninsular part of the country the shallow and medium-deep black soils are predominant. Major cropping systems in the dry semi-arid parts of the country are pearl millet, groundnut, sorghum and cotton-based systems in the rainy season and *rabi* sorghum and chickpea during post rainy season. The wet semi-arid region constituting 25.9% of the geographical area receives mean annual rainfall ranging from 750 to 1100 mm with a growing season up to 120 days. This zone contains sandy loams and loamy soils in the north, medium to deep black soils in the central part and red and medium-deep to deep black soils in the south. Soybean-based, maize-based and sorghum-based cropping systems are dominant in these regions. The dry sub-humid areas that constitute about 7.64% of the geographical area receive a mean annual rainfall of 1100 to 1600 mm. The high rainfall in these regions is conducive for water harvesting. The soils are red loams, laterites, alluvial and deep black soils. Rain-fed rice is the predominant crop, followed by pulses and oil-seed crops, fruits and vegetables.

Yield Gap of Rain-fed Crops

The dominant rain-fed crops in India are sorghum, pearl millet, pigeonpea, chickpea, soybean and groundnut. Some area is also under rain-fed rice and wheat, mustard, rapeseed and cotton. Substantial yield gaps exist between current (farmers') and experimental or simulated potential yields. The farmers' average yield is 970 kg ha^{-1} for *kharif* sorghum, 590 kg ha^{-1} for *rabi* sorghum and 990 kg ha^{-1} for pearl millet. Simulated rain-fed potential yield in different production zones ranged from 3210 to 3410 kg ha^{-1} for *kharif* sorghum, 1000 to 1360 kg ha^{-1} for *rabi* sorghum and 1430 to 2090 kg ha^{-1} for pearl millet.

Total yield gap (simulated rain-fed potential yield minus farmers' yield) in production zones ranged from 2130 to 2560 kg ha^{-1} for *kharif* sorghum, 280 to 830 kg ha^{-1} for *rabi* sorghum and 680 to 1040 kg ha^{-1} for pearl millet. These gaps indicate that productivity of *kharif* sorghum can be increased 3.0 to 4.0 times, *rabi* sorghum 1.4 to 2.7 times and pearl millet 1.8 to 2.3 times from their current levels of productivity.

For legumes, the farmers' average yield is 1040 kg ha^{-1} for soybean, 1150 kg ha^{-1} for groundnut, 690 kg ha^{-1} for pigeonpea and 800 kg ha^{-1} for chickpea. Large spatial and temporal variation in yield gap was observed for the four legumes. The yield gaps for the production zones ranged from 850 to 1320 kg ha-1 for soybean, 1180 to 2010 kg ha^{-1} for groundnut, 550 to 770 kg ha^{-1} for pigeonpea and 610 to 1150 kg ha^{-1} for chickpea. The results showed that on an average, the productivity of legumes and oilseeds can be increased by 2.3 to 2.5 times their current levels of productivity. Supplemental irrigation would further increase these yields. Similarly, the average yield gap relative to simulated rain-fed potential yields was 2560 kg ha^{-1} for rain-fed rice, 1120 kg ha^{-1} for cotton, 860 kg ha^{-1} for

mustard. Such national average yield gaps could not be estimated for rain-fed wheat because of large percent of irrigated area in all states. The mean yield gap based on the average of simulated, experimental and on-farm rain-fed potential yields was 2560 kg ha^{-1} for rice, 1670 kg ha^{-1} for cotton, 460 kg ha^{-1} for mustard and 70 kg ha^{-1} for wheat. It remains to be quantified if these biophysical estimates of yield gaps can be abridged economically.

Integrated Watershed Management for Enhancing Productivity and Water Use Efficiency

ICRISAT has adopted an integrated genetic and natural resources management (IGNRM) approach to enhance agricultural productivity in rain-fed areas, which is a powerful integrative strategy of enhancing agricultural productivity comprising constraint and opportunity mapping, need assessment and priority setting, integration of multiple interventions, encouraging client participation, on-farm testing and verification through multi disciplinary approach, monitoring and evaluation by strategic partnerships and resulting in multiple impacts in the system (Twomlow et al. 2006). The approach has successfully translated into on-farm work across semi-arid regions of five countries in Asia. The contribution of both individual and combined effects of improved technologies evaluated across at various sites in India, on productivity enhancement and water use efficiency is presented here.

Improved Varieties

The adoption of improved varieties always generates significant field level impact on crop yield and stability. The yield advantage through the adoption of improved varieties has been recognized undoubtedly in farmer participatory trials across India under rain-fed systems. Recent trials during rainy season conducted across Kolar and Tumkur districts of Karnataka, India, revealed that mean yield advantage of 52% in finger millet achieved with high yielding varieties like GPU 28, MR 1, HR 911 and L5 under farmers management (traditional management and farmers inputs) compared to use of local varieties and farmer management. These results showed the efficient use of available resources by the improved varieties reflecting in grain yields under given situations (ICRISAT, 2008).

Balanced Nutrition

Low fertility is one of the major constraints for the low productivity under rain-fed system besides water scarcity. The deficiency of N and P among the nutrients are considered as important issues in soil fertility management programs. However, ICRISAT-led watershed program across the sub-continent provided the opportunity to diagnose and understand the widespread deficiencies of sulphur (S), boron (B) and zinc (Zn) in the soils of rain-fed areas. On-farm survey across various states revealed that out of 1926 farmer's fields, 88 to 100% was deficient in available S; 72-100% in available B and 67-100% in available Zn. On-farm trials were evaluated by Rego et al. (2005) for the response of crops to the application of S and micronutrients at the rate of 30 kg S, 0.5 kg B and 10 kg Zn ha^{-1}. The study revealed 79% yield advantage in maize; 61% in castor; 51% in greengram and 28% in groundnut compared to the yield levels without application of S and micronutrients. Impressive economic gains to improved soil fertility management to the extent of Rs 5948 and Rs 4333 ha^{-1} in maize and groundnut, respectively, were reported from ICRISAT-led watershed program across Andhra Pradesh.

Land and Water Management

Dryland agriculture suffers from both water scarcity and destructive floods due to rainfall variability and poor infiltration in most soils in the region. Improved land and water management is needed to protect the soils from torrential rains and conserve maximum rainfall where it falls and to guide safe disposal of excess water from the land holdings. Land smoothening and forming field drains are basic component of land and water management for conserving and safe removal of excess water. Broad-bed and furrow (BBF) system is an improved *in-situ* soil and water conservation and drainage technology for the Vertisols. Contour farming is practiced on lands having medium slope (0.5-2 per cent) and permeable soils, where farming operations such as ploughing, sowing are carried out along the contour. The system helps to reduce the velocity of runoff by impounding water in series of depressions and thus decrease the chance of developing rills in the fields. Contour bunding is recommended for medium to low rainfall areas (<700 mm) on permeable soils with less than 6% slope. It consists of series of narrow trapezoidal embankments along the contour to reduce and store runoff in the fields. Conservation furrows is another promising technology in red soils receiving rainfall of 500-600 mm with moderate slope (0.2-0.4 per cent). It comprises series of dead furrows across the slope at 3-5 m intervals, where the size of furrows is about 20 cm wide and 15 cm deep. On-farm trials on land management of Vertisols of central India revealed that BBF system resulted in 35% yield increase in soybean during rainy season and yield advantage of 21% in chickpea during postrainy season when compared with the farmers' practice. Similar yield advantage was recorded in maize and wheat rotation under BBF system

Integrated Pest Management

Integrated pest management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of regular practices. In other words, IPM is a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health and environmental risks. On-farm trials on IPM comprising suitable varieties, clean cultivation, scouting through pheromone traps, use of NPV against lepidopteron pests and installing bird perches were evaluated in Bundi watershed, Madhya Pradesh, which clearly demonstrated that IPM resulted in yield advantage of 18% and increased net returns (39 per cent) in green pea compared to the practice of chemical control alone.

Crop Diversification

Crop diversification is proven strategy for increasing crop output under different settings of available resources either through broadening the base of the system by adding more crops coupled with efficient management practices or replacing traditional crops with high value crops.

Crop diversification admits to realize the real value of improved water availability through watershed programs either by growing high value crops like vegetables or more number of crops with supplemental irrigation. However, crop diversification takes place automatically from traditional agriculture to high value/commercial agriculture at the field level once the water availability is improved. On-farm survey in Ringnodia watershed, Madhya Pradesh, revealed the spread of high value crops like potato, coriander, garlic etc., and increase in net income from farming activities once the scope for supplemental irrigation is established in the watershed

Conclusion

Rain-fed areas in India have a range of biophysical environments (climates and soils) with varying potential for water harvesting and soil and water conservation. Large yield gaps at farmers' field level exist for the most of the rain-fed crops which need to be abridged. Improved agronomic practices for various moisture regimes are available to reduce yield gaps. The potential of productivity enhancement technologies and conservation of natural resources have been amply demonstrated in various watershed landscapes across states in India. The major contributions to productivity enhancement came from improved crop varieties and integrated nutrient management and their interaction with soil and water conservation practices. Integrated pest management practices contributed more towards reducing in cost of production and protecting the environment. Water harvesting in ponds and recharging of groundwater supported production of high value crops with supplemental irrigation.

b. Monitoring and Evaluation of Watersheds on Hydrological and Environmental Quality

The soil, air and water are an integral component of environment and together with water constitutes the most important natural resource. The soil quality indicators have an important role in assessing the overall impact of natural resource management technology interventions, particularly their impact on the quality of natural resource base. The development and/or identification of accurate and reliable soil quality indicators for monitoring and assessing the impact of natural resource management technologies including watershed management is a rather difficult task. Currently several types of soil quality indicators are available, which can be used for assessing the overall impact of natural resource management technologies (Wani et al. 2003c, Pathak et al. 2004).

Monitoring of hydrological and environmental data play a key role for the transfer of appropriate conservation technologies for watershed project. The hydrological monitoring offers potential runoff water harvesting and groundwater recharges in the target regions and also provides the basic data for the design of hydraulic structures and sustainability of soil and water resources in the target areas. Monitoring of hydrological data is essential to assess the impact of interventions in the watershed.

Runoff and Soil Loss

The effectiveness of improved watershed technologies reflected in reducing runoff volume, peak runoff rate and soil loss and improving groundwater recharge. Hydrological parameters like rainfall, runoff, soil loss and groundwater were measured at watersheds using hydrological gauging station with a digital runoff recorder and rectangular weir to measure runoff and a micro- processor based automatic sediment sampler for soil loss measurement. The microprocessor based automatic sediment sampler is used to measure soil loss as well as temporal changes in sediments during the runoff hydrographs from the agricultural watersheds. The micro processor based control unit works automatically after sensing water flows by sensors and then purging the pipe to clean off old water sample (Fig 13). The whole unit is powered by installed solar panel.

ICRISAT started watershed work in 1976 at Patancheru campus, by developing natural research scale watersheds on black soils, simulating farmer's field conditions on small farms of semi-arid tropics for monitoring the water balance and erosion characteristics across wide range of cropping systems. The long term mean data (1974-2006) revealed that mean runoff of rainfall from watershed under improved management system is 12% compared to 21% under traditional systems. Similarly, mean

Fig 13. Hydrological monitoring station with runoff recorder and sediment sampler and control unit.

annual soil loss is 1.51 t ha^{-1} under improved management compared to 6.46 it ha^{-1} in traditional management followed by farmers.

Seasonal rainfall, runoff and soil loss data from Bundi watershed in Madhya Pradesh revealed that the four year mean runoff potential of the watershed was about 11% of seasonal rainfall. High peak runoff rate of 0.152 m^3 s^{-1} ha^{-1} was recorded from the watershed, which suggests that the hydraulic structures in this area should have good capacity to discharge the high flow rate. In spite of the low seasonal rainfall (370 mm in 2005), high soil loss of 4.3 t ha^{-1} has been recorded Experience from bench mark watersheds across India showed that watersheds having Alfisols and located in less rainfall areas (<700 mm) generate more runoff compared to watersheds situated in Vertisol regions. Similar trend on runoff characteristics was observed in medium rainfall regions (700-900mm). However, it was found to be more in watersheds having Vertisols and in high rainfall zones (>900mm) compared to Alfisols watersheds. Hence, the hydrological data is useful in planning and construction of various cost-effective water harvesting and soil conservation structures in the watershed.

Groundwater Recharge and its Availability

Groundwater is a major dependable source of water for agriculture. Due to improper management of natural resources there is a drastic decline in groundwater in the sources of irrigation. Improved land development in the watershed facilitated controlled disposal of excess rainwater and excess runoff water, which can be stored in water harvesting and groundwater recharging structures in the target areas. Deep drainage is the important character of soil type deciding groundwater recharging in the regions. Data on deep drainage in various watersheds of soil types revealed that is 8% of the seasonal rainfall moves through deep drainage in Vertisols, whereas deep drainage is 22% of seasonal rainfall in Vertic Inceptisols and 31% in Alfisols. The groundwater level rose by 4.7 m in open wells in the treated area compared to the wells in untreated area in Govardhanapura watershed. Simple well water level measuring devices are available (Fig. 14), which can be used for concurrent monitoring of

Fig14. Well water measuring device.

groundwater level for the watershed intervention. The measuring device can be operated by farmers themselves by imparting proper training which comprises long cable having moisture sensor at the end of the cable. The moisture sensor makes sound when it touches the water level in the wells or bore wells and by measuring the length of the cable required to reach the water level can be used as water table from the ground. The cost of the measuring device is only Rs. 600, which will be useful to access the impact of watershed interventions.

Water Quality

Although water is a renewable resource, availability of safe drinking water for human being and live stock is a serious challenge in many parts of the country due to many reasons. Quality irrigation water is required for agriculture; otherwise these elements again enter in the food chain of animals. Quality of water in different sources of water such as tube wells, open wells, hand pumps and dug out ponds was monitored especially for nitrate pollution in Semli and Shyampura (Madhya Pradesh) and Thana and Govardhanapura (Rajasthan) watersheds during *kharif* 2006. Sampling was done in the months of June and August. In Semli and Syampura watersheds in the month of June, nitrate-N levels varied from 1.2 to 8.4 mg L^{-1} in open wells, from 1.8 to 17.7 mg L^{-1} in the tube wells and water in Pandu Talab showed NO_3-N at 11.2 mg L^{-1}. In the month of August, a nitrate-N level in open well and tube well waters was further increased. Open well showed in the range of 2.5 to 15.0 mg L^{-1} and tube wells showed between 5.3 and 35.7 mg $L^{-1,}$ indicating the nitrate pollution of some of these water bodies (>10.2 mg L^{-1}). Hence, analysis of water bodies for nitrate content is essential in selected locations in the watershed where high-value crops or commercial agriculture is being followed. The monitoring of water quality parameters alerts the package of practices being followed that require modified to prevent water pollution.

Conclusion

- High runoff and soil loss coupled with low rainfall use efficiency is common phenomenon under traditional system of land use management.
- There is a compulsion for increased use of surface and groundwater conjunctively from agriculture and other uses which warrant for improved soil water conservation measures. Watershed is an entry point for achieving the objective of efficient use of waters sources thereby increasing rainfall use efficiency.
- Efficient soil conservation measures reduced flooding and siltation in the downstream regions, besides reducing environmental pollution.
- There is excellent scope for improving the design, effectiveness of the structures and reducing the cost incurred in the construction of structures while the hydrological data of the target regions taken into account.
- The monitoring of hydrological and environmental data is essential in selected benchmark watersheds.

c. Equity in the Impact of Watershed Development: Class, Gender and Regions

The Issue

Attaining equitable benefits poses one of the most difficult challenges in implementation of watershed projects where the emphasis is on attaining productivity-enhancement by simultaneously addressing the issues of resource sustainability and equity in benefit sharing. The problems pertaining to equity in watershed projects, to a large extent, emanate due to the concerns for balancing (a) private-social benefits; (b) short term and long term gains; and (c) scientific (i.e. `ridge to valley' and integrated) approach vs. crop-productivity centric approach to resource management.

There are three major sets of factors influencing equity in generation and distribution of benefits from watershed projects. These are: (i) agro-ecological characteristics, locational features in upstream-downstream context; (ii) differential access and ownership and access to natural as well as other forms of capital arising out of the socioeconomic-cultural context; and (iii) inadequacies/ineffectiveness in policy design/implementation with respect to selection of technology, setting-up of the institutional mechanisms and development of market linkages. Recognising that the first two sets of factors are difficult to change as these differences are determined through the forces of nature as well as dominant socio-economic structures, equity considerations in watershed development tend to focus mainly on the third set of factors i.e. addressing the `project-based-equity. This would encompass the issues of what kind of technologies/ activities to be undertaken, how much would be the flow of benefits in short and long term, and who will share the benefits.

The focus on project-based-equity, however, does not mean that the equity-outcomes of watershed development may not exert any positive impact on the other two sets of factors influencing the quantum of benefits and their distribution among different stake holders within the community. Instead it could be argued that project-based-equity could pave a way for breaking the structural inequities across class, castes, and gender, provided the issue of equity is brought to the centre, right from the initial phase of watershed development.

Equity across Class, Gender and Regions: Evolution of the Policy Space

Watershed development projects, being mainly land based intervention, is deemed to benefit mainly those having ownership or access to land, and effective say in the decision-making process. *Prima facie*, landless, powerless, and women are likely to be excluded from the benefits from watershed projects, unless special care is taken to ensure their equitable inclusion right from the initial phase of the project cycle.

In fact when it comes to gender-equity, the issues are further complicated as the discrimination is often more deep rooted, going below the community to household and individual levels. The constraints faced specifically in the context of gender-equity are: productivity gains are often limited to only a sub-set of the households thereby limiting the percolation effect to cover the resource poor; limited access to credit in absence of ownership of land; administrative difficulties in developing and managing CPLRs, especially in absence of clearly delineated user-rights, non-sustenance of gains in productive employment, increased work burden among women in absence of simultaneous changes in gender division of work and requisite amenities at work, lack of new skills to be able to benefit from emerging market opportunities.

Recognising the problem of marginalization, watershed guidelines especially since the mid-nineties have made special provisions especially for inclusion of the landless and women into various stages of planning and implementation. For instance, the stated objectives of the MoRD guidelines prepared by the Hanumantha Rao Committee had special emphasis on `improving economic and social conditions of the resource poor and the dis-advantaged sections of the watershed community such as the asset-less and women'. Subsequently, the revised guidelines (2001) made it mandatory to form user groups and self-help groups, which included women and also recommended special groups consisting only of women. Promotion of income-generating activities through training, credit and marketing support were envisaged as the main planks for addressing the issue of equity in these guidelines. Besides these, membership of women and landless was made mandatory in village watershed committee. Similarly, special emphasis was laid on technology for reducing drudgery and extending support mechanisms through Mahila Mitra Kisan, in the guidelines for NWDPRA prepared by the MoA. Targeted budgetary allocations were made for promotion of income generating activities, focusing specifically on women and the asset-poor.

All these are useful though not sufficient measures for addressing the constraints faced by women and the landless to become direct beneficiaries of the `core' activities of watershed projects are taken. Given this context, stakes of women and landless remained confined mainly to on-site employment gains, development of activities allied to agriculture (such as rearing of small livestock, back yard plantation, nursery raising, inland fishery, etc.), thrift groups, and non-land based activities (such as food processing, traditional crafts, tailoring etc.). It is not clear as to what extent, these interventions per se may pave way for empowerment of the poor, unless the perspective on equity is clearly articulated and shared among all the stakeholders within the project.

Taking a stock of what has been achieved so far and what are the important lessons emerging from a large number of innovative watershed projects from different parts of the country, are very critical before launching the next phase of watershed projects during the 11th Five Year Plan, which has raised serious concern on the issue of equity in watershed development.

Objectives and Coverage

Given this backdrop, this study tries to focus on the following main objectives:

i) to discuss the perspective on equity and examine the evidence from impact assessment studies;

ii) to review innovative experiences from various projects having focused on equity aspect; and

iii) to identify major learnings and draw policy implications.

The analysis is based on review of the existing evidence, and selected case studies prepared by scholars and practitioners from different parts of the country.

Perspective on Equity

Project-based Equity to Empowerment

At present the policy space provided in the guidelines of the major watershed projects in the country seem to represent necessary but not sufficient conditions for attaining equity across class and gender. Also, the issue of upstream-downstream is yet to be fully grasped in the policy design. This implies that the upward progression from project-based equity may be fairly slow especially in the government-supported projects. Conversely, the indicators of equity remain confined mainly to the first level impact viz; membership in the project-based institutions; participation in the group activities, additional income earned, etc.

Clearly, the trajectory is to move from this initial stage of inclusion to empowerment and equal partnership in not only sharing the benefits but also shaping up the design of watershed-led development in the region. Given this perspective, the indicators of equity, may move from sheer membership, presence, and additional income from low-productive stereo-typed activities, to the larger goal of empowerment among the resource-poor and women.

Given the fact that social transformation in terms of narrowing the class and gender differentials is a complex process, mere legislative enactments or statutory provisions within watershed guidelines may not be effective. It is here that the role of social movements and civil society organizations (CSOs) working towards larger goals of equitable development, may assume special role. It is encouraging that a number of initiatives have come from non-government organizations working with greater flexibility – procedurial, financial, and temporal. What is more heartening is that some the learnings emerging from the NGO or donor agency supported projects have been internalized into the state-supported watershed projects.

Evidence and Emerging Policy Concerns

Recognizing that the equity aspect in watershed projects, especially in the major government-supported projects, is at an initial level, its translation into actual practice is mainly in the form of an add-on to the `core' activities of watershed development. As a result, the impact assessment studies have often overlooked the aspect of equity and/or remained confined to primary level indicators like membership, presence, formation of SHGs, etc.

This is reflected in the fact that impact assessment studies undertaken at national level, are often on micro-watershed level with indicators like increase in cultivated and irrigated area, yield, and income rather than on who benefited from what and how much. Whatever limited evidence one finds from

the literature is far from being encouraging. The evidence not only suggests low impact on equity, at times, they indicate increased deprivation in terms of women's/poors' access to resources besides bearing additional work load towards project activities.

There is however, a rich set of case-study material, capturing innovative initiatives and substantial positive impacts on equity focusing on landless and women. The SHG-movement has provided further impetus for enhancing the equity outcomes among watershed projects especially in states like Andhra Pradesh, Karnataka and Kerala.

It is thus, pertinent that formulation of the the 11th Five Year Plan has taken special cognizance of the issue of equity in benefits flowing from watershed projects. While the concern is valid, it is essential to place the issue in a proper context of relatively adverse agro-climatic, economic, and financial setting within which these projects are being implemented. Clearly, addressing the equity issue through watershed projects may require substantial increase in time as well as institutional support with the corresponding increase in funding. What is equally important is building up consensus on the issue of equity across various developmental interventions and convergence among them. Watershed project may create a basis for a progressive move towards equity and empowerment for the other interventions and processes to build further on that. In absence of this, what one may expect at best is project-based-equity as noted above.

Not withstanding these limitations, we come across a number of interventions where different approaches have been tried out to address the issue of equity. These have been of course different approaches tried out under varying operating environment and with differential outcomes. In what follows we have tried to summarise the major features of the approach and the major lessons emerging from each of these experiences.

Approaches and Learnings from Select Case Studies: A Summary

This section draws mainly on 10 contributory papers focusing on the thematic review and or case study based on actual experience of project implementation. These papers cover a range of themes as well as regions across different parts of the country. Some of the salient features have been summarized as follows.

Practicing Equity: Ram Chandradu discussed a broad canvas of the policy approach for addressing the issue of equity in the case of the major watershed projects and examines actual performance in the light of the three sets of parameters viz: processes of implementation at critical stages; institutional space; and allocation of funds. Based on an empirical of 55 watershed projects spread across seven states in the country, the author brings out a fairly realistic depiction of practicing equity through the three parameters noted above. The empirical results highlight substantial gaps between the policy guidelines and the actual practice. According to the author, the gap arises because of the lack of specificity in the guidelines regarding the measures suggested for attaining equity. The author concluded by emphasizing the need for clearly identifying the non-negotiable components pertaining to equity aspects and pleads for the requisite support in terms of selection of appropriate facilitating agencies, building their capacities, and ensuring administrative support as essential preconditions for attaining good practice of equity within the project context; going beyond this may necessitate addressing the structural factors perpetuating inequity across class and gender.

Leveraging Women's Collective Power within the Policy-Space: Sreedevi and Wani (2007) presented a case study of good practices in bringing gender equity in the context of project implementation.

Comparing project implementation in the three micro watersheds implemented by ICRISAT-led consortium in Andhra Pradesh, the authors demonstrated that the impact of watershed development could be enhanced and sustained by leveraging institutions for collective action and harnessing gender power through `prosperity and harmony' within the village community. Describing three different trajectories and drivers of growth the comparative analysis highlights the power of bringing women as managers of watershed project. This has not only resulted in benefits tilting in favour of women but also in mobilizing higher level of participation on a sustainable basis. The pertinent point here is that mobilization of women's collective power was facilitated through the expanded policy-space within the government programers. Equally important is the role played by the facilitating organization, a critical pre-condition for attaining better equity-outcomes, as noted above. The analysis reinstates the focus on youth and functional literacy in order to be able to take up the new market opportunities targeted. Income-generating activities for women not only improved participation but also developed social capital and decision-making power along with increased family incomes.

Bringing Women at the Forefront throughout the Project Cycle: Dharmishta (2007) demonstrated enhancement of gender outcomes by fully utilizing the space within the existing policy-guidelines. She compared the outcomes of two sets of projects – one having direct focus on women's needs and other not having such specific focus. The case studies, once gain, are selected from some of the more successful projects such as Hivere Bazar in Maharashtra and Mokasar, implemented by AKRSP in Gujarat. The analysis brings home an important point that with specific focus on involving women at all stages of the project cycle it is possible to not only meet the practical needs like provision of drinking water, fodder, and fuel but also to address strategic concerns of women, which eventually leads to gender empowerment.

Awareness and Inclusion of Women: Based on the experience from Doon Valley Project in Uttarakhand, Sitling (2007) presented a detailed account of the participatory processes for mobilizing women's participation in watershed projects. She brings to the fore the fact that soliciting women's involvement is an uphill task, requiring special social skills and time. She also underlines the fact that many developmental practitioners fail to recognize the fact that technological interventions for enhancing availability of improved inputs and reducing drudgery may have significant impact on households' food security in hilly regions where physical accessibility is a major constraint. Understanding how small changes could make a big difference on households' well being is very critical to watershed interventions in these remote areas where marked changes in agricultural production is difficult to attain within the a short period of the project-duartion.

Tracking CPLRs-Need for Investing in People's Institutions: Seva Mandir, with its long drawn presence in southern Rajasthan represents one of the few experiences of turning the tide of dealing with the legal complexities as well as community based contestations over CPLRs, which hold the key for equity in watershed projects in some of the central-western regions in the country. Shailendra (2007) presented a case study of how Seva Mandir succeeded in the struggle over CPLR-development, and emphasizes the fact that the process involves setting-up of the mechanisms for identification of encroachers, removal of encroachment, and compensation for the loss accruing to the encroachers. All these require investing a lot in people's institutions, much beyond the policy-space available within the context of watershed projects.

Land for Food Security: Leveraging the existing policy-space for purchase of agricultural land by the landless in Andhra Pradesh, Deccan Development Society has initiated a process of empowerment among landless women by making them owners of land. Regenerating highly degraded land to provide

extra meal to the poor has shown the way to how equity issue could be addressed within the existing policy-space. Of course, this does not happen over night; a committed group of development agencies need to work with confidence and zeal to be able to tread on new paths.

Bringing Local Governance for Water-Use in M.P: The case study by Banerjee (2007) provided a detailed account of how SAMPARK and SPS tried to reverse the structural inequity in use of water in a tribal setting in M.P. This was achieved by making the community come to a common agreement on the rules of water use within watershed projects. There was of course, strong resistance by the caste community. The resistance emanated not only due to restrictions imposed on water usage but, also due to the challenge it posed to the authority of the caste-groups, which they have enjoyed even within a predominantly tribal region. The author points to the fact that challenging the established authorities is often difficult as it draws support from the state administrations. This makes it difficult for a single agency to sustain its effort over a long period of time.

Role of People's Movements: Building further on the issue raised above, Kulkarni (2007) underlined the fact that despite an enabling legislative framework for women to participate in water sector, various structural factors continue to constrain their participation beyond numbers and representation. It is here that role of women's movements/groups/NGOs become critical so as to be able to leverage and expand the public-space created through initiatives like watershed projects for attaining gendered development.

Credit through SHGs-Making a Serious Business: SGHs create important institutional base for addressing the issue of equity across class and gender. The case study by Mandal (2007) indicated that SHGs have proven to be successful for mobilizing women in the project and creating formal women-led community organization. The next phase is to explore how to use these strong organizations beyond micro-finance activities. Clearly, there is need for providing formal space to these SHGs within the watershed institutions.

Linking with the Markets: Harping further on the incomplete agenda of SHGs and micro finance within watershed projects, Datar (2007) suggested the need to overcome some of the barriers created by strait-jacket rules observed by many micro-finance institutions so as to be able to ensure asset-creation among the members of the SHGs. She asserts that the goal should be to stabilize micro-enterprises initiated by these groups rather than thinly spreading the institutional finance, which eventually turns that into doles.

The above case studies illuminate the vast potential and the diverse approaches as well as challenges facing the watershed projects for addressing the equity issue. Clearly, there are no readymade solutions to a deep-rooted problem such as this. The need therefore, is to acknowledge the problem, take it upfront right from the beginning of the project cycle, and invest in institutional support over a long period of time.

Following suggestions may help addressing the issues of equity within the limited context of watershed project, and beyond.

Major Policy Implications

- An integrated policy for land and water use across different agro-ecological zones with special emphasis on water usage efficiency should precede macro level planning for watershed based development of natural resources. This should take care of the spatial prioritization and also the compensation mechanism within an upstream-downstream context.

- Promotion of equitable use of augmented water through the project by providing incentives for adoption of water usage regulation and water-saving crops/technologies so as to facilitate the resource poor to gain from the project.
- Legislative and administrative mechanisms for facilitating poor's access to CPLRs; their intensive management including through enhanced availability of water, and development of livestock, and other high valued farming.
- Some of the processes essential for bringing women's/poor's practical as well as strategic concerns and representation of their SHGs into watershed committees should be treated as non-negotiable right from the initial phase.
- Need to invest in creating local institutions for governing the use of scarce resources on the one hand, and increasing the size of the economic surplus through productivity enhancement such that the poor tend to benefit from direct intervention for income generation and also the trickle down effect as well as market development.

It is imperative to note that social transformation such as equity across class and gender necessitates continued convergence among various developmental initiatives; watershed development projects could play a key role in bringing such convergence as micro-meso and macro levels.

d. National Watershed Management Program: The Capacity Building Challenge

Introduction

The huge public investments in watershed management have yielded relatively less benefit than expected. The Mid Term Appraisal of the 10th Five Year Plan noted that "while expanding the pace and scope of watershed development, much greater attention needs to be paid on why past efforts have delivered less than promised".[4] Various independent evaluation studies have revealed that at present capacity building is one of the weakest links in the public watershed management programs. The Mid Term Assessment of the 10th Five Year Plan, 2005 noted that "some of the problems arise because watershed development is capacity intensive and inherently slow". A Project Scoping Exercise conducted under the Indo-German project "Strengthening capacity building for decentralised watershed management" jointly implemented by the Ministry of Agriculture, GoI, and the German Technical Cooperation (GTZ)[5], has highlighted some key capacity building challenges for the national watershed management programs and recommends potential areas for intervention for improving the efficiency and effectiveness of the public investments in watershed management.

Capacity Building under Public Programs for Watershed Management

The WARASA-Jan Sahbhagita guidelines lay more emphasis on capacity building than the Haryali guidelines. However, the activities detailed in the guideline are confined to orientation and training courses for personnel at various levels – national, state, district, PIA and watershed committees. There is no mention of how the capacity building activities at the national level would be funded. Under the Hariyali guidelines, there is no provision of capacity building at the national, state and district levels. None of the public watershed programs address capacity building at the organisational and systems levels. Networking among training organizations with different expertise for knowledge sharing and

[4] Report of the Mid Term Appraisal of the 10th Five-Year Plan, Planning Commission, 2005.
[5] A Project Scoping Exercise was conducted in May-June 2007.

exchange of resource persons has been emphasised by the NWDPRA guidelines. However, no such effort has been made to network the public and private training institutes for the national watershed programs. The NWDPRA and other watershed programs do not allocate any resource for establishing and supporting such networks.

A brainstorming workshop of experts organized by MoA and GTZ in May 2007 concluded that the capacity building challenges for watershed programs are more systemic and organisational. Capacity building needs to be understood in much broader terms than organising training programs for the officials and community members involved. Capacity building is a "process to strengthen the abilities of people, organisations and systems to make effective and efficient use of resources in order to achieve their own goals on a sustained basis". Therefore, the capacity building interventions also need to focus on the systemic, organisational and institutional dimensions of watershed programs at all the levels – national, state, district and sub-district (PIA, watershed committees, gram panchayat). Capacity building has to take place on three levels to be effective and sustainable:

- systems level, like program and policy formulation, implementation guidelines, resource allocation, etc., that support or hamper the achievement of certain policy or program objectives
- organisational level, like the organisational structure, decision making process, management instruments and processes, standards and quality management, partnerships and networks between organisations
- individual level, like skills and qualification, knowledge, motivation, work ethics, etc.

The capacity building challenges identified at the brainstorming workshop were further triangulated at regional workshops in few states. The following list of challenges at the national, state and district levels emerge from the exercise.

Strengthening Capacity Building under National Watershed Programs - Way Forward

Capacity building need to focus more on the systemic, organisational and institutional dimensions of watershed programs at all the levels – national, state, district and sub-district. Solutions to some of the challenges already exist in different states and projects. What is needed is to learn from these approaches – what works and what does not, why something works and other do not, and integrate the learning into the national programs. The study identified existing approaches with high potential to address capacity building challenges for the national watershed programs.

Consortium Approach for Networking and Delivery of Capacity Building Services

Capacity building service delivery under watershed management requires multidisciplinary skills and competencies. It is not always possible to get all the required skill sets in one organisation. Many a times it is expensive to develop all the required skill sets in one organisation. Moreover, watershed program is being operationalized in decentralized manner and it is required that capacity building services be decentralized level, which can be met through establishment of state level consortium of diverse public and private organizations for delivery of capacity building services to watershed management programs. The Andhra Pradesh Rural Livelihoods Program (APRLP) has piloted the consortium approach for capacity building. The mix of public / private service providers and research institutions in the consortium and its formal link with the program managers proved effective in generating and integrating learnings from the field in program management.

Prioritised List of Key Challenges for Capacity Building at the National, State and District Levels.

National	State	District
• Absence of a national strategy and guideline for capacity building • No resource allocation of for capacity building at the national level • Absence of baseline information for prioritising watersheds and preparing national plan • Lack of adequate human resource • Absence of an effective M&E system, especially for the capacity building component • Lack of objective criteria and process for identifying institutions and organisations to deliver quality services for cpacity building	• Low emphasis on capacity building • Absence of a mechanism for capacity building need assessment • Lack of an objective system for identification of good quality PIAs and service providers for capacity building and M&E • Lack of a functional and effective system for M&E and feedback on project learning • Absence of a qualified and dedicated team to support the watershed project implementing • Low capacity to promote public-private partnerships in watershed management • Lack of objective criteria and data for prioritising watersheds • Lack of departmental and institutional coordination	• Absence of an objective and need based selection criteria for prioritising watersheds • Inadequate baseline database at the district level affects planning as well as M&E • Weak M&E and learning system • Inadequate human resource • Low capacity to use planning tools (log frame, result chain, etc.) in planning and implementation • Absence of quality PIA and capacity building service providers • Inadequate capacity building infrastructure, framework, subject matter specialist and delivery mechanism • Inadequate linkage of PIAs with the knowledge centres

Development and Institutionalisation of Monitoring, Evaluation and Learning System

One of the major challenges for the public watershed management programs is the lack of independent and effective system for monitoring and evaluation. An effective monitoring, evaluation and learning (MEL) system provides timely feedback to the program managers and decision makers for mid-term improvements in the program implementation. The Sujala project in Karnataka has developed an effective MEL system that blends satellite imagery and ground based monitoring system to provide information and feed back regularly on key issues, performance, social and environmental impact to support learning and decision making, which consists of concurrent monitoring comprising process monitoring and input – output monitoring and discrete monitoring of impact assessment.

Public-Private Partnership for Watershed Management

The involvement of private sector in public watershed programs can improve their effectiveness through augmenting public resources with private investment, enhancing economic returns on the public investment through establishing backward and forward market linkages in the watershed areas and offering need based and quality services for capacity building. The Government of Rajasthan is piloting PPP approach for implementation of the Integrated Wasteland Development Project

(IWDP) jointly with the ITC Limited. The partnership makes use of the public investment program (IWDP) of the MoRD for watershed management and adds on the resources from ITC, both in terms of funds and the professional skills to implement watershed based livelihoods project and build community capacity. The ITC has an interest in ensuring better implementation leading to effective management of natural resources and increased income of the community. Both these results will lead to enhancement of their business and achieving the performance indicators for contribution to social development. The State Government is interested in increasing coverage through additional funds and enhancing the effectiveness by using professional skills of ITC. Such initiatives need to be further tested in other projects and states to develop PPP approaches for implementation of national watershed management programs.

Quality Management and Certification System for Service Providers under the Public Programs for Watershed Management

One of the key challenges faced by the national programs is lack of good quality implementing agencies and service providers at the state and district levels with documented capacities and proven track record. Lack of an established quality standard for the service providers under public watershed programs makes it very difficult to assess their institutional capacities. With expansion of the watershed program and involvement of private actors there is an increasing need for quality service providers. A quality management certification system would address the needs of decision makers of the public programs in identifying the service providers. A quality management and certification system would also highlight the institutional strengths and weaknesses of the service providers and motivate and guide them to improve their organizational performance (efficiency and effectiveness). The certification for quality management would provide an opportunity to the organisations to communicate their capacities and credibility to the stakeholders and interested agencies. Development of a quality management standard and certification system would be an innovative approach for capacity building of the watershed management sector as a whole, rather than small number of individual institutes and organisations. A step process for capacity building of the service providers need to be designed so that they could achieve quality management standards, ultimately leading to their certification.

Need for a National Strategy for Capacity Building

A national strategy for capacity building should become part of the watershed management guidelines, allocating earmarked resources for capacity building at different levels including the national level. The national strategy need to facilitate development of state specific capacity building system catering to the specific needs of the states. The national strategy should be designed so that it addresses human resource development, organisational development, cooperation and network development and system development.

4.7 Guidelines for Planning and Implementation of Watershed Development Program in India: A Review

Watershed guidelines in India have been drawing up a series of revisions from time to time to suit the changing situation and to make them more flexible, specific to regional variations and to the demands of new developments in the science and art of natural resource management. In addition, there are different sets of guidelines evolved by the donor agencies and the NGOs, based on their own

understanding of the ground situation and norms of planning and implementation of the watershed development projects. It is proposed in this paper to critically review all these guidelines in the perspective of the demands warranted by the needs of time and space as also the art and science of natural resource management, and to assess how far the guidelines evolved from time to time kept pace with the changing scenarios and learnings from the previous program. These guidelines relate to planning and implementation of the watershed development projects, institutional set up in this regard and the process of monitoring and evaluation of the projects in particular and the program in general.

Methodology and Framework of Analysis

The methodology of the paper consists of documenting these guidelines and putting them in the form of annexures; reviewing the available academic studies and from their findings to draw implications to the kind of guidelines suggestive of such studies; evaluating the received guidelines in the light of the implied guidelines arising from the academic studies, and finally, suggesting what next is to be done for the gaps identified there from. The summary of gaps and learnings under each process are discussed in the report.

Guidelines for Identification, Planning and Implementation

Watershed Development Policy: Governmental Guidelines
improving agriculture productivity being the focus of agriculture development, the state had formulated appropriate policies and strategies to achieve great agriculture productivity. Initially, the focus of agriculture policy was on provisioning of yield-increasing inputs like irrigation, improved seeds and fertilizers. Later, the state policy shifted focus to soil and water conservation, when it was realized that the scope for increasing yields through providing inputs (river water, seeds and fertilizers) was limited. Though India had vast geographical area, much of the land available is degraded and unsuitable for intensive cultivation and majority of cultivable land had the problem of soil erosion. Therefore, the governments at the center and the state levels launched soil and water conservation programs with a view to checking soil erosion and controlling wastage of water.

The state shifted its policy focus from mere conservation to that of integrated land management with focus on conservation and management of land and water resources. Now, the project aimed at retention of moisture, bio-mass production, enhancing incomes of farmers and expanding their livelihood options. This amounted to a policy shift from soil and water conservation to watershed development, emphasizing on supporting livelihood system of the people residing in the degraded land zones.

Identification of Villages for Implementing Watershed Program

The review of guidelines and publications by different authors has provided good insights about watershed areas and village selection to manage effectively and enhance the impacts of watershed programs. They are:

- larger size watersheds (>1250 ha) showed more impact than smaller size watershed (<500ha) as the water flows are connected. Milli watershed approach planning has to be adopted that has proved to be more efficient. In a Milli watershed we should have a cluster approach to develop and implement the watersheds

- selection of watersheds should be based on demand from the community along with technical information available at national level (remote sensing) for prioritizing the watershed development rather than supply driven. Greater proportion of rain-fed area, water scarcity (drinking and for supplemental irrigation), low crop yields, poverty factors need to be considered while selecting the watersheds
- simultaneous development of land, water and biomass (because of the symbiotic and farming systems approach in the watersheds rather than compartmental approach of soil and water conservation) are required
- appropriate technologies for different rainfall zones are needed as evident that current technologies are suitable for 700-1100 mm rainfall zone. There is need to develop suitable technologies for watershed development in <700 and >1100 mm rainfall zone
- improving land productivity through convergence of improved cultivars, cropping systems, fertility management, pest and disease management along with technologies for efficient use of water are essential
- technological backstopping through a consortium of research institutions for the development agencies is needed. In the watershed development programs, provisions for technical support by research institutions is needed
- convergence of different actors (NGOs, government line departments, research institutions, private entrepreneurs, and CBOs) in the watersheds is needed for enhancing the impacts of the programs
- policies for sustainable use of water resources is urgently needed for sustaining the development in the watersheds as overexploitation of water resources can trigger the process of degradation
- ensuring environmental sustainability along with economic viability (through the promotion of low-cost technologies) for soil and water conservation
- creation of non-farm employment (either to release population pressures on land, or to create employment for the landless households) through income-generating activities for better collective action by the community
- development of community-based organizations (CBOs) and empowerment of stakeholders for enhanced impact and sustainability of watershed programs. Community participation is very critical for enhanced impact and sustainability of watershed programs
- no free rides and cost sharing by the individuals and community is pre requisite for sustainability. Ensure tangible economic benefits to large number of small and marginal farmers through knowledge sharing and empowerment of the stakeholders rather than depending on contractual mode of participation through subsidy-based interventions
- cost sharing has to be 'real'. *Shramdan* or contribution of voluntary labor does not necessarily create a feeling of ownership of the assets created for land and water development. Cash contribution and private investment with or without credit ensures commitment to the institution as well as to the project as a whole
- capacity building and empowerment is the key for the success of the watershed programs through sustainable institutions. It is more than creating awareness, technical training and exposure visits. It should lead to empowerment of the community and all the stakeholders up to policy makers for informed decision-making. Capacity building has to be approached as a human resource development

strategy, building institutions and putting processes in place for sustainable management of the natural resource base and for addressing poverty and livelihood security

- strong dedicated and committed leadership helps to bind groups and give direction to the fulfillment of goals and objectives. There is need to develop social capital in order to have sustainable institutions and watershed programs
- an assured flow of funds to the project maintains a high level of motivation. If project activities cannot be completed, or project implementation is delayed, then people's commitment to the project cannot be sustained. Lack of motivation and commitment weakens the local institutions.

Community Mobilization

The 1995 guidelines do explicitly refer to the need for community mobilization by constituting SHGs and UGs with help from the WDT. By insisting on community contribution and community participation in planning and implementation of the project the guidelines issued subsequently indirectly talk about community mobilization. Rajasekhar *et al*. (2003) have shown in their study that in spite of a strong presence of community organizations like SHGs, the process of planning has tended to bypass these institutions. It is observed that NGO staffs have tended to play a more dominant role, particularly in selecting beneficiaries, and ascertaining whether the latter were willing to join the group and to contribute towards watershed activities.

Resolution of Disputes

The guidelines did not seem to have recognised the possibility of disputes arising during or after the project implementation over land and other assets. As such no important guidelines were provided for dispute resolution except suggesting that the *grama sabha* should resolve differences if any, between different SHGs/UGs or among members of these groups (Hariyali). However, where watersheds encompass forest land, the 2001 and Hariyali guidelines suggested that in order to avoid inter-departmental disputes the proposed watershed program should get the technical sanction from the concerned DFO, should co-opt a forest official as a member of the WDT and the project plan to conform to the Forest Conservation Act. Neeranchal appears to have overlooked the need for dispute resolution among the stakeholders. The working group on natural resource management, however, made an important suggestion on how to prevent conflicts among the stakeholders. In this regard it held that if appropriate legal provisions were made on such aspects as formal allocation of user rights over common property resources (CPRs), de-encroachment of common land, social regulation against over exploitation of CPRs much of the dispute potential could be avoided (targeted intervention for drinking water issues will bring suitable preconditions for selection of watersheds).

Participatory Planning and Implementation

The review of studies clearly reflect on problems in the implementation process arising from the following reasons: (i) the project team consisting of personnel drawn from the line departments are given to interacting with their own superiors and as such are not comfortable to do so with the people; (ii) since targets are fixed they have no time to go through the participatory process; (iii) participatory approach which gives power to local communities reduces rent seeking behavior of the bureaucracy. Hence, no incentive mechanism is built into the system that could motivate these personnel to be efficient. Few studies also argued that deputation of personnel from line departments

like agriculture and horticulture have affected the performance of these departments because of increase in administrative staff to technical staff ratio in the departments. It brings out the point that watershed committee members extensively complained that the line department staff hardly visited the villages and interacted with them.

Capacity Building

Capacity building among the stakeholders and those involved in planning watershed development program need not be over emphasized. Recognizing such a need as far back as the 1990s, the Hanumantha Rao Committee had suggested that the functionaries involved in this program and others must get training in planning and implementation processes. It was the Eswaran Committee that devoted a large space in its report to spell out in detail who needs to be trained and what modules to be developed for the purpose and so on. The committee has evolved and recommended an assortment of training modules for each of groups in watershed program separately on the need for regeneration of natural resources and their effective utilization, the role and rationale of the watershed development program, the organizational aspects of the program, its planning and implementation methodology and mechanisms, the functions and composition of various committees and groups if people are involved in this process, the need as also the manner of people's participation in the program, the questions of equity and sustainability and people's contribution towards implementing the project

Project Benefit Targeting

Government guidelines appear to have drawn a blank on how to target benefits to the interest groups under the program, particularly to the weaker sections and the resource poor in watershed programs. However, NGO implemented projects were more successful in rejuvenating the commons and were equity oriented because of the strength the NGOs possessed in social organization in contrast to the government staff whose skills in social organization were not good enough to tackle the complexities. Appropriate guidelines need to be developed on this point to improve equity and address the common people in the community.

Project Duration and Funds of the Program

The project duration specified varies from one set of guidelines to the other. Thus, the duration conceived under 1995 guidelines is four years. The Neeranchal study talks about an eight-year duration with three phases. There is, however no reference to the duration of projects by the other guidelines. The cost norms of the project are fixed by the guidelines and urge the WA, SHG and UGs to explore possibilities of availing bank credit for their activities. Studies showed that often the programs are affected by problems like delays in sanction of funds, and also in the release and use of the funds.

Exit Protocol

The guidelines insist that an exit protocol is to be evolved for the management and maintenance of the assets created by the project implementation authority. However, clear guidelines are not spelt-out on how the modalities of managing and maintaining the assets have to be left to the concerned institutions.

Institutional Structures for Watershed Development

Watersheds constitute an integration of physical areas, whereas the villages form the social and administrative units at the operating level that may exist within or across the physical boundaries of the watershed. In this situation, the institutional mechanism at the operational level becomes critical for the management and development of watersheds. The guidelines evolved over years have undergone changes as follows over institutional structures for watershed development.

- The approach to development of India's drylands has shifted from soil conservation to watershed development.
- The strategy has shifted from mere soil and water conservation to supporting the entire livelihood systems of the people residing in the ecologically fragile zones.
- The line department oriented planning is replaced by participatory watershed development.
- The project funding practice has moved primarily from solely government grant to government grant-cum-user contribution.
- The purpose-wise fund allocation is changing from predominantly natural resource development to natural resource development plus administrative, evaluative and livelihood development.
- There is a move towards more and more of social regulation in natural resource use by various group.
- There is also a move towards targeting benefits of the projects to resource poor and women groups.
- The guidelines have moved from generalities to specific to the needs of time and space.

These institutional changes have influenced the line departments, PRIs, bilateral and multi-lateral agencies to formulate programs under which watershed development have to be achieved since 1990s. These developments in the approach and thrust of the guidelines are indeed welcome. But there are still some differences between the government guidelines and those of NGOs and donor agencies. The NGO-donor agency guidelines appear to be:

- more rigorous in regard to identification of villages and watershed development projects
- more equitable and weaker section oriented when it comes to distribution of project benefits
- insist on user groups' contribution towards project costs more rigorously more stringent when it comes to project fund building and its management
- emphasise more on participatory planning, implementation, monitoring and evaluation
- more willingness to follow the project exit protocol plans and support and encourage user groups and SHGs to take-over project assets for management thereafter.

These distinct features of NGO-donor agency guidelines are important lessons to government agencies in their effort at formulating and revising guidelines for strengthening the institutional arrangements for watershed development. It may not be out of place here to identify some areas where further action is required. While one can be happy about the frequent changes in, and revisions to, the watershed development guidelines by government keeping in view the changing needs of the project and the recommendations of technical committees and academic studies, there is still a need to:

- maintain continuity and link between the past and future in regard to guidelines which have a proven internal strength
- clearly indicate, for the benefit of project planning and implementing, which aspects of the previous guidelines are to be ignored and which are to be retained and followed
- further clarify, especially when emphasis changes in regard to a specific guideline, to what extent the implementing institution can depart from the past practices and how.

Monitoring and Evaluation of Watershed Development Programs

Monitoring is a recognized management tool not only for effective and efficient project implementation but also as a process of learning. It is an integral part of the project's regular operations rather than an on and off event conducted at periodic intervals. It includes measuring, recording, collecting, processing and communicating information. It continuously tracks performance and provides information on whether adequate progress is being made towards achieving the results. Monitoring also looks at the processes and changes in the conditions of the target groups, institutions and natural resources in addition to impact assessment.

Learnings from the Studies

The agency which implements the program should not be entrusted with the monitoring process as well, at least to ensure objectivity. Some donor funded projects such as the World Bank supported Karnataka Watershed Development Project have invested heavily in establishing comprehensive monitoring systems to be undertaken by independent evaluators. This has ensured an unbiased and objective analysis of implementation, a multi-disciplinary integrated approach as well as an independent and need based assessment. Moreover, an independent evaluator is less open to external influences and has a greater acceptability at the field level. The only problem which some of the independent evaluators may face, is the lack of easy access to data / information as the project implementing agencies may not be willing to part with the information in their possession easily.

Impact evaluation follows monitoring and will necessarily have to depend on good monitoring. Evaluation usually yields substantial information on project implementation arrangements, administrative structures and the achievements of immediate outputs. While preliminary evaluation of monitoring results can be undertaken by the project staff, it will be desirable to engage external evaluators to undertake detailed evaluation of outcomes, at definite intervals. Monitoring of a watershed program will be continuous and concurrent, whereas evaluation can be periodic within a specific time frame. Even when external certified/trained evaluators are engaged for effective monitoring evaluation, there still exists a wide scope for improving monitoring mechanisms, particularly through the use of local communities to gather relevant information on an ongoing basis. Specific case studies of the beneficiary farmers including women and the landless labor and focus group discussions with the general public in the watershed will also enhance the quality of monitoring. Detailed and scientific monitoring of benchmark watershed in each district or agroecoregion is recommended. Baseline characterization must be made mandatory to facilitate proper impact studies at later stage.

Watershed Program: A desirable model

A careful examination of different models and comparative study of institutions in different watershed programs indicates that the Karnataka Watershed Development Society model in Bellary involving the

zilla parisad (ZP) could be replicated together with the watershed associations (area groups) of the Sujala model at the micro-watershed level. These two institutions together with the SHGs can form an institutional framework that appears most appropriate for implementation and management of the watershed programs. Perhaps, the committee at the watershed level with representation from the GP/TP would be the appropriate institution at that level to support the program. Effectively linking the area groups with the PRIs at the appropriate level is the key to ensure people's participation in watershed programs as well as for their sustainability. The processes, appraoch and institutional mechanisms from APRLP, Indo-German Watershed Program and Consortium appraoch for technical backstopping of ICRISAT would enhance impact of the watershed programs.

At the watershed level, there is a need to ensure transparency and accountability of management to the stakeholders. Proper accountability would require greater involvement of watershed associations, self help groups and user groups in planning, execution and financial management of the project. The *gram panchayat* should be concerned mainly with facilitating convergence, project review, monitoring and conflict resolution among bodies that should always remain accountable to the *gram sabha*. It may be necessary to prescribe that the action plan for each micro-watershed must be presented for approval at the gram sabha meeting, the summary of the approved plan must be put up for display in a public place, all labor payments must be made in public and regular public hearings must be periodically held, where detailed accounts are presented to the stakeholders. Wherever possible, information technology, GIS and remote sensing should be used to record and manage data as well as to generate information on the indicators to be monitored. Independent monitoring agency coupled with social auditing (as attempted in the Sujala model) could prove to be effective in enhancing transparency, improving quality and ensuring equity for various interventions.

There is an urgent need to have social/legal mechanisms and policies for sustainable use of augmented water resources in the watersheds (Sreedevi et al. 2006) through digging more bore wells and increasing hours of pumping from the wells can tilt the water balance in negative. Water users' associations and the PRIs must be encouraged to charge and collect water and electricity rates from the farmers on the basis of the volume of actual consumption where metering is possible or on the basis of the quantities of water received or electricity consumed as estimated by the farmers' associations in as transparent a manner as possible.

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Appendix I: List of Participating Organizations

National Centre for Agricultural Economics and Policy Research (NCAP)
P.O. Box 11305
Library avenue
Pusa
New Delhi 110 012

Junagadh Agricultural University (JAU)
Junagadh 362 001
Gujarat

Tamil Nadu Agriculture University (TNAU)
Coimbatore 641003
Tamil Nadu

Water And Land Management Institute (WALMI)
9, Chetna Apartments
Bansilal Nagar,
Station Road
Aurangabad 431 005

Institute For Social & Economic Change (ISEC)
Nagarabhavi
Bangalore 560 072

Central Research Institute for Dryland Agriculture (CRIDA)
Santoshnagar
Hyderabad 500 059
Andhra Pradesh

Institute of Economic Growth (IEG)
University Enclave
New Delhi 110 007

Indian Space Research Organization (ISRO)
Head Quarters
Antharix Bhavan
New BEL Road
Bangalore 560 094

International Water Management Institute (IWMI)
P.O. Box 2075
Colombo,
Sri Lanka

Watershed Organization Trust (WOTR)
Paryavaran
Behind Market Yard
Ahmednagar 414001
Maharashtra

BAIF Development Research Foundation
Kua Wali Gali
Baharali Bundi
Bundi 323 001
Rajasthan

Central Soil Water Conservation Research and Training Institute (CSWCRTI)
Dehradun 248 195
Uttaranchal

Gujarat Institute of Development Research
Gota Char Rasta
Ahmedabad 380056
Gujarat 380056

Central Arid Zone Research Institute (CAZRI)
Jodhpur 342 403
Rajasthan

Indira Gandhi Agricultural University
Raipur 492 012
Chattisgarh

National Bank for Agricultre and Rural Develpment (NABARD)
Bldg. No. 8
Krishna Kutir Shagarika
Mumbai

Watershed Support Services and Activities Network (WASSAN)
12-13-452
Street No. 1
Tarnaka
Secunderabad 500 017

Rajiv Gandhi Mission
Room No 508
Vallabh Bhawan
Bhopal 462 005
Madhya Pradesh

GB Pant University of Agriculture and Technology
Pantnagar 263 145
Dist. Udamsinghnagar
Utrtaranchal

Foundation for Ecological Security
NDDB Campus
Anand 380001
Gujarat

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
P.O. Patancheru 502 324
Andhra Pradesh

Ministry of Agriculture
Government of India
New Delhi 100 001

Ministry of Rural Development
Government of India
New Delhi 100 001

Commissionarate of Rural Development
Government of Andhra Pradesh
Hyderabad 500 004
Andhra Pradesh

Commisionarate of Watershed Development Department
Government of Karnataka
Bangalore 560 009
Karnataka

Seva Mandir
Udaipur 313 004
Rajasthan

Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ)
GmbH
D-65760 Eschborn
FR Germany

Appendix II: List of Reports Available on the Web

Sl. No.	Report Name	Submitted by/ Sponsored by	Submitted To
1.	Guidelines for Hariyali (2003)	Department of Land Resources, Ministry of Rural Development, Govt. of India.	-
2.	Warasa – Jan Sahbhagita Guidelines for National Watershed Development Project for Rain-fed Areas (NWDPRA)	Govt. of India, Ministry of Agriculture, Dept. of Agriculture & Cooperation	-
3.	Watershed Development Fund Guidelines_	National Bank For Agriculture & Rural Development Head Office, Mumbai.	-
4.	Final Report on Impact Evaluation Study of Kupli Micro Watershed in Jantia Hills District, Meghalaya	Govt. of India (Ministry of Water Resources) Brahmaputra Board.	-
5.	Final Report on Impact Evaluation Report Of Dargure Chikama Watershed Meghalaya	Govt. of India (Ministry of Water Resources) Brahmaputra Board.	-
6.	Final Report on Impact Evaluation Report of Jendra - Ringi Watershed, Meghalaya	Govt. of India (Ministry of Water Resources) Brahmaputra Board.	-
7.	Impact Evaluation Report of Tapi Watershed in the State of Nagalad Treated under the NWDPRA During 9th Five Year Plan.	ICAR Research Complex for Neh Region, Umroi Road, Umiam, Meghalaya.	Department of Agriculture & Cooperation , Govt. of India, New Delhi.
8.	Impact Evaluation Report of Sanuoru Watershed in the State of Nagaland Treated Under the NWDPRA During 9th Five Year Plan.	ICAR Research Complex for Neh Region, Umaoi Road, Umiam, Meghalaya	Department of Agriculture & Cooperation , Govt. of India, New Delhi.
9.	Impact Evaluation Report of Raipur Rani Watershed, Panchakula Dist, Haryana. - Y.Agnihotri, R.K.Aggarwal, A.K.Tiwari Pratap Singh, Swarn Lata, R.P.Yadav V.K.Bhatt, Ram Prasad, P.Bhattacharyya	Dept. of Agriculture & Cooperation(RFS Division), Ministry of Agriculture, Govt. of India.	-

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Sl. No.	Report Name	Submitted by/ Sponsored by	Submitted To
10.	Impact Evaluation Reports of Sidibo Watershed in the State of Arunachal Pradesh treated under the NWDPRA During 9th Five Year Plan	ICAR Research Complex for NEH Region, UMROI Road, Umiam Meghalaya	Department of Agriculture & Cooperation , Govt. of India, New Delhi.
11.	Impact Evaluation Report of Deoli Kalan Watershed, Kota (Rajasthan)	Central Soi & Water Conservation Research & Training Institute, Research Centre, Kota.	-
12.	Impact Evaluation Report of Baldirai Baldirai Watershed, Uttar Pradesh	Agriculture Management Centre, Indian Institute Of Management Prabandh Nagar off. Sitapur Road, Lucknow.	-
13.	Impact Evaluation Report of Shankargarh Watershed of Allahabad Dist. in Uttar Pradesh.	Agriculture Management Centre, Indian Institute Of Management Prabandh Nagar off. Sitapur Road, Lucknow.	-
14.	Impact Evaluation Report of Chahal Watershed, Bayana Block (Rajasthan)	Central Soil & Water Conservation Research &Training Institute, Research Center, Agra.	Ministry of Agriculture(RFS Division) Govt. of India, Krishi Bhawan, New Delhi.
15.	Impact Evaluation Report of Peach Hoj Watershed, Arunachal Pradesh	ICAR Research Complex for NEH Region, Umroi Road, UMIAM, Meghalaya.	Dept. of Agriculture & Cooperation , Govt. of India, New Delhi.
16.	Impact Evaluation Report of Merverakal Watershed, Thiruvanathapuram, Dist. of Kerala State. - M.Madhu, Subash Chand, P.Muralidharan, D.C.Sahoo, R.Mohanraj.	Ministry of Agriculture Dept. of Agriculture & Cooperation, (RFS Division) Govt. of India.	-
17.	Impact Evaluation Report of Mastihalla Watershed, Sandur, (Bellary dist)	Central Soil & Water Conservation Research & Training Institute, Research Centre, Bellary, Karnataka.	-

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Sl. No.	Report Name	Submitted by/ Sponsored by	Submitted To
18.	Impact Evaluation Report of Khootgad Watershed, Almora, Uttaranchal (NWDPRA).	Central Soil&Water Conservation Research & Training Institute, Dehradun, Uttaranchal.	RFS Division Ministry of Agriculture, Govt. of India, New Delhi.
19.	Impact Evaluation Report of Umlangiong Watershed, Jaintia Hills, Meghalaya	Govt. of India, (Ministry of water resources) Brahmaputra Board.	-
20.	Evaluation of NWPDRA program Implemented During 9th Five Year Plan, Tripura	North Eastern Regional Institute of Water and Land Management Kaliabhomora, Tezpur.	Rain-fed Farming System Division Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India.
21.	Evaluation of NWPDRA program Implemented During 9th Five Year Plan, Manipur	North Eastern Regional Institute of Water and Land Management Kaliabhomora, Tezpur.	Rain-fed Farming System Division Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India.
22.	Evaluation of NWPDRA program Implemented During 9th Five Year Plan, Mizoram	North Eastern Regional Institute of Water and Land Management Kaliabhomora, Tezpur.	Rain-fed Farming System Division Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India.
23.	WARASA-5, Composite Nursery for NWDPRA.	Govt. of India, Ministry of Agriculture, Dept. of Agriculture & Cooperation	-
24.	WARASA-7, Training Manual on NWDPRA	Govt. of India, Ministry of Agriculture & Cooperation Rain-fed Farming Systems Division.	-
25.	WARASA-NWDPRA, Guidelines.	Ministry of Agriculture, Dept. of Agriculture & Cooperation, Govt. of India, New Delhi.	-
26.	Statement Showing the Performance Indicators of NWDPRA Watersheds During IX Five Year Plan.	ISRO	-

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Sl. No.	Report Name	Submitted by/ Sponsored by	Submitted To
27.	Annual Report 2004-2005	Government of India Ministry of Rural Development	-
28.	Annual Report 2005-2006	Dept. of Agriculture & Cooperation Ministry of Agriculture, Govt. of India	-
29.	NATP Rain fed Agro- Ecosystem-Completion Report 1999-2004	Agro-Ecosystem Directorate (Rain fed) CRIDA, Hyderabad.	-
30	Evaluation Study of Watershed Development Project in Shifting Cultivation areas in Loyer Watershed of Nagaland.	North Eastern Regional Institute of Water and Land Management Kaliabhomora, Dolabari, Tezpur, Assam.	Natural Resources Management Division Ministry of Agric Govt. of India.
31	Evaluation Study of Lozu Watershed in Phek Dist of Nagaland under WDPSCA Scheme	Department of Agriculture & Cooperation Natural Resources Management Division, Ministry of Agriculture Govt. of India.	-
32.	Study of Watershed Development Project in Shifting Cultivation Areas in Phongi Watershed of Nagaland	North Eastern Regional Institute of Water and Land Management Kaliabhomora, Dolabari, Tezpur.	Natural Resources Management Division, Ministry of Agriculture Govt. of India.
33.	Report on Evaluation of Piplacherra Watershed Development Project in Shifting Cultivation areas in Tripura	-	Department of Agriculture & Coop. Natural Resources Management Division, Govt. of India, New Delhi.
34.	River Valley Projects Evaluation Centrally -Sponsored Soil Conservation Schemes-Study in Machkund Sileru -AP Orissa and Pochampad in Maharashtra. -C Sithapathi Rao, A A Firdausi, G Vijay Kumar	National Land Use& Conservation Board Ministry Of Agriculture Government of India.	-
35.	Evaluation of Soil Conservation Scheme River valley Project- POHRU Jammu & Kashmir. -C Sithapathi Rao, Turabul Hassan, G Vijay Shyamala, T.V.Suryanarayana.	National Land Use& Conservation Board, Ministry of Agriculture, Govt. of India.	-

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Sl. No.	Report Name	Submitted by/ Sponsored by	Submitted To
36.	Report on Soil Conservation in Catchment of Ramganga under River Valley project in Uttaranchal. -C Sithapathi Rao, G Vijay Shyamala, T.V.Suryanarayana.	National Land Use& Conservation Board, Ministry of Agriculture, Govt. of India.	-
37.	Evaluation and Impact of Implementation of Soil Conservation Measures in Sahibi Catchment in Haryana and Rajasthan.	Natural Resources Management Division Dept. of Agriculture & Cooperation Ministry of Agric., New Delhi.	-
38.	Report on Evaluation Study on Soil Conservation in the River Valley Project of Teesta catchment.	National Land Use Conservation Board Dept. of Agriculture & Cooperation Ministry of Agic. Govt. of India.	-
39.	Evaluation of Integrated Watershed Management program Flood Prone River- Upper Yamuna-UP and HP. - C Sithapathi Rao, C Vijaya Shyamala T V Suryanarayana Rao	National Land Use Conservation Board Ministry of Agriculture Govt. of India.	-
40.	Report on Soil Conservation in Catchment of Ramganga under River Valley project in Uttaranchal	Natural Resources Management Division, Dept. of Agriculture & Cooperation, Ministry of Agric. Govt. of India, New Delhi.	-
41.	Evaluation Study of the Scheme of Soil Conservation in the catchment of River Valley Projects and Flood Prone Rivers, Kundah Catchment, Kerala.	Ministry of Agriculture, Natural Resource Management Division, Govt. of India.	-
42.	Report on Evaluation Study of Soil Conservation in the River Valley Project of Matatila.	Dept. of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India.	-
43.	Evaluation Study of Soil Conservation in the River Valley Project of Nizamsagar.	Dept. of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India.	-
44.	Evaluation Study of Soil Conservation in the River Valley Project of UKAI	Dept. of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India	-

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Sl. No.	Report Name	Submitted by/ Sponsored by	Submitted To
45.	Impact Evaluation of Watershed Development Project for Andharcherra (UC) Watershed Tripura.	National Productivity Council	Dept. of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India.
46.	Impact Evaluation of Watershed Development Project for Phijo Watershed Nagaland.	National Productivity Council	Dept. of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India.
47.	Evaluation and Impact of Implementation of Soil Conservation Measures in Sahabi Catchment	National Remote Sensing Agency (Dept. of Space, Govt. of India), Balanagar, Hyderabad.	Natural Resource Management Division, Dept. of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India, New Delhi.
48.	Evaluation of the Impact of Implementation of Soil Conservation Measures in Kundha Catchment.	Land Degradation Division (Agriculture & Soils Group) National Remote Sensing Agency (Dept. of Space, Govt. of India), Balanagar, Hyderabad.	Natural Resource Management Division, Dept. of Agriculture & Coop, Ministry of Agric. Govt. of India, New Delhi.
49.	Studies on Participatory approach for Watershed Development. -DH Ranade	Lok Biradari Trust New Life Centre Sampark.	-
50.	Evaluation of the Impact of Implementation of Soil Conservation Measures in Ghod catchment, Maharashtra	Land Dégradation Division (Agriculture & Soils Division) National Remote Sensing Agency (Dept. of Space, Govt. of India), Balanagar, Hyderabad.	Soil & Water Conservation Division Dept. of Agriculture & Cooperation Ministry of Agriculture Govt. of India, New Delhi.
51.	Innovations (Learning From Danida Supported Activities in India).	Royal Danish Embassy, New Delhi, Danida	
52.	Study of Watersheds Development Project in Shifting Cultivation Areas in Jeshuk Watershed of Mon Dist of Nagaland.	North Eastern Regional Institute of Water And Land Management Kaliabhomora, Dolabari Tezpur, Assam.	Natural Resources Management Division Ministry of Agriculture, Govt. of India.

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Sl. No.	Report Name	Submitted by/ Sponsored by	Submitted To
53.	Impact of the Centrally Sponsored Scheme on Reclamation of Alkali Soils During 8th plan in Haryana, Punjab & Uttar Pradesh.	Central Soil Salinity Research Institute Karnal	-
54.	Impact evaluation study of Watershed Development Project for Vekhurochu Watershed, Nagaland.	-	-
55.	Impact Evaluation Report of Tumin Kohla Watershed in the State of Sikkim treated under NWDPRA During 9th Five Year plan.	ICAR Research Complex for Neh Region, Umroi Road, Umaim, Meghalaya (India)	Dept. of Agriculture & Cooperation Govt. of India, New Delhi.
56.	Impact Evaluation Report of Ayarkunnam Watershed in Kottyam Dist, Kerala. (NWDPRA: 9th Five Year Plan) -M.Madhu, D.V.Singh, V.Selvi, P. Sundarambal, R.Ragupathy, K.Rangaswamy and B.Chandran.	Ministry of Agriculture, Dept. of Agriculture & Cooperation, (RFS Division), Govt. of India, New Delhi.	-
*57.	List of 31 Severely affected districts.	-	-
*58.	Committee Meeting for Mission on Rain-fed Farming.	-	-
59.	Impact Evaluation Study of Watersheds in Karnataka State. -Prof. T.V.Ramanayya, Prof V.Nagadevara, Prof. Shyamal Roy.	Indian Institute of Management Bangalore	-
60.	Impact Assessment Study of the Watershed Development program - M A Khalid, Mamatha Mehar, Pratibha Nair	TERI	Dept. of Land Resources Ministry of Rural Development Govt. of India.
61.	Evaluation Study of Rajani Watershed Project in Yavatmal dist. - BVS Prasad, B Satish Rao	KFW Under Indo-German Watershed Development program.	-
62.	Evaluation Study of Shedashiwavoshi–Wavoshi Watershed Project in Raigad Dist. - K.P.Deo	KFW Under Indo-German Watershed Development program.	-
63.	Evaluation Study of Mendhwan Watershed Project under IGWDP – Maharashtra State. - B.N.Kulkarni, S.D.Kulkarni, K.U.Viswanathan	-	-

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66.	Representative Watershed Burhanpura, Rajasthan (Experiences of the Indo – German Bilateral Project Watershed Management).	Indo-German Bilateral Project "Watershed Management" (IGBP)	-
67.	Sustainable Natural Resources Management GTZ Indian/Bhutan.	-	-
68.	Study in Representative Watershed Jaunla – Rajwas (Rajasthan). - Kasturi Basu, Dayal Jaiswal	Govt. of India, Ministry of Agriculture, Soil & Water Conservation Division, GTZ & RODECO Consulting.	-
69.	Study in representative Watershed Makara (Uttar Pradesh). - Kasturi Basu, Dayal Jaiswal	Govt. of India, Ministry of Agriculture, Soil & Water Conservation Division, GTZ & RODECO Consulting.	-
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74.	Climate Protection program for Developing Countries (CAPP). - Holger Hoff.	Govt. of India, Ministry of Agriculture and the German Ministry for Economic Cooperation and Development and Implemented by RODECO Consulting on behalf of the German Technical Cooperation.	-

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78.	Indo – German Watershed Development program in Maharashtra for Sustainable Regeneration of Natural Resources.	NGO led program. National Bank for Agriculture and Rural Development.	-
79.	Mid–Term Review of Indo – German Bilateral Project "Watershed Management" - Mr. D.C.Das	Project Process Review Mission of the GTZ on IGBP– Watershed Management.	-
80.	IGBP – RWS – Kinchumanda.	SGD: Forest Dept. Visakhapatnam NGO: Vikasa, Chodavaram, (A.P)	-
81.	WOTR Management Series - Trainer's Manual for Savings & Credit Groups.	WOTR, Ahmedanagar, India.	-
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84.	Decision Support System for Integrated Natural Resource Management on a Watershed Basis. Dr. Indrani Phukan	-	-
85.	Report of the Technical Committee on Watershed programs in India.	Dept. of Land Resources Ministry of Rural Development Govt. of India.	-

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88.	Department of Land Resources Workshop on Strengthening of institutional structure and implementational strategy.	-	-
89.	Drought Prone Area program Success Story k.Ayyampalyam Watershed in Palladam Block of Impact Evaluation of Water Harvesting Structures under dpap/iwdp/sgry Projects in Coimbatore Dist.	Water Technology Centre Tamil Nadu Agricultural University, Coimbatore.	District Rural Development Agency, Coimbatore, Tamil Nadu.
90.	Implementation of dpap (8th Batch) Socio-Economic Baseline Survey of Ten Watersheds of Coimbatore District. - K.Palanisami, S.Radhamani, C.Vasanthi, KN.Tamilselvi	Water Technology Centre Tamil Nadu Agricultural University, Coimbatore.	District Rural Development Agency, Coimbatore, Tamil Nadu.
91.	Impact Evaluation of Integrated Wasteland Development program (IWDP) - Gudhiyalathur Watershed , Erode District - K.Palanisami, P.Namboothiripad, S.Radhamani	Water Technology Centre Tamil Nadu Agricultural University, Coimbatore.	-
92.	Impact Assessment of Select Watersheds in Coimbatore District of Tamilnadu. - K.Palanisami, D.Suresh Kumar	Water Technology Centre Tamil Nadu Agricultural University, Coimbatore.	National Bank for Agricultural and Rural development, Mumbai.
93.	Impact Assessment of Watershed Development Conceptual and Methodological Issues	Water Technology Centre Tamil Nadu Agricultural University, Coimbatore.	-
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96.	Monitoring and Concurrent Evaluation of Watersheds under NWDPRA and RVP in North Karnataka. - Dr. H.S.Vijaya Kumar, Dr. L.B.Kunnal	University of Agricultural Sciences, Dharwad.	Commissionerate of Watershed Development, Bangalore.
97.	Monitoring and Concurrent Evaluation of Watersheds under NWDPRA and RVP in North Karnataka (Oct 2004-March 2005). - Dr. H.S.Vijaya Kumar, Dr. L.B.Kunnal	-	-
98.	Concurrent Monitoring and Evaluation of CSS-RVP Projects in Southern Karnataka.	Directorate of Research, University of Agricultural Sciences, GKVK, Bangalore.	-
99.	Mid-Term of IWDP Watersheds in Pongalur Block of coimbatore district. - K.Palanisami, S.Devarajan, M.Chellamuthu, D.Suresh Kumar.	Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore.	District Rural Development Agency, Coimbatore, Tamil Nadu .
100.	Concurrent Monitoring & Evaluation of CSS-RVP projects in Southern Karnataka 2005-2006.	Directorate of Research University of Agricultural Sciences, GKVK, Bangalore.	-
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103.	NATP Rain-fed Agro- Ecosystem-Completion Report 1999-2004 Part-02	-	-
104.	Evaluation Report Integrated Wasteland Development program Phase 2 in Raichur District	Indian Resources Information & Management Technologies Ltd, (IN-RIMT).	Director, Area Development Programs, Dept. of Rural Development & Panchayat Raj, Govt.of Karnataka, Bangalore.

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106.	Impact Evaluation Drought Prone Area program (phase-1) Bidar District - Karnataka	Agricultural Finance Corporation, Bangalore.	Director Ares Development programs, Dept. of Rural Development & Panchayat Raj. Govt. of Karnataka.
107.	Drought Prone Area program (DPAP) -Phase 1 (42 w/s) in Belgaum Dist. Final Evaluation Report	Indian Resources Information & Management Technologies Ltd. (IN-RIMT)	Director, Area Development programs, Dept. of Rural Devt & Panchayat Raj. Govt. of Karnataka. Bangalore. 2. Chief Executive Officer, Zilla Panchayat, Belgaum Dist.
108.	Final Evaluation Report Drought Prone Area program Phase 1 in Hassan Dist.	Indian Ressources Information & Management Technologies Ltd. (IN-RIMT)	1. Director, Area Development programs, Dept. of Rural Development & Panchayat Raj. Govt. of Karnataka. Bangalore. 2. Chief Executive Officer, Zilla Panchayat, Hassan.
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113.	Impact Evaluation Watershed Development Project under NWDPRA of Barcem, GOA. - S.Manivannan, V.S.Korikanthimath.	Dept. of Agriculture, Govt. of Goa, Panaji.	NWDPRA,Dept. of Agriculture, Govt. Of Goa, Panji.
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116.	Quick Evaluation Report (Preliminary) On Konbancherra NWDPRA During 9th Five Year Plan under Sonai River Carchment, Bishalgarh Block, West Tripura District (Non A.D.C).	-	-
117.	Success Story of Moharcherra National Watershed Development Project.	Govt. of Tripura, Dept. of Agriculture, Teliamura Agri. Sub-Division.	-
118.	Interim Case Study Reports of Some NWDPRA Micro Watersheds under West Tripura District of the State Tripura [10th Plan Project]	-	-
119.	Report on Evaluation Study of Piplacherra Watershed Development Project in Shifting Cultivation Areas in Tripura.	Agricultural Finance Corporation Ltd.	The Dept. of Agriculture & Cooperation, National Resources Management Division, Govt. of India.
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121.	Success Story of Dhaniilashcherra WDPSCA [9th Plan] under Kumarghat Agri. Sui-Division.	-	-
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126.	Evaluation of River Valley Project Watershed .	-	Government of India.
127.	Report on Natural Resource Management Project in 2 Different Watersheds under NWDPRA Scheme.	CRIDA, Santoshnagar, Hyderabad.	-
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134.	Report on Haripura Watershed of Rajathan, 2007.	Govt. of Rajasthan, Directorate of Watershed Development & Soil Conservation.	Technology Networking & Business Development (TNBD), Division Council of Scientific & Ind Research (CSIR).

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137.	Draft Report of Impact Assessment Study of Core and Prasar Villages Adopted under GVT's WIRFP Projects. - Dr. Himadri Sinha, William Norman, & Nalini Ranjan	Xavier Institute of Social Service.	-
138.	Impact Evaluation Studies of Bishangarh Watershed, Durgapura, Jaipur.	Deputy Director (Soil Survey) Watershed Development and Soil Conservation. Durgapura, Jaipur.	-
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141.	Report on Haripura -Watershed of Rajasthan, 2005-2006.	Govt. of Rajasthan Commissionerate of Wasteland. Watershed Development and Soil Conservation.	National Productivity Council, New Delhi.
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