Integrated Management of Watersheds for Agricultural Diversification and Sustainable Livelihoods in Eastern and Central Africa: Lessons and Experiences from Semi-Arid South Asia

International Crops Research Institute for the Semi-Arid Tropics

SWMnet

Citation: Shiferaw B and Rao KPC (eds.). 2006. Integrated management of watersheds for agricultural diversification and sustainable livelihoods in Eastern and Central Africa: Lessons and experiences from semi-arid South Asia. Proceedings of the International Workshop held at ICRISAT, Nairobi, 6-7 December 2004. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 120 pp. ISBN 92-9066-487-8. Order code CPE 158.

Integrated Management of Watersheds for Agricultural Diversification and Sustainable Livelihoods in Eastern and Central Africa: Lessons and Experiences from Semi-Arid South Asia

Proceedings of the International Workshop
held at ICRISAT, Nairobi
6-7 December 2004

Editors

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2006

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Abbreviations and Acronyms

APRLP	Andhra Pradesh Rural Livelihoods Program
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
CPRs	Common Property Resources
CRIDA	Central Research Institute for Dryland Agriculture
DA	Development Agents
DPAP	Drought Prone Areas Programme
ECA	Eastern and Central Africa
EPA	Environmental Protection Agency
FFS	Farmer Field School
GDP	Gross Domestic Product
GOI	Government of India
HNPV	Helicoverpa nuclear polyhedrosis virus
ICAR	Indian Council of Agricultural Research
IGNRM	Integrated genetic and natural resource management
IWM	Integrated Watershed Management
IWMI	International Water Management Institute
LE	Larval Equivalent
LLPPA	Local Level Participatory Planning Approach
MDGs	Millennium Development Goals
MERET	Managing Environmental Rehabilitation in Transition to Sustainable Livelihoods
MoA	Ministry of Agriculture
MP	Micro Plots
NARES	National Agricultural Research and Extension Systems
NGOs	Non-Government Organizations
NRM	Natural Resource Management
NRSA	National Remote Sensing Agency
NWDPRA	National Watershed Development Project for Rainfed Areas
RUE	Rainfall Use Efficiency
RWH	Rainwater Harvesting
SAT	Semi-Arid Tropics
SCRP	Soil Conservation Research Project
SHGs	Self Help Groups
SROs	Sub-Regional Organizations
SSA	Sub-Saharan Africa
SWC	Soil and Water Conservation
WC	Watershed Committee
WDT	Watershed Development Team
WFP	World Food Programme

Session 1:

Welcome and Opening

ICRISAT in Eastern and Central Africa: Partnerships in soil and water management to create opportunities for improving livelihoods

Said Silim[1]

First of all, on behalf of ICRISAT and on my own behalf, I wish to extend to each one of you a warm and cordial welcome to this workshop on "Integrated Management of Watersheds for Agricultural Diversification and Sustainable Livelihoods in Eastern and Central Africa: Lessons and Experiences from Semi-Arid South Asia" organized in collaboration with Soil and Water Management Research Network (SWMnet) of ASARECA.

As you all know, for many developing countries a more rational, efficient and sustainable utilization of natural resources, especially the land and water resources, offer the only significant prospect for income generation and employment creation required for economic growth and poverty alleviation. East and Central Africa (ECA) is a region gifted with abundant natural resources and a wide range of ecosystems, yet it remains a paradox. The region which covers about 8.5 million sq km with climatic and geographical features varying from humid highlands of Ethiopia to deserts in Sudan is well paced to take advantage of the critical changes that influence the agricultural sector. Globalization affects the prices of agricultural exports; and because of urbanization and income growth the demand for high value agricultural products increases. It is also the region where important rivers, such as the Nile and Congo originate. The sub-region is also famous for several great lakes among which the largest and best known are Lake Victoria and Lake Tanganyika providing livelihoods for nearly 2 million and contributing significantly to food supply The sub-region has vast areas of arid and semi-arid lands (ASALs), as well as alluvial plains, such as in Sudan, Eritrea and Madagascar, which can be transformed into economic assets under sound management. Yet many of these countries have very low per capita income levels and suffer from high levels of food insecurity.

It is for this reason a recent Millennium Project report emphasizes the need for increasing investments in agriculture for attaining the poverty reduction targets set by the Millenium Development Goals (MDGs). Similar emphasis on agriculture and sustainable management of land resources is also evident in

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the strategies of various national and regional organizations. For example, the Comprehensive Africa Agricultural Development Programme (CAADP) of the New Partnership for Africa's Development (NEPAD) has emphasized the need to extend the area under sustainable land management and reliable water control systems. Similarly, the strategies for poverty reduction of the countries in ECA have paid priority attention to increasing productivity and reducing variability through improved water and soil fertility management. The challenge therefore is to develop practical approaches that can assist these nations in converting the strategies into actions and that will enable poor farmers to utilize the available resources in a more efficient but sustainable manner to produce more food and diversify income sources to facilitate income growth and poverty reduction.

This is by no means an easy challenge especially when it comes to the semi-arid tropics (SAT). The SAT is an extremely difficult environment where agricultural production is largely dependent on making use of low and uncertain rainfall on soils that are low in fertility and fragile with high susceptibility for degradation when cultivated. Widespread soil degradation caused by erosion, nutrient mining and loss of organic matter is reducing the productive potential of the land. It is estimated that in ECA, erosion alone will contribute to a 14.5% reduction in yields by 2020, if the current rates of erosion continue unabated. Limited use of inorganic fertilizers, decline in soil organic matter, and insufficient attention to crop nutrient requirements is leading to severe nutrient mining. In densely populated semi-arid areas, net NPK losses have been estimated at 60-100 kg per hectare per year. Scarcity of water is another serious constraint in the semi-arid systems. Crop production is risky and the payback to productivity-enhancing or conservation technologies is slow. The majority of the farmers are poor and avoid taking risk in adopting a new technology until they are sure about its benefits. Soil and water management practices have a great potential to transform these marginal production environments into more agronomically productive areas through interventions that would enhance agro-ecosystem sustainability while also providing livelihood benefits for the poor.

In the past, soil and water management research was conducted largely at small-plot and field scales. This approach failed to provide a basis for scaling up solutions to a larger scale, eg, a watershed. Further, the amount of water that can be conserved using these methods is limited by the storage capacity of the soil, which is often insufficient to sustain crop growth during prolonged dry spells. ICRISAT, since its inception, has adopted the concept of watershed management to improve rainwater utilization. The concept of integrated watershed management is designed to firmly establish the linkages between utilization of natural resources at the landscape level and the tangible benefits for resource uses such as profitability, food security, and sustainable livelihoods. The entry point here is water. Watershed management approaches, in addition to improved soil fertility management and conservation at a landscape level, aim at conserving as much rain water as possible in the soil profile, effectively drain the excess water, and use this water for supplemental irrigation during drought periods. Such a system of land and water management reduces soil erosion and increases agricultural production. The economic benefits of watershed management (for example, a 2-3 fold increase in grain production) are well demonstrated by data from 23 successive years of cultivation at ICRISAT-Patancheru, India.

Governments and non-governmental organizations in India and elsewhere have sought to promote watershed-based management, aiming to integrate sustainable land use with high and diversified agricultural production. In India, watershed management started off as a land and water management program, but soon broadened into a strategy for overall development of drylands: improved water availability for supplemental irrigation provided immediate economic benefits by increasing productivity and promoting crop diversification. Major rural development programs - with an annual budget exceeding US$500 million - have been reorganized around the watershed approach. Watershed projects, particularly those with strong community participation, have made significant contributions to agricultural productivity and natural resource conservation, and have helped reduce regional disparities and increase employment opportunities for the rural poor in rainfed areas. The question then is - Are there lessons to be learned form this South Asian experience that could benefit the countries in the ECA region? ICRISAT strongly believes that there are important lessons and is ready to facilitate the inter-regional transfer of such knowledge and experiences, including that of its own long term research on integrated watershed management in semi-arid India.

The broad developmental challenges that the ECA region faces today are very similar to that in South Asia. In both regions more than 70% of the total population directly or indirectly depends on agriculture with no dramatic changes expected over the next few decades. About a third of GDP of these regions comes from agriculture. Both regions have rapidly increasing populations and the resource base that is expected to support the increased numbers of people is gradually degrading. These are also the regions where low input farming persists and investments from national governments are inadequate. However, South Asia has achieved a much higher growth rate in agriculture compared to ECA or SSA since the 1960s. For example, India and sub-Saharan Africa each produced 50 million tons of food in 1960, but by 1988 India was producing 150 million tons while food production in sub-Saharan Africa remained at the same level. Despite the differences in socio-economic environments, ICRISAT strongly believes that there is a lot that can be learned and exchanged between the two regions from both successes and failures that they have experienced.

It is in this context that ICRISAT decided to put emphasis on leveraging more benefits through adaptation of existing knowledge by promoting partnerships that explore innovative ways to overcome the challenges faced by the two regions. Considering the relevance of Indian experiences to the region, ICRISAT in collaboration with IWMI and ICAR facilitated a delegation from SWMnet to visit India in March 2004, to gain first hand experience of the success stories in India and to interact with the research managers, researchers, and farmers, particularly focusing on integrated management of watersheds and the role that policies, institutional arrangements and community empowerment had played in this process. The delegation was thoroughly impressed by the landmark achievements in improving the productivity of resources in rainfed environments through integrated management of watersheds, and recommended a strong partnership with ICAR to facilitate a two-way exchange of knowledge and experiences. This recommendation has received strong support from ICRISAT, IWMI, ICAR and ASARECA. This was followed by two other mission trips during which scientists from ICAR, ICRISAT, IWMI, and the ECA region got an opportunity to understand each other and visited selected locations within the ECA region to assess the potentials and determine stakeholder demand for such exchange of lessons and experiences. What these missions achieved is the recognition of the need for integrating activities for agricultural production, income growth and conservation through careful planning and policy support that would enhance the participation and empowerment of local communities.

The purpose of this meeting is to build further on this momentum by bringing together researchers and stakeholders from the ECA region and by facilitating the interaction with researchers from ICAR, ICRISAT and other partners in Africa and India. I hope, with your active participation in the workshop, we will be able to prepare a plan of activities and initiatives for ICRISAT and its partners in this important area of natural resource management and make a significant contribution in helping the member countries of this region to reduce food insecurity and poverty at a rapid rate.

I wish you successful deliberations and I look forward to receiving your suggestions and the final outcome of this workshop.

Introduction and objectives of the workshop

Bekele Shiferaw[1]

Why this workshop?

Along with pervasive poverty and livelihood insecurity, degradation of agroecosystems and threats to sustainability are major concerns for economic growth and agricultural development in many poor regions of the world, where livelihoods primarily depend on exploitation of natural resources. This is especially the case in the arid and semi-arid regions where water scarcity, frequent droughts, soil degradation and other biotic and abiotic constraints seriously undermine agricultural productivity and the resilience of the system. In sub-Saharan Africa (SSA), rainfed agriculture underpins the livelihoods of the majority of the poor concentrated in rural areas. The semi-arid and drought-prone areas, which are also less favored in terms of agricultural and socioeconomic investments and development infrastructure, account for the largest proportion of the poor, food insecure and vulnerable populations in the world. These areas are particularly unlikely to meet the poverty, hunger, environment and other Millennium Development Goals (MDGs) adopted by the global community to be attained by 2015. Countries that are predominantly semi-arid and drought-prone will suffer most from the combined effects of poverty and ecosystem degradation. Hence, these areas in Africa are now being referred to as 'MDG hotspots', as opposed to the bright spots with promising opportunities to attain the stated millennium goals.

Poverty reduction and livelihood security in water-scarce and degrading environments will require meticulous application of advances in science and technology to solve the multiple challenges. Developments in agro-biological sciences, agroecology, and social sciences offer new opportunities for sustainable management and intensification of agriculture in these areas. Integrated watershed management (IWM) - an approach that links production, conservation and livelihood objectives of the poor through multiple knowledge-based interventions at the farm and landscape level - is one promising option that offers a suitable strategy for improving productivity and sustainable intensification of agriculture in rainfed regions. The concept of IWM goes beyond traditional integrated technical interventions for soil and water conservation to include crop and livestock production and market related

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innovations that help diversify livelihood opportunities, offer new sources of income growth, and reduce market and climate-induced risks. The concept ties together the biophysical notion of a watershed as a hydrological unit for technological interventions with that of the community and local institutions that determine the demand, viability and sustainability of such interventions. Integration of the hydrological concept of a watershed with the socioeconomic notion of a community helps to combine appropriate technical interventions on the supply side with collective community-based planning, implementation and monitoring that is required on the demand side. Hence, the community-based but landscape wide IWM interventions create synergies between targeted technologies, policies and institutions that improve productivity, resource use sustainability and market access for resource users.

Effective implementation of an IWM program, however, requires careful consideration of the special attributes of watersheds both as biophysical as well as socioeconomic units, and the implications for policy and institutional arrangements. A watershed, as a hydrologically defined unit, includes diverse natural resources that are unevenly distributed within a given area where water drains into a common point. These resources are utilized by diverse groups of people holding unequal use rights and entitlements. The socially heterogeneous groups of people that inhabit the watersheds along the gradient create opportunities for opposing interest groups, potential conflicts in resource use and tradeoffs in the sharing of costs and benefits. This implies that effectiveness of watershed interventions will depend on the ability to treat the entire hydrological landscape, not just a portion of it, and the capacity of the community to develop proper institutional arrangements for regulating use, sharing costs and benefits and coordinating activities. Therefore, the biophysical and social complexities and the need to harmonize the two for sustainable management of water, soil and biodiversity resources require suitable technological, policy and institutional arrangements that encourage and stimulate both private and collective efforts.

Several studies and pilot interventions have shown the potential of IWM for improving productivity and generating essential ecosystem services that enhance resilience and sustainability of agroecosystems. Some studies have also shown the roles that IWM can play in stimulating market-orientation in agricultural production, a contribution associated with its benefits in terms of diversification of production to high-value crops, improved land productivity and low vulnerability to drought risk. These factors jointly create incentives for smallholder farmers to intensify production, and adopt profitable production and resource management technologies and practices. While IWM creates the essential conditions for market-orientation of production, market access improves the relative profitability of IWM interventions, thereby accelerating wider adoption and impacts. This shows how IWM can support and accelerate the ongoing market-led policies and development programs which are being implemented in Africa for poverty reduction, income growth and environmental recovery.

India, which perhaps has the largest watershed program in the world, has adopted IWM as a fundamental strategy for rural development and poverty reduction in drought-prone regions. India also has a long tradition of watershed management and development. It has accumulated a stock of knowledge and experience on best practices and efficient approaches for adopting and implementing community-based resource management projects. For a long time and across diverse agro-climatic areas, the Indian Council of Agricultural Research (ICAR) has been spearheading the research in designing and implementing these programs. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has been working along with ICAR and other partners [including the International Water Management Institute (IWMI)] in developing technical, policy and institutional innovations suitable for the semi-arid regions of India. It is widely recognized that this stock of knowledge from Asia would be a valuable asset to African countries sharing similar agroecologies and suffering from similar problems of poverty and degradation of the resource base. This perception inspired the need to bring together scholars and scientists from India and Africa to exchange their knowledge, share experiences and best practices and discuss opportunities for mainstreaming IWM in the African region.

Prelude to the workshop

Based on the lessons and successful examples of IWM for poverty reduction and environmental rehabilitation in semi-arid India and in recognition of untapped potentials in parts of Africa, the international research centers (ICRISAT and IWMI) are facilitating inter-continental partnerships and technical cooperation between the ASARECA region and India, with ICAR at the forefront. Such south-south collaboration is regarded as mutually beneficial in terms of sharing knowledge and facilitating spillover of technical and institutional innovations in agriculture and Natural Resource Management (NRM). In this regard, a group of researchers and policy analysts from the ASARECA countries visited agricultural development and watershed management projects in India, while scientists from ICAR, IWMI and ICRISAT visited several countries in the ASARECA region. This has allowed the African team to see for themselves on-site the alternative IWM models and their impacts on poverty and environmental recovery in different parts of India.

Prior to this workshop, the ICAR team - accompanied by scientists from ICRISAT, IWMI and ASARECA/SWMnet - visited several countries (Eritrea, Ethiopia, Kenya, Tanzania, Rwanda and Uganda). They consulted with national stakeholders (scientists, policy makers, and development agencies) to assess the needs and potentials for implementing IWM as part of the national agricultural development strategy for sustainable improvement of livelihoods and agroecosystem resilience. The team visited some existing IWM initiatives in some countries and provided additional insights for careful integration of interventions that link production, marketing, value addition and agroecosystem sustainability. The team was impressed by the positive reception of the IWM concept, the need for sustainable watershed management strategies along the lines, and successful experiences from India. The visits have also provided useful lessons. The team uncovered that IWM is not entirely new to the region although its effectiveness and impacts on poverty, vulnerability of livelihoods and generation of desirable ecosystem services can be further enhanced through careful adaptation of lessons and best practices from the Indian experience. After completion of the country working tours, the team along with invited participants from various stakeholders across the Eastern and Central Africa (ECA) finally met in Nairobi for a two-day workshop to discuss and crystallize concepts, learn more from the Asian experience and develop concrete R&D plans for IWM in the region.

Workshop objectives

- Review the concepts, approaches, practices and experiences in integrated management of watersheds in Asia and draw relevant lessons for the semi-arid areas of ECA.
- Explore how the IWM approach can contribute to rural income growth and competitiveness of natural resources based enterprises.
- Identify priority areas for development research and strategies for promoting IWM to improve livelihoods in the semi-arid regions of ECA.

Expected outputs

- Exchange of experiences and knowledge between countries and continents enhanced and the understanding of concepts, potentials and constraints for IWM improved.
- The potentials for harnessing the watershed approach to accelerate market-led agricultural development and more sustainable NRM in the semi-arid areas of ECA identified.
- Research gaps, needs and priorities for market-oriented IWM identified and a draft outline of a program of intervention in ECA with respect to research, outreach and capacity building based on CGIAR, ASARECA and NARS partnerships developed.

Structure of the book

The workshop was organized into six main sessions that included plenary presentations of keynote papers, breakout sessions to discuss key thematic issues and plenary deliberation on the findings from group discussions. The workshop program, the terms of reference for group discussions, and the list of participants are given in Annex 1-3. The breakout sessions were organized into three groups:

- Technological needs and adaptation strategies
- Markets, policy and institutional issues
- Outreach and capacity building issues

Each group was provided a 'terms of reference' with a list of key questions to stimulate discussions and brainstorm to identify priority areas and intervention points for development research and capacity building in IWM in the ECA region. This proceeding brings together a summary of the five papers presented during Session II (Review of Concepts and Enabling Conditions) and the key findings from the group discussions as modified and developed during the plenary discussions.

Based on the experiences and lessons from Asia, the following chapter by Wani et al. (2006) presents the major concepts, approaches and practices in IWM. The paper highlights the evolution of the approaches for soil and water management in India and the associated changes in institutional arrangements to empower local communities in planning and implementation of watershed interventions. In doing so, and based on a meta analyses of watershed projects in India, the paper notes that the estimated mean benefit-cost ratio of these projects in the country was quite modest, ie, 2.14, while the internal rate of return was 22%, which is comparable to other rural developmental programs. The meta analyses has shown that the performance of watershed projects across the country was highest in regions receiving an annual rainfall of 700-1000 mm. Such projects were jointly implemented by state and central governments in low and medium income regions, and were able to stimulate effective community participation in the design and implementation of interventions. The paper also notes how recent watershed development models, including the consortium approach evaluated by ICRISAT and partners in semi-arid Indian watersheds, have generated significant local environmental benefits, sizeable economic and employment opportunities, and increased the cropping intensity.

This is followed by a review of the policy and institutional issues for watershed management with a view to draw lessons, and identify remaining gaps in knowledge and areas for future intervention. In this chapter, Shiferaw et al. (2006) reviews the problems of incomplete property rights, unequal access to resources, public good problems and externalities that necessitate collective action and the need for new types of policy instruments and institutional arrangements to enable effective and sustainable community-based IWM. It also reviews the role that external agencies may play in organizing communities and facilitating the emergence of institutions that foster trust and lower the individual transaction costs of collective action. It presents the key determinants of collective action in community watershed management and draws from the lessons of IWM in semi-arid Indian watersheds. The lessons from Adarsha watershed show how the basic incentive problems for enabling user participation in IWM were initially addressed through knowledge-based on-farm interventions that improved crop yields and incomes for individual farmers, which were further enhanced through watershed-linked livelihood opportunities (eg, production of bio-pesticides and bio-fertilizers) to create incentives for landless households and marginal farmers. The results also indicate how IWM contributed towards market-orientation of production through diversification, increased land productivity and reduced production risk.

The two conceptual papers that presented best practices, lessons and experiences from Asia are followed by a review of the research on integrated soil and water management in Eastern and Southern Africa (ESA), offer insights based on past experiences and outline areas for future research. In this chapter, Twomlow and Rao (2006) discuss the past and current thrust of ICRISAT's research in the areas of integrated soil and water management in the ESA region and highlight four areas for future research. These include work on developing tools and approaches for climate variability management, development of new tools and simulation models for technology evaluation, developing alternative methods for outreach and facilitating technology uptake, and bridging south-south collaboration and adaptive research on technological and institutional options for successful watershed management in the region. This is followed by a review of the experiences and needs for watershed development and resource management in ECA (Hatibu 2006). This chapter assesses the natural resources challenges for agriculture in the ten ASARECA member countries and discusses lessons learned from the past, particularly in soil and water conservation. The paper highlights priority areas for the ECA region with respect to management of natural resources for increased productivity and competitiveness of the agricultural systems. The paper notes that the kind of technical interventions in ECA and South Asia for integrated soil and water management are generally similar. What differs is their impact, and explaining why these differences occur provides a good entry point for IWM in the region. The observed differences in effectiveness show that technical innovations by themselves are not adequate to bring about increased productivity of land, water and labor. There is a need for equal emphasis on innovations in policy, marketing, institutions, infrastructure, and financing for IWM interventions to succeed. The paper points out that closer collaboration and partnership between SSA and South Asia with respect to IWM is a strategic necessity that will generate mutual benefits to both parties.

The chapter by Zeleke (2006) reviews the watershed management experiences in the region with emphasis on the experiences and lessons from Ethiopia, a country which has suffered one of the most serious problems of land degradation and livelihood deprivation, and which initiated one of the most extensive integrated soil and water conservation efforts in the region. The paper offers useful insights on the extent and severity of land degradation and the diverse IWM experiences in Ethiopia. Despite the long-standing efforts in addressing the extensive problems of land degradation and food insecurity in the country and despite several small successful pilots, adoption and impact of IWM has been quite limited. The paper summarizes the major constraints in relation to this limited coverage of IWM practices as compared to the magnitude of land degradation in the country.

Some of the reasons include (1) lack of participatory planning and implementation with local communities, (2) poor technical interventions to address diverse agroecological and production environments, (3) lack of integration of conservation technologies with production and livelihood activities of smallholder farmers, (4) lack of effective policy support and enabling institutional arrangements that stimulate community action and empowerment.

The last section brings together the outcomes from the brainstorming sessions. Along each of the points of deliberation, the groups have attempted to outline the challenges and opportunities for IWM, priority areas for intervention, as well as the main objectives and expected outputs from these interventions. The suggested priorities will be very useful in guiding and informing the formulation of research-for-development projects and programs that address the crosscutting priorities for IWM and generate national and trans-boundary benefits for poverty reduction, sustainable intensification and diversification of production while safeguarding the environmental resource base.

Session 2:
Review of Concepts and Enabling Conditions

Issues, concepts, approaches and practices in integrated watershed management: Experiences and lessons from Asia

SP Wani[1], YS Ramakrishna[2], TK Sreedevi[1], TD Long[3], Thawilkal Wangkahart[4], P Pathak[1] and AVR Kesava Rao[1]

Introduction

The semi-arid tropics (SAT) is home to 38% of the poor in developing countries, 75% of whom are in the rural areas. Over 45% of the world's hungry and more than 70% of the world's malnourished children live in the SAT. Even with growing urbanization, the challenges of poverty, food insecurity and malnutrition will continue to be greatest in the rural SAT. South Asia features the world's densest concentration of poverty. The poorest in this region inhabit its drylands. In addition to the population pressure, SAT rainfed regions are characterized by fragile ecosystems, land degradation, recurrent droughts, low investments in productivity enhancing technologies, and poor infrastructure. This is further complicated by a policy environment often biased towards high potential regions and incentive systems that discourage adoption of water-saving crops and technologies adapted to dryland areas (Shiferaw et al. 2003).

The inherently limited water resources within the SAT set the ultimate limit to the plant material production on which both human and animal populations are dependent. Furthermore, erratic rainfall results in widely fluctuating production leading to production deficit thereby causing land degradation through soil erosion and reduced groundwater recharge. Population growth, accompanied by the heightened demand for natural resources, further exacerbates the existing problem. Thus, a process of progressive degradation of resources is set into operation, which intensifies with every drought and the period following it. If not checked timely and effectively, it leads to permanent damage manifested as loss of biodiversity and degradation of natural resources.

"The deterioration of natural resources in the dry areas, the loss of natural vegetation and its irreplaceable biological diversity urge a reformulation of the

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development paradigm," said Ismail Serageldin, Chairman of CGIAR and Vice President, World Bank (CGIAR 1997). Unless the nexus between drought, land degradation and poverty is addressed, improving the livelihoods that are dependent mainly on the natural resources can be farfetched (Wani et al. 2003). Water is the key-factor and through sustainable management of water resources, entry could be made to break the nexus. Land degradation caused by soil erosion (by wind or water, nutrient depletion, and loss of biodiversity), is the cause and effect of poverty and livelihood insecurity. There is a very strong link between the well-being of the people, the communities and the condition of natural resources. Much of the rainfall comes in high-intensity storms often falling on grounds with low vegetative cover thereby causing high levels of soil erosion and runoff. In many developing countries such as India, the extent of land degradation is quite severe; hence about two-thirds of the land area suffers from one or another form of land degradation.

Watersheds as suitable platforms and entry points

Watershed, a defined hydrological area, that is suitable for improved management of land and water resources, is also a logical planning unit for sustainable resource management. Sustainable watershed management is the rational utilization of natural resources, which leads to optimum production to fulfill the present needs without compromising the needs of future generations. As discussed below, conventional watershed approaches in the past focused only on soil and water conservation measures, and hence did not bring in much productivity gains or improvement in the people's livelihoods. However, watersheds are not only hydrological units but provide essential life-supporting ecosystem services to the rural people. People and animals are integral parts of the watershed agroecosystem and their actions and resource use patterns directly affect the ecosystem services being provided by watersheds. If local agroecosystems are not managed properly, renewable and non-renewable natural resources within watersheds can be degraded rapidly, thereby threatening current and future livelihoods.

The innovative farmer-participatory consortium approach for integrated watershed management (IWM) developed by ICRISAT and its NARES partners has shown promising results in India, China, Thailand and Vietnam. The new model is based on a strategic alliance between partners (including farmers and communities). The alliance was established based on relative strengths and comparative advantages, and allows integration of tested key interventions and participation of local communities for sustainable and efficient management of natural resources. The IWM interventions, implemented through this new consortium approach, have contributed towards mitigating the effects of drought and land degradation, better management of natural resources and income growth for communities.

This paper discusses the evolution of concepts and approaches for watershed management based on the extensive experiences in Asia in general and in India in particular. It documents the drivers of success and the effectiveness of the evolving approaches for watershed management in terms of economic and sustainability benefits for the affected communities in the drought-prone regions. It discusses the shortcomings of the conventional approaches and changes that have been made under new policies and guidelines for enhanced watershed management to link conservation with improvement of the livelihoods of the rural poor.

History and evolution of watershed management approaches in India

The first initiative in the country towards efficient management of rainwater was the setting up of a few irrigation projects in parts of India by the Famine Commission in 1880. It was only in 1923 that Mr VA Thampane initiated systemic research on dry farming for the scarcity tracts of erstwhile Bombay State which was continued by Mr NV Kanitkar from 1926. Later, the Imperial Council of Agricultural Research provided the financial support for a comprehensive project on dryland farming at five centers in India. Recommendations from these early studies emphasized mainly on soil and moisture conservation measures. Accordingly, the Indian Council of Agricultural Research (ICAR) established eight Soil Conservation Research Centres and Demonstration & Training Centres in 1954 to promote the adoption of improved soil and water conservation practices.

The Drought Prone Areas Programme (DPAP) was one of the major developmental programs launched by the Government of India (GOI) in 1972-73 to tackle special problems faced by those fragile areas that are constantly affected by severe drought conditions. There were several operational research projects under the DPAP. The work carried out under these projects on soil and water conservation issues on both arable and non-arable lands, gradually evolved into watershed and landscape-based conservation technologies. Recognizing the potential of watershed based management of soil and water in mitigating the impacts of droughts, a program for development of dryland agriculture based on watersheds was initiated in 1983 with 47 model watersheds in different agro-ecologies. The programs put emphasis on soil and water conservation measures, crop management and alternative land use systems. The benefits of the watershed management were clearly visible to all the stakeholders - from farmers to planners - during the severe drought that the country faced in 1987 and convinced the GOI to take it as a major developmental program in the drier areas of the country. Accordingly, the GOI initiated the National Watershed Development Project for Rainfed Areas (NWDPRA) in 1990-91 during the VIII Five Year Plan.

The earlier generation of watershed programs went through the technocratic and structure-driven approach for soil conservation and rainwater harvesting, with limited focus on productivity enhancement and livelihood improvement. Soil conservation programs became synonymous with contour bunding and water conservation with check-dams, and these measures were implemented through a compartmental and top-down contractual approach. The programs lacked transparency and resulted in inequitable distribution of benefits among the community members. For example, the rich who could invest in a bore-well have harnessed the benefits of the augmented water sources, while small and poor landholders comprising about 85-90% of the community could not get any benefit from the conservation measures. As such they always looked at these interventions as employment opportunities during the project period and people's participation was not adequate (Wani 2003). Also, most of the projects implemented by non-government organizations (NGOs) and government line departments lacked technical backstopping.

With the realization of the crucial role of people's participation in the planning and implementation of the watershed programs, the Ministry of Rural Development, GOI, in 1994 developed a new set of guidelines. These Guidelines for Watershed Development were adopted in 1995, and subsequently revised in 2001 (GOI 1994). The aim was to involve village communities in the implementation of watershed projects under all the developmental programs namely, Integrated Wastelands Development Programme (IWDP), Drought Prone Areas Programme (DPAP) and Desert Development Programme (DDP) through creation of watershed committees with powers to decide on the development plans, review progress of work, verify accounts and authorize expenditures. The 1994 guidelines also provided special emphasis to improve the economic and social conditions of the resource-poor and disadvantaged sections of the watershed community. Some important aspects of the new guidelines are as follows:

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

The guidelines suggested that the approximate size of the watershed be 500 ha. Further, they proposed that the village community be consulted in the selection process. The criteria of acute shortage of water, preponderance of wasteland and common lands, community participation in implementation and evaluation, as well as community empowerment were also the emphasis of the guidelines. These guidelines were further revised under the name of *"Guidelines for Hariyali"* that were issued in April 2003 (DOLR 2003) by the Department of Land Resources, Ministry of Rural Development, GOI, to further simplify procedures and involve the *Panchayat Raj* Institutions (PRIs) more meaningfully in planning, implementation and management of economic development activities in rural areas.

The new generation of watershed management models gives priority to the empowerment of the community and the stakeholders, by changing the approach from supply-driven to a demand-driven and participatory approach, where farmers and communities would have a strong sense of ownership and a clearly defined responsibility to manage their own resources. Earlier experiences drawn from various watershed projects have indicated that a straightjacket approach will not yield the desired results and that the joining up of individual and community-based interventions are essential for desirable outcomes. Multi-disciplinary teams are involved to provide all the technical expertise to solve the problems at community level. The benefits are transparent and distributed well among the community members including women. Further, transparency of the new models would allow the community members to be aware of the benefits gained from participation in every aspect of the program. This encourages the watershed community to invest more in land and water conservation technologies thereby ensuring long-term benefits and improved livelihoods via holistic and more integrated interventions that go beyond resource conservation. Thus, watershed management and water harvesting is often considered as an entry point for improved livelihoods in drought-prone regions. Figure 1 shows the evolution of the watershed approach in India over time.

The watershed development program is now planned, implemented, monitored and maintained by the watershed communities. To bring about uniformity in programs being implemented by various agencies in India, the Watershed Areas' Rainfed Agricultural Systems Approach (WARASA-*Jan Sahbhagita)* guidelines have been brought out in conformity with the "Common Approach/Principles for Watershed Development" agreed upon by the Ministries of Agriculture and Rural Development, GOI.

NWDPRA has been restructured during the IX Five Year Plan with greater decentralization and community participation, higher degree of flexibility in choices of technology and suitable institutional arrangements for ensuring long-term sustainability. An area of 2.76 m ha has been treated with an expenditure of Rupees 9108 million (~ US$ 207 million) during the IX Five Year Plan period (Joshi et al. 2004).

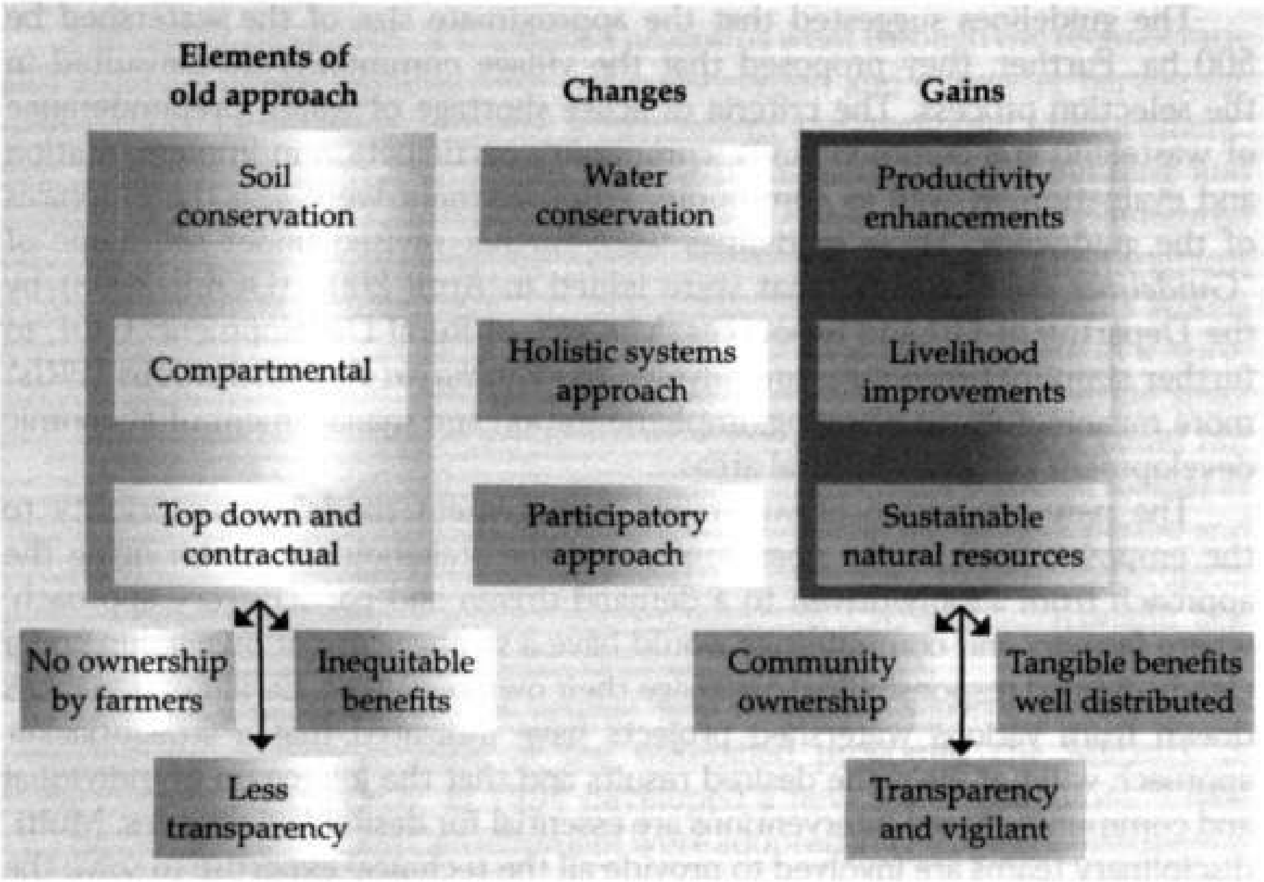

Figure 1. Evolution of watershed management approaches in India.

Experiences and lessons learnt

Although the watershed programs in India were initiated more than four decades ago, activities became more vigorous only after the 1990s. The watershed programs covered different agroecological regions of the country and their nature and scope were continuously modified. The Sukhomajri watershed management project, one of the oldest that has been implemented, has provided several new insights and concepts of developing farm and forestlands together with people's participation (Grewal et al. 1995). The lessons from this project stimulated and inspired new ways of thinking and implementation of IWM projects. It also re-oriented the focus from conservation to community participation and improvement of people's livelihoods.

On the other hand, despite the long history of watershed development programs in India there were no systematic and large-scale impact assessment studies on performance of watershed programs. There was a lack of proper indicators and evaluation methods to assess tangible and non-tangible economic, social and sustainability benefits from the watershed programs. The mid-term appraisal by the IX Plan of Planning Commission (PPC), GOI, of the watershed program, expressed satisfaction about beneficial impacts on resource conservation, increased crop productivity, crop intensity, farming system diversification and employment. However, it was noted that increase in agricultural production did not last for more than 2 years. Structures were abandoned because of the lack of maintenance and there was no mechanism to look after common lands. Subsequently, the projects failed to generate sustainability due to failure of government agencies to involve people (GOI 2001). Kerr et al. (2002) also reported that the extent of success of watershed projects is determined by the extent of people's participation. Of all the watershed projects, projects that emphasized participation and sound technical input performed the best. Swarn Lata and Samra (2001) reported that beneficiary participation increased as the project progressed chronologically from the planning to implementation and maintenance stages. Gender inequalities were not fully eliminated.

Based on qualitative assessment of the impacts of the DPAP, Hanumant Rao (2000) reported an overall positive and significant impact of the program. Farrington et al. (1999) also provided an overview of the documented impact of watershed development in India. Results indicate that successful projects have in fact reduced rainwater runoff and recharged groundwater aquifers, improved drinking water supply, increased irrigated area, changed cropping pattern, increased crop intensity, enhanced agricultural productivity, increased availability of fuel and fodder, and improved soil fertility. However, the impact of these projects on stabilizing the yields is less clear. Palainsamy et al. (2002) reported that the watershed program did not perform well in terms of controlling reservoir siltation, mitigating the impact of drought and improving/stabilizing the production of crops (such as pulses and oil seeds) that are generally grown in rainfed areas. The production of rainfed crops fluctuated depending on the pattern and quantity of rainfall.

A joint study conducted by ICRISAT and the International Water Management Institute (IWMI) has assessed the performance of watershed programs in India by employing meta-analysis (Joshi et al. 2005). A review of 311 watershed programs in India revealed that the mean benefit-cost ratio of the watershed program in the country was quite modest at 2.14 (Figure 2). The internal rate of return was 22%, which is comparable with many rural developmental programs. The watershed programs generated enormous employment opportunities, augmented irrigated area, cropping intensity, and conserved soil and water resources. The watershed programs performed better in areas with rainfall ranging between 700-1000 mm, when jointly implemented by state and central governments, targeted to low and medium income regions, and involved active participation of the communities. The study concluded that the watershed program was silently rejuvenating and diversifying agriculture into high-value products in the rainfed areas. It was noted that lack of appropriate institutional support to such promising approaches was impeding the tapping of potential benefits associated with these programs.

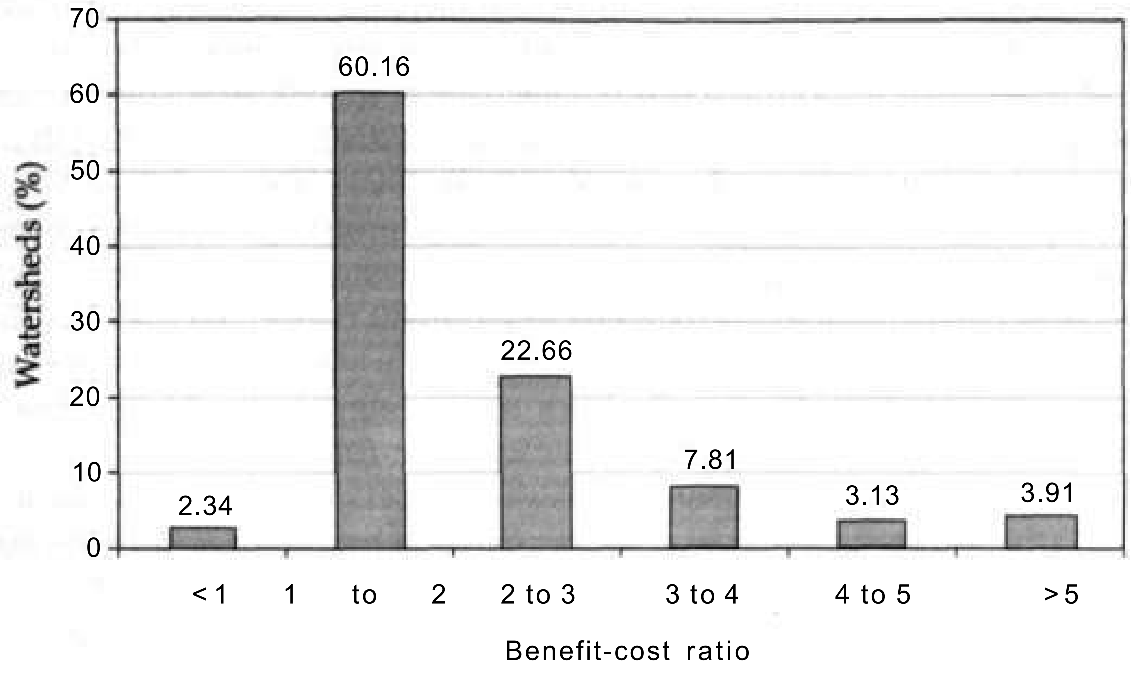

Figure 2. Distribution of watersheds (%) according to BCR.

Joshi et al. (2004) studied the policy and institutional constraints to sustainable watershed management in India. The paper highlighted the following issues for sustainable watershed management: (1) Market failures and externalities, (2) Incentive problems for collective action in management of common property resources, (3) Incentive problems for private investment in watershed management. It also discussed the need for innovative policy and institutional arrangements to address the incentive problems and internalize the externalities. The most important policies and programs launched by the GOI that affect the success of watershed programs are the National Agricultural Policy, Water Policy, Land Policy, Forest Policy and the Watershed Development Guidelines.

The annual budget of the various ongoing national, bilateral and internationally aided watershed development projects in India is estimated at US$500 million per year (Farrington et al. 1999). A strong commitment by the GOI and good policy support for the watershed program have attracted a widespread recognition of the role that the watershed programs could play in agriculture and management of the natural resource base in the drylands. Available estimates indicated that by the end of the IX Plan in 2002, about 27.5 million ha would have been covered under the watershed programs (Joshi et al. 2004). This is approximately 25% of the potential area for watershed development in the rainfed regions.

The consortium approach for integrated watershed management

Watershed research work started at ICRISAT in 1974-75, which was operationally perfected over several years. Improved watershed management yielded impressive successes both on research farms and farmers' fields. An institutional innovation for sustainable and efficient management of natural resources in the SAT has emerged from the lessons learnt from the long-term watershed-based research conducted by ICRISAT in partnership with NARS (Wani et al. 2002 and Wani et al. 2003). The approach underpins a strategic alliance of a coalition of actors (consortium) that facilitates convergence and coordination of targeted interventions to generate complementary benefits for the local community. The convergence model also underpins people's participation and empowerment of the stakeholders as an integral part of the new IWM model. The model is a holistic systems approach and relies on collective and complementary efforts of the various actors to address the complex production, resource management and livelihood problems in watersheds.

In each implementation zone, along with ICRISAT, a consortium of partners with complementary competencies that included non-governmental organizations, agricultural universities, national research institutions, advanced research institutions, and farmers' groups was formed. Among others, the partners included the Central Research Institute for Dryland Agriculture (CRIDA); the Indian Institute of Soil Science (IISS); the National Remote Sensing Agency (NRSA); State Governments of Andhra Pradesh, Madhya Pradesh and Rajasthan; the Vietnam Agricultural Sciences Institute (VASI); the Thai Royal Department of Agriculture and the Royal Department of Land Development; Guizhou Academy of Agricultural Sciences; Yunnan Academy of Agricultural Sciences; the Michigan State University (MSU); and the University of Georgia.

The important features of the new approach, which are distinctly different from earlier models, are as follows:

- Facilitates the participation of beneficiaries through cooperative mode, and not through contractual mode,
- Uses new science tools instead of replicating different components, for management and monitoring of changes in the watershed,
- Focuses on improving the livelihoods of the people through a holistic systems approach rather than merely addressing soil and water conservation,
- The consortium of various institutions facilitates technical backstopping, motivation of beneficiaries and development of input and output markets,
- Allows self-reliance of the smallholder farmers with minimal initial support in the provision of new technologies for evaluation and adaptation,

- Identifies and recommends low-cost and profitable soil and water conservation measure and structures that help generate quick income benefits to beneficiaries,
- Facilitates identification and integration ofscientific knowledge with traditional indigenous knowledge for efficient management of natural resources,
- Facilitates generation and diversification of private benefits through new cultivars and land and water conservation measures for raising productivity on individual farms along with community-based soil and water conservation measures,
- Facilitates learning and adaptive management through dynamic monitoring and evaluation by the stakeholders,
- Empowers individuals and communities in the watershed and strengthens village institutions for managing the watershed program.

Unlike the supply-driven approach of the past, the new approach relies on facilitating knowledge-based and demand-driven technology exchange to stimulate local innovation for self-reliance and empowerment of the community and its service providers.

The impacts of the participatory consortium model

The new model was first initiated and evaluated in Adarsha Watershed, Kothapally, Ranga Reddy district, Andhra Pradesh, India. Using a combination of indigenous and improved technologies, multiple interventions such as low-cost soil and water conservation structures, environment-friendly nutrient management options, eco-friendly pest and disease control, crop diversification with legumes, and improved groundwater management were designed and implemented by the communities. In addition, income-generating options for landless farmers were introduced to enhance the equity impacts of watershed interventions. High value crops, profitable cropping systems and non-farm income-generating options offered higher incentives for landless laborers, women and youth to participate in watershed activities. The impact was monitored and assessed using data on crop productivity, household income, groundwater recharge, runoff, and soil and nutrient loss. Automatic weather stations, satellite imagery and geographical information system were used to complement the monitoring. The growing period and dry spells at watershed level were characterized and the moisture availability was monitored using a water balance approach during the *kharif* 2003 (Wani et al. 2004).

The results show that at Kothapally, groundwater levels improved by 5 to 6 m and green cover increased from 129 ha in 1996 to 200 ha in 2000. The soil and water management measures in the treated watershed included field bunding, *gully* plugging and check dams across the main watercourse. There was a significant reduction in the runoff from the treated watershed compared

Table 1. Seasonal rainfall, runoff and soil loss from the Adarsha sub-watershed.

Year	Rainfall (mm)	Runoff (mm)		Soil loss (t/ha)	
		Untreated	Treated	Untreated	Treated
2000	1161	118	65	4.17	1.46
2001	612	31	22	1.48	0.51
2002	464	13	0	0.18	0
2003	689	76	44	3.20	1.10
2004	667	126	39	3.53	0.53

to that of the untreated watershed (Table 1). In the high rainfall year (2000), runoff from the treated watershed was 45% less than the untreated. Adoption of improved crop management technologies have increased crop yields significantly - maize by 2.2-2.5 times and sorghum by 2.3-3.0 times (Wani et al. 2003a). Intercropped pigeonpea yield increased by 4-5 times (Table 2).

The coalition of project partners identified and initiated the training, production, storage and usage of *Helicoverpa* nuclear polyhedrosis virus (HNPV) on different crops for minimizing pest damage. The farmers quickly adopted the technology, produced 2,000 larval equivalent (LE) of HNPV, and used it on cotton, pigeonpea and chickpea crops. The shift in cropping system from cotton to maize/pigeonpea resulted in reducing the use of chemical pesticides worth US$44 to 66 per hectare. Consequently, income from alternate cropping systems increased. Key change agents such as watershed committee members and agricultural and extension officials were trained on different aspects of IWM. Special emphasis was given to increasing awareness of new management options among women farmers, as they play a key role in the adoption of new technologies. Women were trained in vermicomposting technology, and

Table 2. Average crop yields with improved technologies in Adarsha watershed, Kothapally, 1999-2003.

Crop	1998 Baseline	Yield (kg ha^{-1})				
		1999	2000	2001	2002	2003
Sole maize	1500	3250	3750	3300	3480	3290
Intercropped maize	-	2700	2790	2800	3080	3130
(Traditional)		700	1600	1600	1800	1950
Intercropped pigeonpea	190	640	940	800	720	950
(Traditional)		200	180	-	-	-
Sole sorghum	1070	3050	3170	2600	2425	2290
Intercropped sorghum	-	1770	1940	2200	-	2110

educated youth were trained in skilled activities such as HNPV production and vermicomposting, which enabled them to generate incomes. Adarsha watershed has served as a benchmark watershed in demonstrating the benefits of IWM that attracted the attention of farmers from the nearby watersheds of Ranga Reddy district and Adilabad district.

The success of the model watersheds attracted the attention of the Asian Development Bank for scaling up activities in India, China, northeast Thailand, and northern Vietnam. The Government of Andhra Pradesh, financially supported by the Department for International Development (DFID) of the UK Government, selected the participatory-consortium model for promoting IWM in five target districts through the Andhra Pradesh Rural Livelihoods Program (APRLP). The Sir Dorabji TATA Trust decided to promote the model to the states of Madhya Pradesh and Rajasthan in India in order to minimize the land degradation and improve rural livelihoods through technical backstopping from the ICRISAT-led consortium. Benefits recorded from various watershed interventions in these locations are summarized below.

Improved land, soil and water management practices

Improved land management practices such as Broad-Bed and Furrow (BBF) on Vertisols and Alfisols in various study sites enhanced soil moisture content, increased infiltration, and reduced runoff during the crop growth period. Crop yields have increased by 10-40% through enhanced rainwater use efficiency. At Lalatora watershed in Madhya Pradesh, the seasonal runoff from the treated watershed was 55 mm compared to 291 mm from the untreated watershed. At Tad Fa watershed, Thailand, less than half of seasonal runoff (194 mm) was recorded from the watershed under improved (fruit trees and seasonal crops) land use system compared to the watershed with conventional (seasonal crop) land use system (473 mm). Improved watershed technologies were also quite effective in reducing soil loss. Improved technologies recorded 70% lower seasonal soil loss compared to untreated watershed at Lalatora. Similarly, at Tad Fa watershed, the seasonal soil loss from untreated watershed was 15.4 t ha^{-1} compared to 10.31 ha^{-1} from the treated watershed. Major impact of improved watershed technologies was seen in the groundwater recharge. The groundwater level rose by 5.75 m in treated watershed at Lalatora compared to groundwater level in untreated watershed. Improvement of marginal lands with appropriate management resulted in biodiversity improvement as achieved in Bundi, which is a very dry watershed in Rajasthan, India.

At Thanh Ha watershed, northern Vietnam, the use of polyethylene and straw mulch increased the soil temperature by 2-3°C in autumn-winter and 1-2°C in spring at 10 cm depth and contributed to the maintenance of soil moisture in the entire soil profile (Long et al. 2003). Farmers harvested 71 to

100% more groundnut in the watershed by using improved cultivar, soil, water, nutrient and pest management options. Farmers in the surrounding areas are adopting this technology.

Introduction of improved crop cultivars and cropping systems

Improved cultivars of soybean, groundnut, wheat, pigeonpea, chickpea, sorghum, pearl millet, maize, vegetables and mung bean were evaluated for large-scale cultivation with improved SWNM options. At Lalatora, the intervention of chickpea varieties ICCV 10, ICCV 2 and ICCC 37 increased production by 4% to 50% (957 to 1471 kg ha^{-1}) over local varieties. Similarly, in other benchmark watersheds, crop productivity increased by 10 to 50% through adoption of high-yielding cultivars. In Tad Fa watershed of northeast Thailand, maize yield increased by 27 to 34% over a maize-maize system when preceded by short duration legumes (black gram, rice bean, and sunhemp). At Thanh Ha watershed, Vietnam, mung bean-groundnut-water melon, mung bean-soybean-water melon and groundnut-water melon cropping systems provided the highest income (262 to 268%) over the traditional maize-maize cropping system. In Rajasthan, a short-duration pigeonpea, with better drought-tolerance and nitrogen-fixing capability, was introduced in three districts and was a great success in the very first year. About 100 farmers participated in the program and have harvested up to 1500 kg ha^{-1}. Given the low soil fertility and drought-proneness of the region, productivity valued at about Rs 22,000 per hectare is a good achievement for the farmers.

Micronutrient amendments

During baseline characterization, soil analysis results showed that 80 to 100% farmers' fields were critically deficient in B, Zn and S nutrients in addition to N and P. Micronutrient amendments with Zn, B and S to overcome deficiency showed remarkable gains. In Thanh Ha watershed, Vietnam, micronutrient application resulted in 27% higher pod yields over farmers' practice (2.75 t ha^{-1}) in groundnut. In the Lalatora watershed of India, micronutrient amendments increased the net profit by $ 193 per ha in case of soybean-wheat system over the profit of $394 per ha from the farmers' practice. At Lalatora, Madhya Pradesh, the economic analysis of the "On-Farm Trials" showed that intervention of combined application of boron and sulphur yielded maximum benefit with 1:1.8 benefit-cost ratios as compared to control with traditional practices (1:1.3) and the benefits to farmers increased by 49% (Patil et al. 2003). Farmer participatory research and development trials in Andhra Pradesh, Madhya Pradesh, Rajasthan and Gujarat showed 30 to 60% increased crop yields due to micronutrient amendments (Rego et al. 2005), which also increased rainfall use efficiency (RUE). In soybean, the RUE was increased by 25% through micronutrient amendments. The highest RUE of 117% was observed for sorghum. The RUE in terms of net economic returns for the rainfed crops was substantially higher by 1.5-1.75 times.

Micro-enterprise development and income generating activities

Micro-enterprises such as village seed banks, vermicomposting, nursery raising, poultry, piggery and artificial insemination for livestock were initiated to provide new income sources for the poor and to diversify production and livelihood opportunities. Village seed banks provided access to improved varieties in the village at affordable prices and reduced the dependence on external seed sources. Women Self Help Groups (SHGs) set up vermicomposting enterprises. Women members each earn about Rs 500 per month. By becoming an income-earning member of the family, they were more involved in the decision-making process. Consequently, their social status improved. Vegetable cultivation, nursery raising, enhanced milk yields through better livestock management, improved rural livelihoods, particularly for women. In Thailand and Vietnam, farmers' incomes were substantially augmented through pig, poultry and fish rearing.

Rehabilitation of degraded common property resources (CPRs)

Through soil moisture conservation measures and collective action, the CPRs were rehabilitated with fruit tree plantations and grass seeding in benchmark sites in India. Custard apple (*Annona spp)*, ber *(Zizyphus spp.)*, *Jatropha* and *Pongamia* plantations were tested with contour trenching along with *Gliricidia* plants on bunds to serve as live fences. Avenue plantation was also introduced as a part of the afforestation program. For example, twenty-five hundred fruit trees and teak plants were planted on the field bunds. These efforts resulted in enhanced greenery along with reduced land degradation and increased carbon sequestration.

Improved soil and water management and cropping systems (sorghum/ pigeonpea intercrop) also resulted in higher carbon sequestration in Vertisols. Soils up to 120 cm depth contained about 34% more organic carbon (C) than the traditional (fallow-sorghum) system and a gain of 335 kg C ha^{-1} per year was obtained (Wani et al. 2003). When replicated on a large scale in Asian agriculture, substantial global environmental benefits in terms of reduced greenhouse gases and global warming were likely to be obtained.

Changes in vegetative cover

Watershed interventions, if successful, will show significant positive changes in the vegetative cover of the watershed areas. The impact of various watershed interventions on increased vegetation was monitored using satellite imagery. The Normalized Difference Vegetation Index (NDVI) was used to monitor the resulting changes. The land cover and vegetation density in Adarsha watershed, Kothapally, was monitored using the IRS-1C and -1D LISS-III images of April 1996 and April 2000. The analysis revealed that the spatial extent of moderately dense vegetation cover during postrainy season had increased from 129 ha to 200 ha during 1996-2000. A comparison of the vegetation cover in Milli watershed, Lalatora, in Vidisha district of Madhya Pradesh, India, during 1997-2001, showed a significant increase in the vegetation cover to the tune of 269 ha (3,402 ha during 1997 versus 3,672 ha during 2001). Much of this came from reduction in the fallow/barren lands in the watersheds. These results provided direct evidence of increased cultivation during the postrainy season, which is mainly due to the increased water availability in the soil, in the water harvesting structures or in the wells.

Impact on national policy

Integrated watershed management is identified as the most suitable approach to improve the rural livelihoods through increased productivity and efficient management of natural resources in the drylands of the SAT. The National Commission on Farmers (2004), India, stated that the principal constraints observed in reaping the full benefits from dryland farming research are (1) lack of watershed approach with all members of the watershed community working together to save and share water; and (2) lack of social synergy in the area of land and water use planning, with emphasis on collaborative efforts in both production and postharvest phase of farming. The Commission recommended that high priority should be given to augmenting water availability by vigorously promoting rainwater harvesting, restoring water bodies, and extensive well-recharging programs. Convergence and synergy of all agricultural programs around a watershed is the need of the day. The National Commission on Farmers appreciated the success of the ICRISAT-led consortium model and pointed out that this holistic innovative model changed the paradigms for watershed management in India, where watersheds were used as an entry point for improving the livelihoods and protecting the environment. Watershed programs have a very high potential for bringing favorable changes in drylands of the SAT Holistic systems approach through IWM and community participation can result in sustainable and increased farm productivity and improve the livelihoods of rural poor in the dry regions (National Commission on Farmers 2004).

Drivers for success

There are many successes in watershed programs and it is necessary to analyze the drivers of these successes, so that the findings and lessons will help in better implementation of watershed programs in other dryland regions. ICRISAT and consortium partners tried to understand the factors that contributed to the transformation of people's lives in Adarsha watershed at Kothapally (Sreedevi et al. 2004). The interplay of multiple factors contributed to efficient utilization of development funds and better management of the resource base, which has already improved agricultural productivity and household incomes substantially. The drivers for success of watershed programs could be summarized as follows:

- Integrated approach to watershed management
- Enhanced collective action and people's participation
- Tangible economic benefits to individuals
- Good local leadership
- Demand driven programs - empowering and involving the community in decision making
- Choice of low-cost conservation structures that provide benefits to large segments of the community
- Water harvesting structures planned on common land to avoid conflicts
- Working with the SHGs (affinity groups) for implementing activities (no contractors) which has generated local employment
- Funds managed by village committee ensured transparency and accountability
- Knowledge-based interventions and technical backstopping by a consortium of experts
- Motivation for self-reliance with minimal subsidies for technology evaluation and generating local public goods
- Constant participatory monitoring and evaluation
- Strengthened forward and backward linkages
- Concerted local capacity-building efforts by all partners.

Summary and conclusions

The SAT is threatened by problems of high population, poverty, land degradation and drought. Water is the key-factor, and improvement of rural livelihoods through IWM has shown promising results. Along with several socioeconomic studies, which documented the weaknesses of various watershed management approaches, experience has also shown the difficulties of the top-down approach to Natural Resource Management (NRM). This has led to the development of new policies and guidelines for a common approach to watershed management across the different implementing agencies in India. These policies emphasize the role of community participation. The policy and institutional issues for watershed management are mainly related to profitability of interventions, problems of collective action and active participation by the community, cost-sharing between individual farmers and the community/state, distribution of the gains from watershed management (equity) and negative externalities (eg, upstream-downstream tradeoffs). ICRISAT has adapted the innovative farmer-participatory consortium approach for IWM in India, China, Thailand and Vietnam.

The results have shown that this approach could significantly increase the economic benefit to the community via increased productivity, reduced land degradation, reduced pesticide use, improved water availability, and improved employment through efficient management of natural resources. Soil and water management measures resulted in a significant reduction in runoff compared to that of the untreated watershed in the study areas. Adoption of high-yielding cultivars combined with suitable cropping systems and soil and water management practices boosted land productivity and incomes for the poor. Micronutrient application, on the other hand, has shown remarkable gains over the traditional practices, and increased water productivity and rainfall use efficiency.

The synthesis has shown that the integrated watershed model has provided a useful conceptual and institutional framework for the development of rainfed agriculture and livelihoods. The IWM examples have also shown the diverse options that can be applied for improving sustainability of agriculture and reducing vulnerability to drought and other shocks. Therefore, the consortium approach, as successfully demonstrated in the SAT of India, offers good opportunities for sustainable intensification and diversification of production systems in comparable production systems in Africa. This would however require selected pilots for adaptation and refinement of technical and institutional innovations to specific conditions in the African context.

Acknowledgments

The authors would like to thank all the partners of the consortium, viz, CRIDA; ICAR; NRSA; SAUs; Government Departments such as Drought Prone Area Projects of Andhra Pradesh; Andhra Pradesh Rural Livelihoods Program; Rajiv Gandhi Watershed Mission of Government of Madhya Pradesh; Directorate of Watershed and Soil and Water Conservation Mission, Rajasthan; NGOs such as MV Foundation; Bharatiya Agro Industries Foundation and Samaj Pragati Sahyog; farmers and the SHGs; the Vietnam Agricultural Sciences Institute (VASI), the Thai Royal Department of Agriculture and the Royal Department of Land Development; Guizhou Academy of Agricultural Sciences; Yunnan Academy of

Agricultural Sciences for their help and cooperation. We acknowledge the help of Dr RC Sachan for compiling the results of this study. The financial support provided by the APRLP-DFID, ADB and Sir Dorabji Tata Trust is gratefully acknowledged.

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Policy and institutional issues and impacts of integrated watershed management: Experiences and lessons from Asia

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Introduction

Coupled with pervasive poverty, degradation of agroecosystems and declining sustainability are major concerns for agricultural development in many poor regions of the world where livelihoods depend on exploitation of natural resources. This is especially the case in the arid and semi-arid areas where water scarcity, frequent droughts, soil degradation and other biotic and abiotic constraints lower agricultural productivity and the resilience of the system (Shiferaw and Bantilan 2004). In sub-Saharan Africa (SSA), rainfed areas account for over 90% of the cultivated area and house a large share of the poor, food insecure and vulnerable population. Integrated watershed management (IWM) is being recognized as a suitable strategy for improving productivity and sustainable intensification of agriculture in rainfed drought-prone regions. The concept of IWM goes beyond traditional integrated technical interventions for soil and water conservation to include multiple crop-livestock and market related innovations that support and diversify livelihoods to better withstand risks induced by market and climatic variability. The concept ties together the biophysical notion of a watershed as a hydrological unit with that of the community and institutional factors that regulate the demand and determine the viability and sustainability of such interventions. The hydrological approach helps to identify the appropriate technical interventions on the supply side, while the village or community-based planning and implementation is fundamental to create institutions for community empowerment and sustainability on the demand side.

However, effective implementation of an IWM program requires careful consideration of the special characteristics of watersheds both as biophysical as well as socioeconomic units and the implications for policy and institutional arrangements. A watershed is a spatially defined unit that includes diverse natural resources that are unevenly distributed within a given geographical

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area where water drains into a common point. Watersheds encompass diverse natural resources (soil, water, trees, biodiversity, etc) utilized by diverse groups of people holding unequal use rights and entitlements (Farrington et al. 1999; Knox and Gupta 2000; Johnson et al. 2002; Joshi et al. 2004). Watersheds are also inhabited by socially heterogeneous groups of people located at different points along the terrain creating potential conflicts in resource use between those on the upper, middle and lower reaches of catchment. Clearly, watersheds are ecologically and socially complex geographical units characterized by temporal and spatial interdependence between resources as well as resource users. This implies that effectiveness of watershed interventions will depend on the ability to treat the entire hydrological landscape, not just a portion of it.

Moreover, because of the lateral and downhill movement of soil and water resources (Swallow et al. 2002), unilateral action taken by any single resource user may impose positive or negative consequences (externalities) on any other resource user. The ability to exclude or prevent these externalities is determined by the nature of property rights held by the resource users. When negative externalities are difficult to exclude or prevent at low cost, some of the production and resource use decisions for certain resources may fall under the control of other agents. When the externalities are negative, the production or resource use levels may be socially supra-optimal. The reverse is true for desirable externalities for which individual resource users are not fully compensated. The ability to internalize these kinds of mutual spillover effects resulting from spatial and temporal interdependence among resource users requires interventions mediated through targeted policies and institutional incentives that encourage cooperation and collective action. Fragmented land ownership and settlement patterns coupled with unequal access and use rights create conflict and diverging interests. This reduces the incentives for cooperation and increases the transaction costs involved in organizing resource users for collective action.

Based on the lessons and experiences in South Asia and other areas, this chapter reviews the policy and institutional needs for IWM and shows how this may contribute to improvement of economic and environmental conditions in drought-prone regions.

Policy and institutional issues

A number of factors that determine incentives for collective action in natural resource management have been discussed (Olson 1965; Bardhan 1983; Jodha 1986; Ostrom 1990; Meinzen-Dick et al. 2002). Three major factors seem to determine the incentives for individual participation in watershed management programs. These are spatial scale, temporal scale and property rights (Swallow et al., 2002; Shiferaw et al. 2005). These factors imply the need for certain policy and institutional arrangements to enhance individual incentives for collective action in watershed management.

On the other hand, investments in several Natural Resource Management (NRM) technologies required for watershed management do not pay back in a short period. Typical examples are tree planting, construction of check dams and terraces for soil and water conservation. Unlike the seed-based crop production technologies that provide returns within a single season, NRM technologies often have a longer gestation period. The costs are incurred up-front, while economic returns are often delayed and accrue in small incremental flows over a long period. Some of the social benefits from watershed management are non-tangible public goods such as improvements in ecological functions and environmental services that improve sustainability and ecosystem health. Such benefits are not fully captured by individual resource users. This means that unlike other short-duration agricultural technologies (eg, new varieties) the resource-improving IWM interventions require a relatively longer planning horizon (Shiferaw et al. 2004).

Another important factor in IWM is related to the property rights regime that governs the use of land, water, forest and other resources. Costs and benefits from watershed development efforts are determined by the stock of resource use rights and entitlements of individual holders and the ability to exclude others from benefiting with such investments. Excludability depends on biophysical conditions (eg, topography), property rights and the prevailing legal and institutional framework, including customary laws. In many cases, land is either privately owned or leased from the government or other rights owners based on some defined contracts. In the latter case, land cannot be sold and may not be used as collateral to access institutional loans. Surface (rivers and lakes) and groundwater resources are mainly held under common property regimes. This means that resource users belonging to certain group will have unregulated access to exploit these resources typically without payment. These resources are not priced and in the absence of collective action, there is lack of incentives and institutional mechanism to regulate use. This can cause a major problem in watershed management. For example, when water is free and regulatory systems are now in place, the groundwater level in watersheds begins to decline while the individual cost of drilling a new well increases. A study in 12 semi-arid villages of Andhra Pradesh has shown that more than 65% of the open wells and 28-45% of the tube wells have dried up. In many of the villages, more than 90% of the open wells have completely dried up (Shiferaw et al. 2003).

Clearly defined and secure property rights would combine the elements of excludability, duration, robustness and assurance (Place et al. 1994). Duration measures the temporal extent of the rights; robustness measures the scope and depth of the rights held; assurance measures the ability to enforce the agreed rights. In watersheds, there is a lateral movement of soil and water resources. Unilateral action taken by any single resource user may impose positive or negative consequences (externalities) on any other resource user. In some cases, the externalities move in one direction (unidirectional externalities) while in other cases they may move in multiple directions (reciprocal externalities). Lack of excludability of undesirable effects means that part of their resource use decisions and production choices fall under the control of other farmers. In the presence of negative externalities, the level of private resource use is in excess of what is socially optimal while the reverse is true in cases where the effect is positive. These kinds of mutual spillover effects that emerge from spatial and temporal interdependence among resource users require interventions mediated through targeted policies and institutional incentives that encourage cooperation and collective action.

The social dimension is also important for IWM; diverse social groups with differing entitlements and rights to use natural resources inhabit watersheds. Ethnic and tribal heterogeneity as well as unequal rights to land and water among the inhabitants often imply that costs and benefits from watershed investments are unequally distributed. Fragmented land ownership and settlement patterns coupled with unequal access and use rights create conflict and diverging interests. This reduces the incentives for cooperation and increases the transaction costs involved in organizing resource users for collective action. The classic mismatch between the boundaries of the watershed and a village or a community is well known. Rivers and other natural boundaries often delineate villages or local administrative units whereas they often lie at the interior of a watershed. A good strategy to overcome this problem is to identify a village that coincides with a micro-watershed that will in turn form a watershed when multiple villages are brought together. The biophysical and social complexities and the need to harmonize the two for sustainable NRM will require appropriate policy and institutional arrangements that promote both private and collective efforts.

Organizational issues

Collective action in watershed management is very unlikely to emerge autonomously on its own. This is mainly because small farmers and resource users are often disorganized and scattered and face high transactions costs in mobilizing communities. Building institutions for collective action in watershed management requires formulation of rules, regulations and guidelines that facilitate effective implementation of community programs. There is a clear role for the state in terms of defining proper guidelines and rules, which facilitate cooperation and collaboration among resource users and provide a legal framework for existence of community organizations. There is also a role for the state in terms of providing strategic public support in establishing community and local public goods that serve as the founding blocks for emergence of successful and effective collective action. However, the level of such support that communities may require is likely to be context specific. Proper targeting of such support and establishing the legal checks and balances needed to prevent misappropriation of funds and opportunistic behavior is also essential.

Proper organizational structures are critical for the success of community action. India has established institutional arrangements for community watershed management that extend from the central and state levels to the grassroots level. At the local level, a number of land owners form user groups (UGs) while landless and marginal farmers form self-help groups (SHGs) that together establish a watershed association (WA), which will be led by a watershed committee (WC). The WA serves as the rule and decision-making body with the WC as its executive arm. The WC is made up of representatives from SHGs, UGs, the Panchayat (Village Council) and the Watershed Development Team (WDT). The WDT is a multi-disciplinary team of advisors constituted by the District Watershed Committee. Selected watersheds receive about US$50,000 from the government in the form of public strategic investment to establish local institutions for collective action and to implement IWM activities. User SHGs are expected to make additional cash and in-kind contributions towards this strategic public support.

This shows the clear responsibility that the governments could play in creating enabling conditions. What roles should other players in the process of watershed management play? Obviously, it will be the primary responsibility of the individual farmers to manage privately owned land and other resources. It will however be the primary role of the community to invest and manage common property resources. The non-governmental research and development institutions will have an important role in supporting farmers, communities (and the government) in providing essential resources, innovations and best practices for improving productivity and the environmental resource base. It is critical that the different actors work in close partnership with a common goal and vision. Such a coalition of the willing should be established based on a team spirit and based on the principles of complementarity and comparative advantage.

However, it will be the responsibility of all players to contribute towards building of effective and sustainable institutions (Table 1). As local institutions are developed, it is useful to note the need for an exit strategy for the partners to hand over the primary responsibility for management of all the local public goods to the community. This does not mean that technical backstopping and periodic monitoring by the NGOs and governments should be stopped. Success will depend on the ability of the communities to adjust to the changing conditions as well as leadership and governance for coordination of resource use and conflict resolution

Table 1. The role of different players in community-based watershed management.

	Roles for different actors			
Issues	Household	Community	Government	NGOs for Research and Development
Private land & water management	Primary	Secondary	Secondary (targeted subsidies, etc)	Secondary (advisory role and social protection)
Common property resources and assets	Secondary (compliance)	Primary (Collective action)	Secondary (cost-sharing for investments)	Secondary (support communities and households)
Policies, rules and regulations	Secondary (compliance)	Secondary (enforce rules and policies)	Primary (legislator)	Secondary (advice on good policies and best practices)
Institution building	Secondary	Primary	Primary	Primary

Determinants of community efforts

Incentives for collective action (CA) vary with the type of CA problem that communities and resource users face. The emergence of CA in a given context depends on the awareness of interdependence and realization of potential welfare gains from coordinating the activities of individual agents. Individual choices to participate in CA are contingent upon expectations of the behavior of others. Even if the potential gains are high, cooperative behavior may not translate into practice unless individuals expect other potential beneficiaries to do likewise. The presence of assurance and trust facilitates the potential for reciprocity and emergence of cooperative behavior (Runge 1981; White and Runge 1995). Individual participation may also depend on household-specific (idiosyncratic) factors that determine the transaction costs and benefits from participation. The household's existing stock of physical and financial assets as well as human and social capital can especially play a significant role in determining the relative gains from participation. The success of CA in a given situation once it evolves depends on several factors. The classic impediments of CA are group size and inequality (Olsen 1965). Ostrom's synthesis of case studies describes many success stories of collective action in governing commons - incidences where people, recognizing a need, have created institutions that overcome the problems of CA and allow them to organize successfully for the collective benefit. A number of factors, either internal or external to the group, were identified as important determinants for the success of collective efforts in managing commons. These include clearly defined boundaries, monitoring, mechanisms for conflict resolution, recognition of rights to organize and presence of graduated sanctions to penalize violators (Ostrom 1990).

There is a serious paucity of empirical studies in relation to watershed management at both household and group levels. White and Runge (1995) investigate the factors that determine the emergence and evolution of CA to control soil erosion using data from 22 micro multi-owner catchments in Haiti. The study highlights how realization of interdependence, assurance about the behavior of others and a critical mass of motivated individuals contribute to successful cooperation in watershed management. Similar to the findings in the study of Indian watersheds (Kerr 2001; Kerr et al. 2002), this study also identifies the critical role that equity in the distribution of benefits can play in sustaining collective efforts.

Impacts of collective action - some examples

Collective action in watershed management has the potential to provide multiple economic and environmental benefits - tangible and non-tangible - to rural communities. Such CA allows smallholder farmers to jointly invest in management practices that provide collective benefits to all members. While watershed management contributes to enhancing resource productivity and sustainability, increased commercialization and market access provides the outlet for disposing the surplus generated and the opportunity to diversify into high-value crops, and creates the economic incentives for agricultural intensification and adoption of new technologies. Based on quantitative and qualitative analysis of panel data collected from household surveys, PRA studies, and focus group discussions, the environmental and economic benefits derived from implementation of IWM interventions in Adarsha watershed are presented. The study also documents the associated effects of IWM on commercialization of subsistence agriculture and increased participation of smallholder farmers in markets.

Adarsha watershed is located in Kothapally village (longitude 78°5' to 78°8'E and latitude 17°20' to 17°24' N) in Ranga Reddy district, Andhra Pradesh, nearly 40 km from ICRISAT, Patancheru. It covers 465 ha of which 430 ha are cultivated and the rest is non-cultivated marginal land. The IWM interventions were implemented through a consortium that included ICRISAT, Indian NARS, local government, NGOs and the local community. This drought-prone village/catchment was selected in 1997 based on its high vulnerability to drought, severity of water scarcity, the extent of land degradation and widespread poverty relative to other dryland villages in the district (Wani et al. 2003).

(a) Environmental benefits

The environmental benefits were not valued but measured using selected biophysical indicators such as changes in runoff, soil loss, groundwater levels and ground cover that were monitored over time. The soil and water management measures implemented in the watershed included field bunding, gully plugging and check dams built at certain intervals along the main watercourse that cuts across the village and catchment. In order to facilitate comparability, untreated areas within the catchment that contained only farmers' practices without any technological interventions served as counterfactuals to determine the effect of soil and water conservation measures. The evidence collected for two years (2000-01) shows a significant reduction in runoff and soil loss from the treated segment of the watershed compared to the untreated portion (Table 2). The runoff has declined by about 20 to 60%, the highest reduction coming from years with high rainfall. Although soil erosion levels were not measured in all years, the results from 2001 show over 60% reduction in erosion levels.

Table 2. The impact of watershed management on runoff and soil loss, Adarsha watershed, 1999-2004.

Year	Rainfall (mm)	Runoff (mm)		Soil loss (t/ha)	
		Untreated[1]	Treated	Untreated	Treated
1999	584	16	*	*	*
2000	1161	118	65	4.17	1.46
2001	612	31	22	1.48	0.51
2002	464	13	Nil	0.18	Nil
2003	689	76	44	3.20	1.10
2004	667	126	39	3.53	0.53

[1] Untreated = control with no development work, Treated = with improved soil water and crop management technologies,
* Not installed

The changes in groundwater levels were monitored using 62 geo-referenced open wells located along the main watercourse in the watershed at differing distances from the check dams constructed for recharging groundwater levels. The results show a significant improvement in the yields of most wells, particularly those located near check dams (Figure 1). The land cover and vegetation density studied using satellite images also shows an increase in vegetation cover from 129 ha in 1996 to 200 ha in 2000.

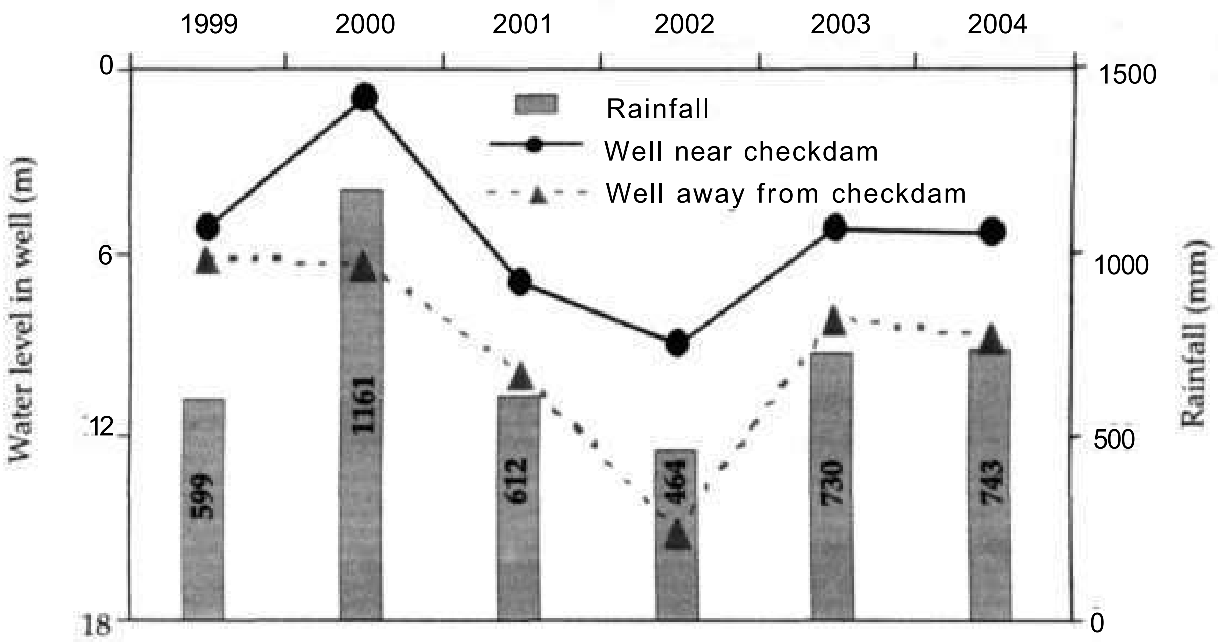

Figure 1. The effect of watershed management investments on groundwater levels. Source: Sahrawat et al. (2004).

(b) Economic benefits

The average net income from the three major sources (crops, livestock and off-farm) and their relative share in 2001 and 2002 is given in Table 3. The income from crops is computed as returns to family labor and land, ie, net of all variable costs other than owned land and family labor using the 2001 constant prices. Did IWM make a significant contribution to crop and total household income? In 2001, the average crop income was about 20% higher in the project villages, but the difference increased to about 300% in 2002. Overall household income was 47% higher in the project villages in 2001, but declined to 37% in 2002. This seems to indicate a significant effect of IWM. In order to isolate the effect of other correlated influences, an econometric model was used to estimate the relative effect of IWM and drought factors on crop income and total household income. The results have shown a significant effect of IWM on crop income and overall household income even in years when drought occurs (Shiferaw et al. 2005).

(c) Drought mitigation benefits

The basic goal of watershed management in drought-prone rainfed systems is to improve livelihood security by mitigating the negative effects of climatic variability while protecting or enhancing the sustainability of the environment and the agricultural resource base. As shown above, adoption of soil and water conservation interventions resulted in significant reductions in runoff and soil

Table 3. The effect of watershed management interventions on alternative sources of household income (Rs 1000).

Year	Villages group	Statistics	Crop income	Livestock income	Off-farm income	Household Income
2001	Non-Project	Mean	12.7	1.9	14.3	28.9
	(N=60)	Std. dev	23.3	3.8	12.6	26.3
		%	44.0	6.6	49.5	100.0
	Project	Mean	15.4	4.4	22.7	42.5
	(N=60)	Std. dev	16.4	6.4	45.0	51.3
		%	36.2	10.4	53.4	100.0
2002	Non-Project	Mean	2.5	2.7	15.0	20.2
	(N=60)	Std. dev	13.4	4.7	30.0	36.9
		%	12.2	13.3	74.5	100.0
	Project	Mean	10.1	4.0	13.4	27.6
	(N=60)	Std. dev	19.4	6.7	17.8	31.3
		%	36.7	14.6	48.7	100.0

erosion, rise in the groundwater level and increase in vegetation cover. Hence, additional land is brought under cultivation in the project villages using small-scale and supplemental irrigation in the postrainy season using improved varieties and cropping systems. Adoption of improved practices has resulted in increased land productivity and profitability of crops and cropping sequences. The mean income for the two groups of households from alternative sources (crops, livestock and off-farm) in 2001 and 2002 is given in Figure 2. The average in rainfall in 2002 (571 mm) was about 16% less than that in 2001 (676 mm).

The results show that crop and household incomes are generally higher in 2001 than in the drought year 2002. In 2001, crop incomes constituted about 36% and 44% of household income in Adarsha watershed and in the non-project villages, respectively. In 2002, crop income for the non-project village declined by 80% while it only declined by about a third in the project village. Hence, the contribution of crop income to household incomes in the non-project villages declined to a mere 12% while it remained unchanged at about 36% in the project villages. This was largely compensated by increased migration and off-farm employment in the non-project villages, where the share of off-farm income increased from about 50% in 2001 to almost 75% in 2002. This shows how IWM has contributed to stability of crop incomes in the watershed despite the serious drought conditions in 2002.

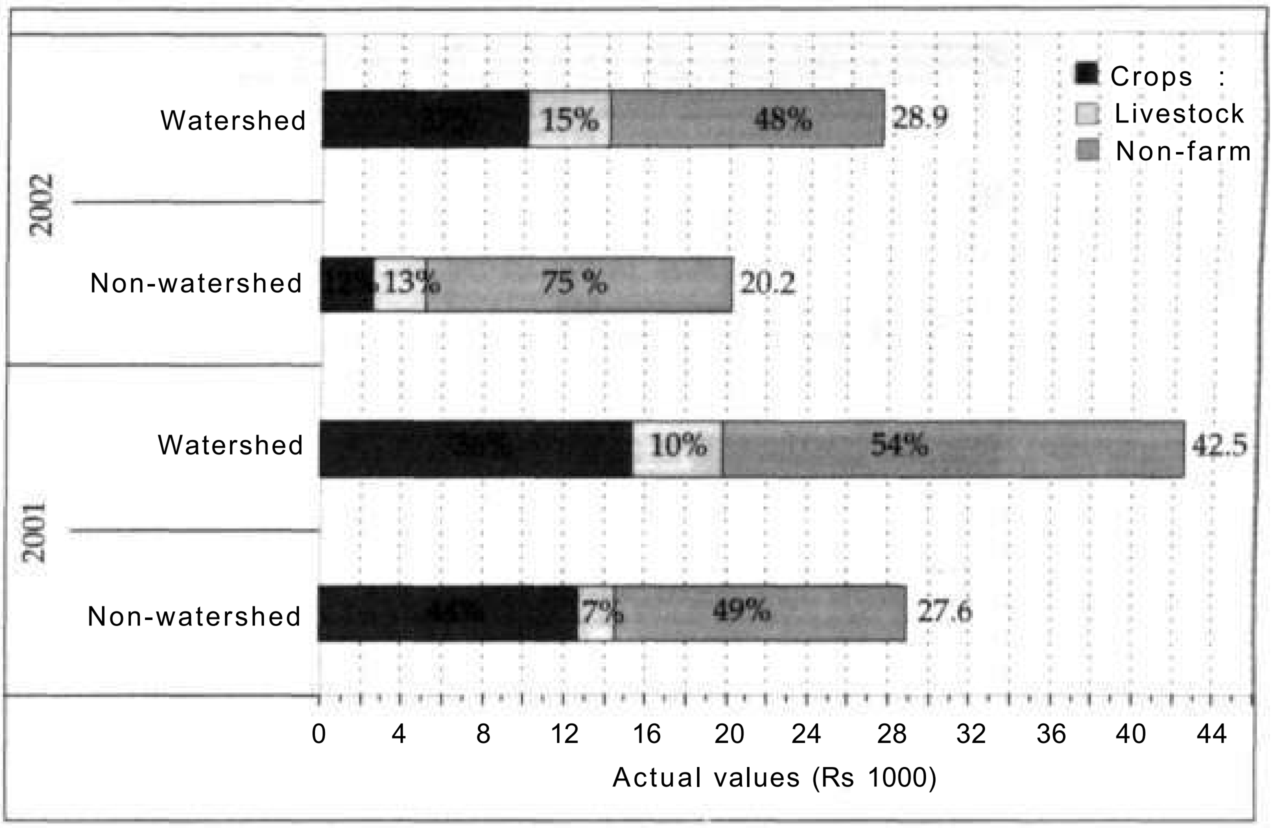

Figure 2. Effects on income sources and stability and resilience of livelihoods.

(d) Agricultural diversification and commercialization

Another potential social benefit of IWM is related to its contribution to the transformation and re-orientation of traditional agriculture towards commercial farming. Integrated watershed-based interventions that combine improved soil, water and pest management with new cultivars and livestock management options seek to address the binding biotic and abiotic constraints in the system. This reduces the pervasive production risk and improves the productivity of the system. Improved water availability helps to diversify production towards high-value products (eg, legumes, vegetables, fruits, trees, livestock, etc), boost the productivity through supplemental irrigation and mitigate the risk of drought-induced crop-livestock losses. Adoption of integrated and complementary interventions and the associated higher productivity allows hitherto subsistence or sub-subsistence level households to be able to diversify income sources and generate sizable marketable surpluses. The reduced production and market risk creates opportunities for largely subsistence farmers to begin to trust local markets and gradually reduce self-sufficiency. This would create opportunities for diversification into high-value products and enhanced market participation although risk-averse farmers may still prefer to ensure food security for products for which markets cannot be fully relied on.

A similar process of change has taken place in Adarsha watershed. An analysis of the crop choice decisions and the level of marketed surplus of sample

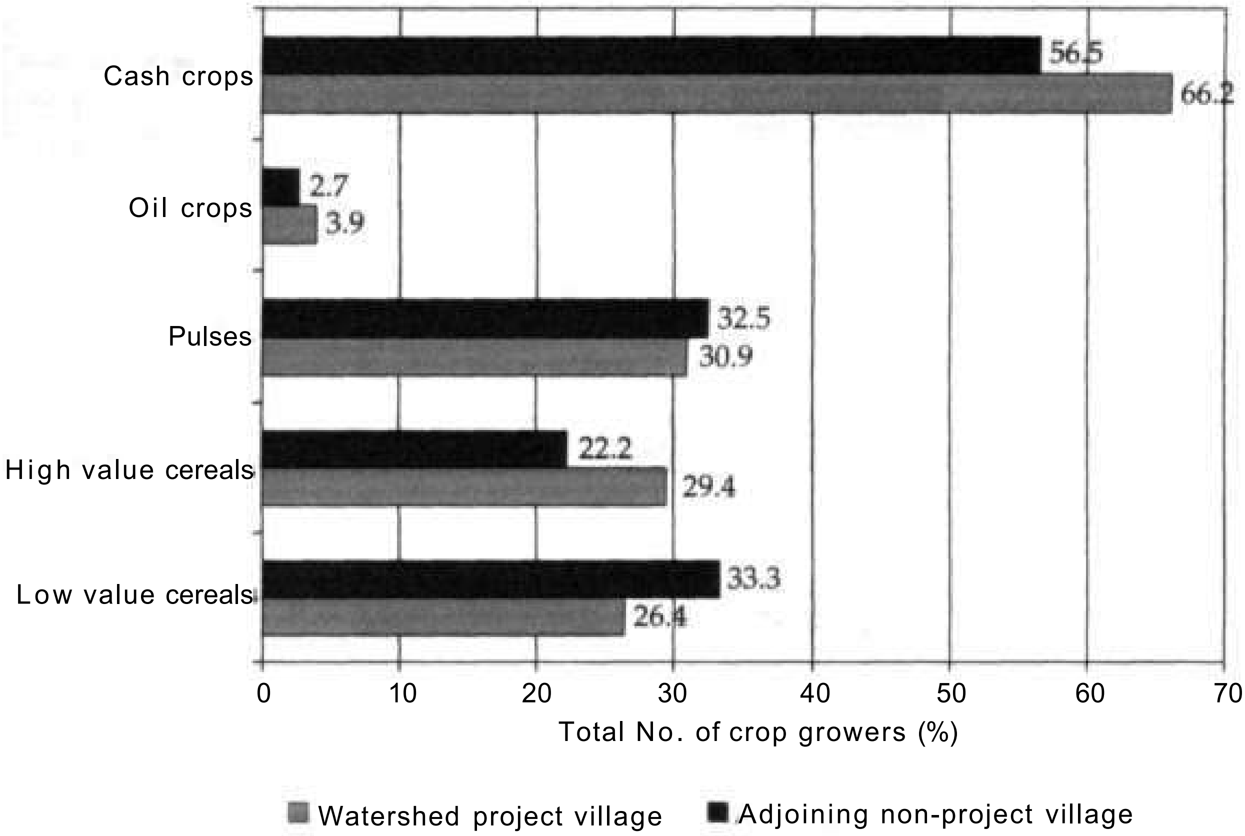

Figure* 3. *Effect of integrated watershed management on commercialization of production.

farmers support these observations. Based on census data for 2001, Figure 3 shows the percentage of farmers that grow different crops within and outside the project villages. About 26% of the growers (compared to 33% in the non-project villages) in the project village grow low value cereals (mainly sorghum). In terms of diversification into high value cereals (paddy, wheat and maize) the comparative shares are 29% within the watershed project villages and 22% in the adjoining non-project village. In general, except for low value cereals and pulses, a larger percentage of farmers in the project villages have diversified production into high value cereals, oil crops and cash crops (cotton, sugarcane, vegetables and fruits), which contributes to growth and diversification of income sources.

The drivers of change in Adarsha watershed

Preliminary assessment of data collected through household and community surveys and participatory rural appraisals show several driving factors that contributed to the success of collective action in Adarsha watershed. These include the following:

- Acute water stress
- Shared goals and common interest

- Good leadership
- Active participation in design and implementation
- Knowledge-based interventions for private benefits and equity
- Training and capacity enhancement
- A coalition of partners with a shared vision

In summary, we find that when water scarcity is a commonly felt need for the community, and when local institutions that provide good governance and leadership are in place along with knowledge based entry points and local capacity building, the community with shared goal/s was able to participate more actively in implementing the watershed program which led to significant improvements in both economic and environmental conditions in the watershed. However, there are some remaining challenges (eg, the threat of depletion of groundwater) that may influence the sustainability of the watershed interventions. There will be a need to spread the equity impacts of IWM and evolve local norms and mechanisms that help regulate utilization of groundwater.

Summary and conclusion

Smallholder farmers in the drought-prone areas of sub-Saharan Africa are poor, have low capabilities for risk taking, and are unable to invest in best practices that enhance livelihood resilience and ecosystem health, especially when such investments are characterized by long gestation periods. Experiences from South Asia and some countries in Africa show that integrated interventions for watershed management and improved access to innovations and markets can be promising strategies for diversification into high-value products, improved resilience of livelihoods and enhanced resource use sustainability. However, a watershed is a complex biophysical and socioeconomic unit that necessitates special policy support and institutional arrangements for emergence of local collective action. Whereas technical considerations justify a watershed as a suitable spatial landscape unit for intervention, social considerations and the need for collective action dictate a community or village unit as a basis for such interventions. The biophysical and social complexities and the need to harmonize the two for sustainable management of water and soil resources require suitable policy and institutional instruments that encourage and stimulate both private and collective efforts. The emergence of local institutions for collective action can help internalize externalities and reduce transaction costs that limit the incentives for individual farmers to participate in sustainable management of local public goods in watersheds. This contributes to empowerment of communities and facilitates joint investments for improving productivity and resource use sustainability at the landscape level. Hence, the community-based but landscape wide IWM interventions create synergies between targeted technologies, policies and institutions that improve productivity, resource use sustainability and market access for resource users.

India is one of the countries in South Asia that has adopted micro-watershed development as a strategy for poverty reduction and sustainable rural development in dryland areas. Experiences in semi-arid areas of India show that when property rights to collectively held resources and investments are clearly defined and beneficiaries respect the agreed rules, farmers in drought-prone areas can benefit from increased availability of drinking and irrigation water, improved availability of fodder for livestock, reduced soil erosion, enhanced sustainability and improved environmental quality (Kerr et al. 2002; Farrington et al. 1999; Shiferaw et al. 2003; Joshi et al. 2004). Such collective investments also enhance the profitability of other divisible inputs like fertilizer and improved seeds, and encourage adoption of productivity-enhancing innovations by individual farmers.

The results from analyses of panel data collected from Adarsha watershed and adjoining project villages show that IWM interventions had a significant positive effect on crop and household incomes. Even after controlling for the effect of drought, the analyses indicated higher crop income shares, higher crop and household incomes in the IWM village compared to adjoining villages that do not benefit from such interventions. This shows the vital contribution of IWM interventions in terms of diversification of income sources into high-value products and mitigating the effects of drought-induced shocks on livelihoods. We also found that IWM had accelerated diversification into high-value products and significantly enhanced the marketed surplus of smallholder farmers, contributing towards commercialization of production. However, there are several cases where watershed management had failed in India and it would be useful to understand the major drivers for emergence and sustainability of effective community action. The experience of Adarsha watershed provides useful insights on these factors. Government support for establishing key local institutions and implement tested IWM interventions in partnership with the community was a critical first step that laid the foundation for collective efforts. The incentive problems for enabling the participation of small farmers in IWM were initially addressed through on-farm interventions that improved crop yields and incomes for individual farmers. This was further enhanced through linked livelihood opportunities (eg, production of bio-pesticides and bio-fertilizers) for the landless and marginal farmers who may not directly benefit from irrigation and higher land productivity. In order to spread the benefits widely and more equitably, low-cost water recharging and harvesting structures were constructed along the watercourse. The remarkable progress made in Adarsha watershed needs to be replicated in other dryland villages across the region.

However, more work is needed to better understand why certain types of groups fail and others succeed; how governments and other stakeholders can play an active role in the process; how the benefits and costs of IWM can be distributed more equitably; how landless and marginal farmers can benefit from collective action; and how new kinds of institutional arrangements for collective action can be developed to regulate groundwater use, reduce depletion and ensure sustainability.

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Research on integrated soil and water management in semi-arid eastern and southern Africa: past experiences, current activities and future thrusts

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Introduction

The agroecosystems of semi-arid sub-Saharan Africa (SSA) have developed in response to the needs of both rural and urban populations. The traditional production systems of rural households are thought to be generally sustainable under conditions of low population pressure and lack of market integration, with system productivity geared towards subsistence (Barrow 1988; Reij et al. 1996; Barbier 1998). These systems remain in sustainable equilibrium until change, such as population growth or external economic pressures, occurs at a rate faster than can be accommodated without resource degradation (Fischer and Heilig 1998). These internal and external forces can bring about an intensification of agriculture, or an extensification into marginal lands, where the risk of crop failure, environmental degradation and loss of biodiversity increases due to inappropriate management practices that can exhaust the soils of nutrients and organic matter and leave them vulnerable to erosion (Gregory and Ingram 2000). Many of the changes taking place reflect higher community expectations and better opportunities because of integration of urban and rural livelihoods, physical (roads) and social (schools) infrastructure development, and general economic growth. The new expectations and opportunities compete for available resources for investment choices, often at the expense of investment in Natural Resource Management (NRM); indeed, they may encourage over-exploitation of natural resources.

The problem is that incentives to pursue environmentally sustainable practices are commonly lower than incentives to simply extract natural resources. The value of an additional dollar of output today is worth far more to most small-scale farmers than the value of much larger production levels in the distant future. Many developed countries have resolved this problem by paying farmers either to take land out of production or to adopt more sustainable

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practices. Unfortunately, few developing countries have the capacity to make similar investments. In fact the majority of Africa's and Asia's poorest and most food-insecure households live in the semi-arid tropics (SAT) - home for 45% of the world's hungry, and 70% of the world's malnourished children (Sanchez et al. 2005). To survive in such a harsh and variable environment, they pursue a range of livelihood strategies. Different households pursue different development paths. But almost all seek to diversify their income sources and investment strategies as a means to reduce risk and, if possible, respond to rapidly changing market conditions.

Unfortunately, commercial agriculture may be too ambitious for this group, we need a subset of technologies that specifically target food security in the poorest households and provide them diversified options for generating income through access to alternative crops, new varieties with marketing potential, and through organizational and institutional development. Correspondingly, technology delivery can be linked with the development of inter-rural markets to move food from surplus to deficit areas, in addition to being linked with the commercialization of production for sale to urban or export markets. In areas with better farming conditions and market access, research programs should focus on market-orientated production and value addition; but technologies must offer competitive returns to labor and capital compared with alternative income-earning opportunities.

ICRISAT's approach in eastern and southern Africa

To address these rapidly changing situations, ICRISAT undertook a program of global consultations with partners and colleagues from National Agricultural Research and Extension Systems (NARES), Sub-Regional Organizations (SROs), donor organizations, International Agricultural Research Centers (IARCs), Advanced Research Institutes (ARIs), newly emerging partners from Non-Governmental Organizations (NGOs) and the private sector, on the new priorities for agricultural research in the SAT (Ryan and Spencer 2001). A consequence of this wide ranging consultative process is that the ICRISAT global team revised its regional research strategies to target real development impacts on human and environmental well-being, in both the short and medium term that have been identified by the respective SROs. In an important departure from the past, the primary development strategy is not crop- or technology based, but starts with the identification of real opportunities for smallholder farmers. It then seeks to develop those opportunities into tangible benefits at the farm level by pursuing science for development, the creation of new partnerships, and by linking farmer-producers to the market chain. Simplistically multiple hypotheses must be linked to achieve impact.

ICRISAT has been involved in areas that complement (rather than displace) the activities of other stakeholders and generate widespread regional public goods and benefits. While a comprehensive description of all ongoing activities in the area of integrated management of natural resources in the region is beyond the scope of this paper, a brief description of some important on-going research activities is provided.

Climate variability management

Climate variability has been, and continues to be, the principal source of risk in rainfed crop production across the SAT. The high risk associated with variable rainfall acts as a major deterrent for the farmers to invest in expensive inputs such as fertilizers and improved seeds required to achieve higher productivity. Farmers, particularly smallholders in developing countries, show risk-averse behavior (Binswanger 1980) and adopt conservative management strategies that reduce negative impacts in poor years, but at the expense of reduced average productivity and profitability (Rosenzweig and Binswanger 1993). Much of the past research on managing climate variability has been devoted to the analysis and understanding of the complexities associated with the variability and distribution of rainfall (Sivakumar et al. 1983). However, many critical agricultural decisions must be made several months before impacts of climate are realized, making it difficult to tailor the management to the season's potential. Recent developments in the understanding of interactions between the atmosphere, sea and land surfaces, and in modeling the global climate system made it possible to predict climatic conditions months in advance in many parts of the world (Hansen and Indeje 2004). In east Africa, a collaborative effort with ICPAC (IGAD Climate Prediction and Application Centre), KARI-Katumani and ICRAF is looking into the opportunities for use of seasonal climate forecasts in farm level decision-making.

Using new tools and decision support systems

Simulation modelling that is complemented by on-farm research with farmer participation can be an efficient way of identifying critical factors and knowledge gaps and eventually facilitates application of research findings to the large variety of micro-environments that characterize the SAT. Some interesting initiatives on application of simulation models to production systems are now underway at ICRISAT-ESA. Working closely with farmers, these studies aimed at exploring complementarities between farmer participatory research and modeling in addressing soil fertility management issues at the farm level, thus strengthening the capacity of scientists and farmers to interact better by incorporating farmer participation in the conceptualization of questions, definition of variables and provision of data that can be used to construct realistic scenarios for simulation and the formulation of recommendations/options for improved soil fertility management and future research.

Alternative methods for scaling up and out

In Zimbabwe, the Farmer Field School (FFS) model has been shown to be a solid and practical mechanism to communicate new ideas in order to convince farmers that a range of soil and water management technologies offer significant benefits under their conditions, to develop skills to implement the technologies and to reduce likelihood of failure and risk. To date, 138 FFS have been held in four districts in southern Zimbabwe, in which 3,300 farmers were trained and 50,000 farmers exposed to improved soil fertility and water management practices through field days and farmer-to-farmer communication. The national extension services are convinced that FFS can be used for disseminating information-intensive technologies such as improved rainwater harvesting and soil fertility management technologies to a large number of farming groups over a wide geographical area and have adopted the approach as one of the major models to be used in the country. The future challenge is now one of long-term sustainability

Promoting watershed development through South-South cooperation

ICRISAT along with the International Water Management Institute (IWMI) is facilitating the process of developing collaborative links between East and Central Africa and the Indian Council of Agricultural Research (ICAR) to share and benefit from each other's experiences in the area of soil and water management. Initially a few exchange visits were facilitated to gain first hand experience of the technologies and approaches used by ICAR in extending the SWM technologies for farmer adoption. The watershed approach used by ICAR, where water for both productive and domestic uses is the main entry point, has attracted the attention of scientists from ECA. The holistic approach that integrates bio-physical and socioeconomic aspects, deliberate empowerment of farmers through public investment and optimal utilization of inputs made watershed programs a good example to demonstrate how soil and water conservation can be made more effective if adequate attention is paid to the availability, equitable access and conservation of water resources. A pilot watershed development program is currently being implemented in Rwanda with technical assistance from ICAR.

Conclusions

The lessons learned are that technologies and interventions need to be matched not only with the crop or livestock enterprise and the biophysical environment, but also with the market and investment environment that include functional seed systems, which are supported by regionalized breeding programs. In eastern and southern Africa, ICRISAT in partnership with the SROs have been promoting an increased awareness of integrated strategies for improving productivity, market access for smallholder farmers and sustainable management of natural resources. ICRISAT has developed and evaluated a number of low-cost soil fertility management and water conservation and utilization options that enhance productivity and reduce vulnerability to climatic variability. This has been complemented by new tools and decision support systems that facilitate identification of impact domains (technology adaptation and profitability regions) enabling market and policy options for up-scaling and wider dissemination. In order to accelerate agricultural rehabilitation and environmental recovery, innovations for soil fertility and water management have been promoted along with rural seed distribution systems to ensure farmers have access to crop varieties that improve household subsistence. Part of this work includes understanding the paradigm shifts required by public and private sector research and extension to support farmer-processor-market linkages, especially contract farming and obligation of each party involved. Plant breeders and the NRM scientists must integrate their work with the change agents (both public sector and private) so that flexible cropping systems are developed, with target groups that can respond to rapid changes in market opportunities and climatic conditions. In the long term, carefully prioritized biotechnology work, that acknowledges consumer concerns, will underpin these activities. There will also be increased focus on the NRM strategies that facilitate diversification of systems and support market-led development through integration of legumes, horticulture and livestock in the semi-arid regions. New tools and methods that allow better understanding of the temporal and spatial aspects of production risk, and which enhance the ability to cope and adapt to future climatic variability, will be developed and promoted.

With this in mind, ICRISAT has established regional research programs that emphasize integrated genetic and natural resource management, public-private partnerships, demand-led technology development, greater regional efficiency in crop improvement and dissemination, and the pursuit of sustainable diversification and intensification of crop-livestock systems for poverty reduction, food security, agricultural recovery and adaptation to climatic variability

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Watershed development and natural resource management experiences in eastern and central Africa and the need for partnerships with South Asia

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Introduction

This paper assesses the natural resources challenges for agriculture in the ten ASARECA member countries and discusses lessons learned from the past, particularly in soil and water conservation. One of these lessons is that technical innovations and technologies by themselves are not adequate to bring about increased productivity of land, water and labor. There is a need for equal emphasis on innovations in policy, marketing, institutions, and infrastructure and financing. This paper further describes the emerging ASARECA strategy to address these issues and concludes that technologically, interventions in sub-Saharan Africa (SSA) are almost similar to those in South Asia. What differs is their impact. Explaining these differences provides a good entry point for improving interventions in SSA. Equally important, many years of experience in SSA can also contribute to further development of strategies being pursued in South Asia. Therefore, collaboration and partnership between SSA and South Asia with respect to strategies for integrated management of watersheds is a strategic necessity.

The paper stresses the need to seriously consider questions such as

1. What can the SSA region in general and the ECA sub-region in particular learn from India and the rest of South Asia with respect to integrated management of natural resources (specifically land and water) for increased income and food security?
2. Did the Green Revolution in Asia follow the ability to pay for modern inputs? This is because it is evident that the Green Revolution was driven by a strategy to use high cost inputs such as fertilizer, pest and disease control and irrigation.
3. If yes, what supported the ability of farmers to pay for modern inputs, strategic public sector investments, access to financial services or attractive farm gate prices?

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4. What has been the role of strategic public investments such as rural infrastructure to improve access to the expanding urban markets brought about by the parallel industrial development?
5. How can SSA benefit from these insights about the potential of IMNR as a strategy for agricultural development?
6. Is management of natural resources (specifically land and water) for agriculture a follower or a leader in the struggle for income growth and sustainable livelihood security?

We set the scene for this debate by providing in section two a brief description of the land and water resources base for agriculture available in the ECA sub-region, with occasional reference to the whole of SSA. In section three, we review the performance and lessons learned from past investments in land and water resources development, management and conservation for agriculture in the ECA sub-region. In section four, the paper looks at the priorities identified by ASARECA with respect to management of natural resources for increased productivity and competitiveness of the agricultural systems. This leads to a discussion on how knowledge exchange between India (or South Asia) and Africa can help in setting priorities for management of natural resources in general and watersheds in particular.

Land and water resources for agriculture in the ECA sub-region

The ECA sub-region includes some of the highest population concentrations in SSA, poverty hot-spots, and is highly vulnerable to climatic variability. About 80% of the population depends on agriculture for its livelihood, which on average contributes about 38% to the gross domestic product (GDP) (see Table 1).

Land resources: in plenty but fragile

One of the key challenges for sustainable agriculture development in the ECA sub-region is that more than 95% of crop and livestock production is produced by smallholder subsistence farmers and pastoralists, mostly using low levels of external inputs. For example, the use of fertilizers (both organic and inorganic) in SSA is only one tenth of the world average (Table 2). Consequently, there is a general net removal of nutrients from smallholder fields due to inadequate replenishment. Soil fertility on smallholders' fields is deteriorating at an alarming rate especially in terms of levels of nitrogen, phosphorous and soil organic matter. Estimates at continental level show that the rate of loss of nutrients from smallholder fields are in the range of 660 kg N ha^{-1}, 75 kg P ha^{11} and 450 kg K ha^{-1} (Buresh et al. 1997). Strategic interventions are therefore

Table 1. The socioeconomic profile of ASARECA member countries.

Country	Area (000 km^2)	Pop. million	Population density (per/km^2) and population growth rate (%)	Population living below $1 a day (%) 1990-2002	GDP per capita annual growth rate (%) 1990-2002	GDP (Mill US$)	Contribution of agriculture to GDP (%)
Burundi	28	7.1	255 (2)	58.4	-3.9	719	49
Congo, DR	2,350	58.3	25(3)	41.7	-0.5	5,700	56
Eritrea	126	4.3	34(2)	59.3	1.5	582	25
Ethiopia	1,127	67.3	60(2)	26.3	2.3	5,990	52
Kenya	587	31.3	53(2)	23.0	-0.6	12,100	19
Madagascar	587	16.4	28(3)	49.1	-0.9	4,510	27
Rwanda	26	8.2	311 (2)	35.7	0.3	1,740	42
Sudan	2,506	32.4	13(2)	36.0	3.1	13,500	37
Tanzania	945	35.9	38(2)	19.9	0.7	9,380	45
Uganda	241	23.4	97(3)	36.4	3.9	5,870	31
Total	8,523	284.6					

Source: ASARECA NRM SPPS, 2004

Table 2. Comparison of regions in terms of use of manufactured fertilizers (After FAO Website).

Region	Fertilizer use kg (N, P_2O_5, K_2O)/ha 1980/81	1990/91	1997/98
Sub-Saharan Africa	8	10	9
Africa	21	22	21
M. East & N. Africa (excl. Egypt)	45	67	62
South Asia	37	80	104
East Asia, SE Asia & China	121	179	235
L. America & Caribbean	100	100	75
Developed Countries	120	112	86
World Average	88	100	100

called for to reverse these unsustainable rates of soil mining. The outstanding challenge is to design combinations of organic, inorganic and biological sources of nutrients and application techniques that enhance nutrient use efficiency by plants. This will call for crop selection, precision application and targeting of nutrients, and adequate availability of soil-moisture.

However, in some parts of the ECA sub-region, long term erosion and deposition has improved the fertility of soils located at the bottom of the topo-sequences and in alluvial plains. In countries such as Burundi, Rwanda and Uganda, these areas have great potential that is yet to be utilized, mainly due to technical difficulties in implementing effective drainage. Furthermore, Vertisols are estimated to cover some 55 million ha in the semi-arid areas of mainly Chad, Sudan, Ethiopia, Kenya, Tanzania and 11 other countries in SSA (Syers et al. 2001). Most Vertisols are inherently fertile due to their occurrence at the lower parts of the landscape where floodwater and nutrients accumulate each season, but remain largely un-utilized because these soils are difficult to manage. Therefore, facilitating the sustainable utilization of Vertisols presents one important challenge in the development of watersheds in ECA. Is this another potential candidate for collaboration and learning from South Asia which has also developed appropriate land management strategies to intensify agriculture on Vertisols?

Water resources - a major challenge

Temporal and spatial variability of climate, especially rainfall, is a major constraint to productivity growth, competitiveness and commercialization of crop and livestock systems as well as sustainable management of watersheds in ECA. The coefficient of variation of rainfall in semi-arid areas can be as high as 50% and most of the annual rainfall is often received in few rainfall events within 3 to 5 months of the year. It is common for the ECA countries to move from flood-induced disasters to drought-induced ones and back to floods again within a space of five years. Droughts following floods have been a major cause of famines affecting millions of people in the last 50 years (Table 3). A major drought affecting several countries is recorded in ECA at least every ten years with amazing regularity. The most memorable of these disasters is the 1984 famine that hit Ethiopia affecting 8.7 million people and leading to about one million deaths.

Table 3. Effects of droughts, floods and famines in SSA in the past 30 years.

Issues	Droughts related Famines	Floods
Events which were declared disasters	508	448
Number of people which were affected (million)	368	32
Number of people who lost lives (million)	1.08	0.02
Estimated cost of damages to individual and public assets (billion US$)	5	3

Source: EM-DAT- the OFDA/CRED International Disaster Database, Universite Catholique de Louvain - Brussels - Belgium (www.em-dat.net)

Therefore, understanding, adapting and coping with climate variability is an important aspect of natural resources management (NRM) for agriculture in the sub-region. Research has started to show some links between climate variability in the sub-region and prevailing oceanographic patterns in the Indian Ocean. Could this as well be a candidate for future collaborative research between India and the ECA sub-region? However, despite the climate variability problems, water is abundant in SSA in the form of renewable annual rainfall. But most of the available surface water disappears through direct evaporation from open water surfaces. The proportion of water depleted from a particular basin by direct evaporation or evapo-transpiration is often more than 60% of inflows. A classic case is Lake Victoria where water balance analysis shows that nearly all the water that falls as rain into the lake evaporates directly back into the atmosphere.

Nevertheless, the sub-region has many river basins covering an area of more than 100,000 km^2. These include the Congo and Nile rivers, which are among the largest rivers in the world. The sub-region is also home to several lakes with more than 25 km^2 surface area, including Lake Victoria and Lake Tanganyika. Wetlands are critical ecosystems in the sub-region with the Sud marshlands in Sudan being one of the largest continuous wetlands in the world. Even in highland countries such as Burundi, Rwanda and Uganda, wetlands are important components of the water catchment systems.

In general, most ECA countries have adequate water resources but face an economic water scarcity due to inadequate investments in water control structures and management systems. Only 3.2% of the total arable land in the SSA countries is irrigated compared to 38.3% in South Asia (FAO 2003). Even in the semi-arid areas there is plenty of rainwater but more than 60% of the rainwater often goes back to the atmosphere unutilized for any productive purposes. The main requirement is management interventions, which enable beneficial plants to use effectively, through transpiration, the available rainwater on the farm. However, opportunities have been missed due to the failure of many past programs to observe this simple rule in managing land and water in an integrated manner.

Management of land and water in the ECA sub-region

Past work in the sub-region has mostly focused on soil and water conservation (SWC) especially erosion control. Another focus has been on irrigation biased towards civil engineering structures for water diversion. Investments in crop-water productivity and management in an attempt to optimize field level water use efficiency has not received the requisite attention. This section reviews these trends and draws lessons.

Fertility management and improvement

Two major reviews of soil fertility management in SSA were published recently (CIAT-TSBF 2003; Buresh et al. 1997). The verdict is that fertility management requirements are well known but are hardly applied, especially by smallholders. In the 1970s, nearly every country in the sub-region was manufacturing and locally supplying inorganic fertilizers. Most of these factories have been closed down. Consequently, smallholder farmers pay almost double the world market price for imported fertilizers. Combined with low farm-gate prices for agricultural products, smallholder farmers experience a double squeeze, which explains the minimal application of inorganic fertilizers as described in the previous section. How can this vicious circle low input use and low productivity be broken? We need a better understanding of how public investments in knowledge generation, dissemination and use as well as targeted incentive systems can be used strategically to break the vicious circle.

Soil and water conservation (mainly erosion control)

Past SWC programs in the ECA sub-region were mostly oriented towards control of soil erosion to save the land, rather than the people. SWC statistics often present the extent of work rather than achievements and impact (Table 4). Recent assessments show that many erosion control systems have failed due

Table 4. An example of SWC statistics of the past - Eritrea (1992-2000).+

SWC Intervention	Units	Total (1992-2000)
Hillside terracing	km	18,394
Bench terracing	km	56
Stone bund terracing	km	29,088
Soil bund terracing	km	18,211
Fanya-juu terracing	km	4,339
Check dam construction	km	2,693
Earth dam construction	no.	80
Embankment construction	km	500
Micro-basin construction	no.	1,267,873
Diversion construction	km	39
Canal construction	km	41
Pond construction	no.	115
Well development	no.	155
Area closures	ha	195,117
Planting and replanting of seedlings	no.	61,579,666

+Source: Hatibu et al. (2001)

to poor construction and/or maintenance, but there has been very little follow-up to determine the survival rate of the thousands of seedlings distributed free to villages, schools, other institutions and individuals. This means that SWC measures have done very little to increase land productivity. These shortfalls have been reviewed by many authors starting with Hudson (1991) who identified reasons for success or failure and defined what SWC practices should offer in order to be adopted by farmers. Other reviews include Scoones et al., 1996; Pretty and Shah 1994; and Hatibu et al. 2001. This re-thinking of SWC provoked a re-evaluation of indigenous soil-and-water conservation techniques (Reij et al. 1988; IFAD 1992; Reij et al. 1996).

The question then becomes what external interventions and incentive systems can be used to increase adoption of effective practices and methods in ways, which facilitate adaptation and innovation by farmers themselves to promote more sustainable SWC practices? Two major publications have been attempted to deal with this question. An evaluation of watershed development projects in India concluded that for integrated watershed management (IWM) to succeed there is a need to adopt a "watershed plus" strategy. The term 'watershed-plus' emerged in 1998 to describe a 'new-look' in watershed projects that would step beyond their usual limit in order to address the needs of marginalized groups of people, such as those with no land, women and the poorest of the community, through integration of watershed development with activities that support capacity building, livelihood support and convergence of other schemes and services (collectively called "watershed plus") (APRLP 2004). It has been shown that access to markets contributes to the success of watershed management projects (Kerr et al. 2002). Similarly, the "more people less erosion" case study of Machakos in Kenya found that improving the road connection between Machakos and Nairobi and the canning plants encouraged increased production of vegetables, which in turn was the reason for farmers to invest in terracing and conservation practices (Tiffen et al. 1994). Such findings should inform future strategies and plans for watershed management.

Rainwater harvesting (RWH)

In situ rainwater harvesting refers to soil and water conservation practices that promote the infiltration of water into the soil (rather than only preventing erosion). Rainwater is conserved where it falls and no additional runoff is introduced from elsewhere. There are several technologies available for rainwater harvesting.

Smallholder farmers generally and rationally want to reduce the risk of crop failure due to dry spells and drought before they consider investments in soil fertility, improved crop varieties, and other yield enhancing inputs (Hilhorst and Muchena 2000). Therefore, soil-moisture shortage or variability limits the variety, quantity and quality of products that a smallholder can produce, resulting in a very narrow range of options for commercialization. Rainwater harvesting has proven to have great potential to promote the commercialization of smallholder agriculture in ways that enhance food and income security (Hatibu 2002; Agarwal and Narain 1997).

The subject of soil and water management and conservation has generated a large literature with several extensive reviews (Kiome and Stocking 1993; Twomlow and Hagmann 1998). A good example is pitting, which is commonly practised in Sahelian countries such as Mali, Burkina Faso and Niger, where shallow pits are dug in the field to increase soil surface water storage capacity and increase opportunity time for infiltration (Reij et al. 1996). A notable example in the ECA sub-region is the "ngoro" technique of the Matengo Highlands in Mbinga District of Tanzania. Many other practices have been perfected for intercepting runoff from upslope and promoting infiltration in the cropped area. In all approaches, the basic principles are simple:

1. Optimize infiltration: reduction of non-productive rainwater depletion through evaporation and run-off, while reducing erosion and increasing re-charge of groundwater;
2. Increase the water-holding capacity of soil within the root zone in order to make most of the captured water available to plants;
3. Ensure an efficient water uptake (high ratio of transpiration/evapo-transpiration) by beneficial plants through appropriate agronomic and husbandry practices; and
4. Optimize the productivity of water use by plants, in terms of product value and choice of marketable crops.

Runoff farming

A runoff farming system is technically similar to in situ rainwater harvesting, but is designed to provide more water for crop growth through the diversion of storm floods from gullies and ephemeral streams into crop or pasture land. For runoff farming to be effective, it must be done in addition to an in situ rainwater harvesting. Using this approach, many farmers in the semi-arid areas of Tanzania have changed from the cultivation of sorghum and millet to rice or maize with follow-up legume crops that exploit residual moisture in the field. This system is now widely used in nearly all the semi-arid areas of central Tanzania (Meertens et al. 1999). The system accounts for over 70% of the area cultivated with rice and over 35% of the rice produced in Tanzania. It has enabled farmers to grow a marketable crop in dry areas, providing a window of opportunity for poverty reduction. As a strategy for upgrading rainfed farming, this approach has proven to be successful under different conditions in Asia as well. Examples in India (Agarwal and Narain 1997) and in China (Zhu and

Li 2001) show that external water harvesting systems, adding runoff water to cultivated areas, are common.

Small-scale harvested water storage

The small-scale storage of harvested water improves runoff water control and complements the storage capacity ofthe soil. It helps farmers to deal adequately with the most critical problem posed by inter- and intra-seasonal variability of rainfall. Studies in eastern Africa have shown that agricultural dry spells exceeding 15 days often affect maize grown on sandy soils during the critical flowering and grain filling stages, at a frequency of three out of four rainy seasons (Barron et al. 2003). Such dry spells wipe out the benefits from crop water use. The crop could use high quantities of water for transpiration but produce very little grain and biomass at the end, leading to very low productivity of water. Small scale storage of harvested water can provide protective or bridging irrigation to reduce or reverse the negative effects of dry spells while increasing the productivity of green water flows (Oweis et al. 1999). This may include farm ponds, charco dams and small to medium size reservoirs, coupled with efficient application of the water in required quantities. On-farm research in Tanzania has demonstrated that protective irrigation to bridge dry-spells can triple returns especially when integrated with improved inputs and agronomic practices (Figure 1). The results are from a comprehensive survey of farmers' fields over several seasons. It will be noted that rainwater harvesting (RWH)

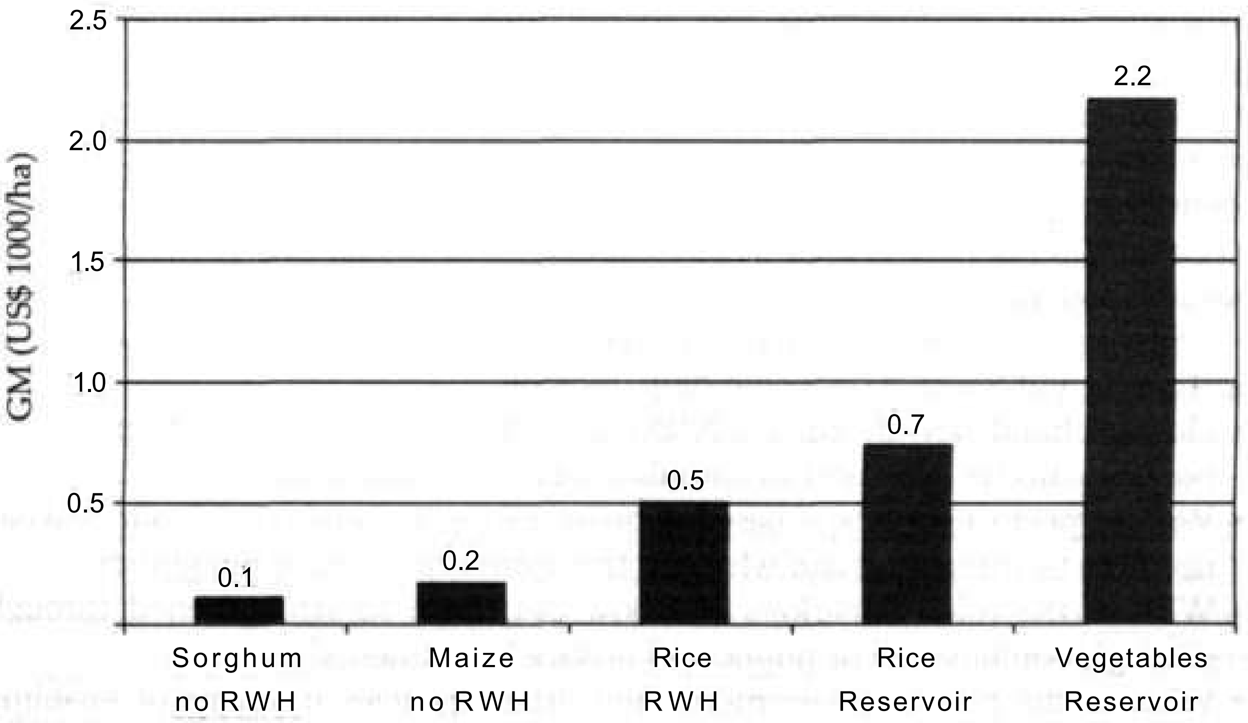

Figure 1. Improvement of gross margins with runoff farming systems (after Hatibu et al 2004).

is rarely used for sorghum and maize enterprises. Nearly all farmers who have adopted RWH with or without storage, use the water for higher value crops notably paddy rice and vegetables.

The most important and outstanding issue is that although the principles of rainwater harvesting have been known for a long period and the potential benefits have been proven, they are not widely adopted. Limited studies have shown that farmers rarely adopt innovations and technologies that do not increase their incomes or benefits compared to the traditional practices under use (Robbins and Ferris 2002).

The emerging NRM strategy and knowledge exchange with South Asia

ASARECA is currently developing a sub-regional strategy for improving management ofnatural resources and to deal with some ofthe problems described in the previous section (ASARECA NRM-SPPSC 2004). This is therefore a very opportune time for the ECA sub-region countries, individually or collectively, to learn from the experiences of India and South Asia. The emerging strategy of ASARECA was discussed by regional stakeholders in October 2004, and it contains three main thrusts for ensuring a focus on "resource-to-consumption" management. The concept of "resource-to-consumption" describes a chain of integrated management of natural resource base, production, postharvest operations, marketing and attention to consumer needs.

The thrust on *NRM and agro-enterprise development* is driven by the realization that management and conservation of natural resources cannot be separated from economic development and poverty reduction. There is a need to increase the understanding of the potential held in agroecosystems with respect to agricultural production and environmental services and then to identify and promote agro-enterprises that enable NRM to contribute effectively to poverty reduction, economic development and sustainable management of natural resources.

Some critical questions, upon which exchange of knowledge and experiences with India and South Asia would help, include:

- How profitable are alternative NRM innovations to smallholder farmers and how can this be increased to stimulate large-scale adoption?
- With respect to landscape-based approaches (eg, watershed or basin) - what needs to be integrated and what are the optimum levels of integration?
- What is the role of markets and how can these be strengthened through strategic combination of public and private investments?
- What is the role of governments and other agencies in terms of enabling policy environments or incentive systems that support private investment in NRM?

- Do environmental services and externalities of improved management of agroecosystems justify public investments, and what are the accounting procedures?

The thrust on *policies and institutional frameworks* is central because technical solutions are well known but hardly implemented (WEHAB 2002). There is a strong nexus between lack of markets, poor infrastructure, low agricultural investment and pervasive poverty in rural areas. Farmers in poor areas lack the incentives to produce marketable surplus because there are no accessible markets and agro-industries; private sector participation is very limited by lack of rural infrastructure; governments' investment in rural infrastructure is low because of the low production volume; and so on. This is where we need to deal with the question, is NRM a follower or leader in the sustainable development? Asia's experience in relation to the role of the following issues would be useful to the ECA sub-region:

- Strategic public investments - otherwise known as subsidies
- Secure access, control and tenure by local managers of resources
- Institutions and local organizations, and their powers and authorities in planning, implementation and evaluation
- Inclusiveness in negotiating policy, strategies and regulatory frameworks

The thrust on *capacity building and knowledge management* for the ECA sub-region was designed to ensure

- adequate human resources at all levels from resource users to policy makers for ensuring innovations and adaptation;
- a better and well-informed framework for decision and choice making at all levels - through improved availability of knowledge and its management and utilization;
- leveraging more benefits from existing knowledge from both research and field experiences including indigenous knowledge; and
- increased linkages between research, development and training in NRM.

It can be seen that in all the three thrusts of the emerging ASARECA strategy, there will be considerable benefits of evaluating the evidence from South Asia with respect to how past and current investments in NRM and watershed management have contributed to the recorded improvements in production, poverty reduction and economic growth. There is a need to learn from both positive and negative experiences since doubts have been raised about the social impacts of NRM in South Asia, especially with respect to equity in access and sharing of benefits (van Koppen et al. 2002). These lessons are required to assist in forming a consensus on how natural resources can be managed at field, watershed and basin levels in ways that minimize costs while maximizing economic, social and environmental benefits to individual farmers and communities.

Conclusion

Technologically, countries in SSA have attempted almost similar interventions for soil and water conservation as those implemented in South Asia. What has been different is the impact of these interventions. Explaining these differences will be a good entry point for formulating strategic development pathways in ECA and SSA at large. Equally important, many years of experience in SSA may also contribute to further development and refinement of strategies being pursued in South Asia. Therefore, collaboration and partnership between ECA (or SSA at large) and South Asia with respect to strategies for integrated management of watersheds is a strategic necessity of paramount importance. One critical issue would be an assessment of best bets with respect to policy and institutional frameworks, which seems to have been a strong factor in the relative success of NRM strategies registered in India and other South Asian countries, and perhaps the main contributor to the failures observed in SSA.

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Acknowledgment

This paper draws very heavily from the work of the Soil-Water Management Research Group of the Sokoine University of Agriculture, Tanzania. It also uses analyses made by the NRM stakeholders of ASARECA in the process of formulating the NRM strategy of ASARECA. All these contributions are acknowledged. We also wish to acknowledge the commitment of IWMI, ICAR and ICRISAT to the initiative to develop partnership for mutual learning between India and ECA.

Integrated watershed management experiences in eastern and central Africa: Lessons from Ethiopia

Gete Zeleke[1]

Introduction

Ethiopia is one of the well-endowed countries in sub-Saharan Africa (SSA) in terms of natural resources and valuable diversity in the production environment. Its location in the tropics coupled with impressive altitudinal variations within short ranges allows the country to enjoy both temperate and tropical climates and this gives a wealth of biophysical resources including relatively fertile soils, biodiversity and fresh water resources. For millennia, this rich natural resource base has been serving as the foundation for agricultural development and for meeting the food security and basic needs of the rural population in the country. However, the country has been affected by the interlinked and reinforcing problems of land degradation and extreme poverty, both of them supported each other and further aggravated by high population pressure (currently about 72 million), are susceptible to recurrent droughts and stagnation of agriculture.

A cursory investigation of the land degradation processes in Ethiopia, mainly in the highlands, shows that every year billions of tons of soil are detached from the soil mass. Land degradation caused mainly by soil erosion and nutrient depletion in much of the highlands of Ethiopia has reached a stage where it is increasingly difficult to even maintain the present day production of basic foods, a level that is already insufficient in some regions (Zeleke 2005). According to the EPA (1997), approximately 17% of the potential annual agricultural GDP of the country was permanently lost because of physical and biological soil degradation. The dominance of cereal production in the farming system, which accounts for about 73% of the total cultivable area (Ezra 1997), greatly contributes to soil degradation. Most of these cereals, particularly teff and wheat, need fine seedbed preparation and provide little ground cover during the most erosive storms of June and July. This situation combined with poor land management practices and the consistent push of cultivation towards increasingly marginal areas due to population pressure (Figure 1), contributes to high soil loss rates and significantly reduces the productivity of land. Shortage of land pushes farmers to the very last remaining marginal areas.

1. Environmental Economics Policy Forum for Ethiopia, PO Box 2479, Addis Ababa, Ethiopia (formerly Advisor, Environment and Natural Resource Management, World Food Programme (WFP), Addis Ababa, Ethiopia)

Figure 1. An example of very steep land deforested and cultivated with traditional farming implements in the North-western highlands.

Moreover, the steadily increasing population with persistent need for food, firewood and building material, over the centuries, led to the clearing of vegetation cover from the landscape and exerted more pressure on an already fragile environment. Consequently, considerable damage has been done to the ecology in many parts of the highlands, some beyond recovery. There is a strong nexus between land degradation and worsening poverty in the country (Grepperud 1996; Holden et al. 1998; Shiferaw and Holden 1998). Rural poverty is typically linked to the loss of soil productivity and forces the poor to depend more on scavenging the remaining natural resources inducing more degradation and damage to the ecology. As a result, the high forest cover is currently reduced to about 2.4% of the total area compared to the estimated 40% initial coverage of the country (Tedla and Lemma 1998). Even then, the remaining forest is being depleted at an estimated rate of 80,000 to 200,000 ha per annum (EPA 1997). This is partly attributed from the fact that nearly 95% of the total energy consumption originates from biomass fuels such as fuel wood, cow dung and crop residue. Moreover, burning of cow dung as a source of fuel (Figure 2) instead of using it as a soil conditioner, which was pushed by shortage and/or lack of fuel wood and alternative energy sources, is considered to cause a reduction in grain production by some 550,000 tones annually (EPA 1997). Similarly, the scarcity of grazing land and the shortage of livestock feed has forced widespread use of crop residues for feeding livestock.

Figure 2. Animal dung has high value as a source of fuel and the crop residue as a source of feed for livestock.

Land degradation is a long-term and salient process where its effect and steady expansion is hardly noticed until it manifests itself with disastrous drought and famine. That is why the policy attention to the problem was very little until the 1974 drought, although it has not still received policy support commensurate to the high risk it poses to current and future livelihood security. Often land degradation is only associated to the tonnage of soil loss per ha. It is in fact the loss of productivity, which is more damaging as erosion removes the most fertile top soil, along with soil nutrients, organic matter, reduced soil depth and soil moisture holding capacity. However, the use of fertilizers without proper soil and water management practices can mask this effect especially in areas with relatively deeper soil depth (Shiferaw and Holden 2004). This resulted in the degradation of many high potential areas, which could have been avoided with the use of proper land management practices.

Considering the above complex and interwoven problems ofland degradation and poverty, it is, therefore, self-evident that for Ethiopia, characterized by subsistence agriculture, extensive land degradation and chronic food insecurity, a conservation-based agricultural development strategy following an integrated watershed management (IWM) approach is not just an option, but rather an indispensable element of all development efforts. It was with this understanding that massive soil and water conservation programs were initiated in the 1980s.

However, past extensive soil and water conservation programs had largely failed due to poor planning, poor design of structures, lack of participation by the communities, inappropriate conservation methods, poor linkages with livelihoods of the poor and lack of an integrated approach that goes beyond soil conservation to address the interlinked productivity, market access, land policy and resource management problems (Shiferaw and Holden 1998). Based on the lesson learned from earlier approaches, some new projects however adopted a more integrated approach leading to improvement of resource conservations and the livelihood of the people. A case to mention is the MERET project, which has been implemented and supported by the Ministry of Agriculture and Rural Development (MoARD) and financed by the World Food Programme (WFP) of the United Nations.

The main purpose of this paper is, therefore, to highlight the extent and severity of land degradation, evolution of the resource management approach, and to review some experiences on IWM in Ethiopia. Although the effort applied to address problems of land degradation and food insecurity in the country is diverse, and many smaller successful experiences exist, this paper will largely focus on the experiences of Managing Environmental Rehabilitation on Transition to Sustainable Livelihoods (MERET) and Soil Conservation Research Project (SCRP) on the development and research side respectively. It will also attempt to raise some salient points on major constraints in relation to limited coverage of IWM practices as compared to the magnitude of land degradation in the country.

Research and development experiences of IWM in Ethiopia

Experiences in development: the case of MERET project

Following the 1974 famine that killed about a million people, the government launched a massive soil and water conservation program in many parts of the country in the 1980s as a way of redressing the degradation of the natural resource base and increasing land productivity. The major part of the initiative, which was led by the then Community Forestry and Soil Conservation Department (CFSCD) of MoA, was supported by the WFP through its Food-for-Work Land Rehabilitation Project (ETH 2488). The activities of the project were concentrated on selected large watersheds located mainly in the highly degraded parts of the highlands of Ethiopia. The project was following "top-down" planning approach where *technical correctness* played a significant role rather than sustainability and acceptance by communities.

During the late 1980s, it became apparent that the "top down" approach to development that focused on technical and physical works alone would not lead to the desired environmental objectives. Moreover, focusing on large watersheds has resulted in less participation of communities, dilutes efforts and creates problem on the sustainability of activities. It was then realized that watershed development needed to be more participatory, taking into account community and household concerns and should focus on smaller watersheds. Based on the above considerations, the project was re-oriented to follow a more participatory approach on a smaller watershed scale, called minimum planning approach. In 1993, the WFP and the Ministry of Agriculture, based on earlier soil and water conservation experiences, produced a set of guidelines known as the Local Level Participatory Planning Approach (LLPPA). With WFP support, the LLPPA was tested in various agroclimatic and socioeconomic conditions before being scaled up in 1994-95 through large-scale training of trainers and grassroots level development agents (DAs) in over 60 districts (woredas). To date, this is expanded to 74 woredas.

The focus of LLPPA was on people-centered watershed development aimed at tackling severe problems of land rehabilitation. The guidelines incorporated good practice such as awareness raising, participatory planning and community participation. This approach changed the whole picture of soil and water conservation in the country where quality, sustainability, livelihood and environmental impacts of measures were more highly valued than fulfilling quotas. Based on the field experience, this approach was revised four times to accommodate new technologies and methods until it heavily contributed to the birth of the National Participatory Watershed Development Guideline in 2005 (Desta et al. 2005).

Towards the end of the 1990s, the concept of "sustainable livelihoods" began to emerge, with a focus placed on better understanding of household dynamics, livelihood sources and the coping strategies used within the rural community. A greater awareness was reached that food security and rural development could only be addressed through actions aimed at increasing food availability and access at household level. The livelihoods focus saw people displacing technical solutions that do not provide quicker livelihood benefits, and resulted in the introduction of a broader and more diverse set of interventions that meet people's livelihood and environmental objectives.

This background paved the way, in 2002, for the fourth phase of the WFP Food-for-Work based environmental rehabilitation program, under the name MERET that strengthened the 'people centered' focus on participatory Natural Resource Management (NRM) and income generation (Barry et al. 2005). Within the MERET design, special effort was exerted on enhancing the capacity of rural communities to organize them to plan, manage and implement broad-based, community-wide activities for conservation and land rehabilitation. In comparison to previous land rehabilitation initiatives strong emphasis was placed on household income-generating activities. The focus on household and community asset building proved to be an important stage in the evolution of the project itself and the thinking behind IWM.

According to the recently conducted mid-term evaluation report (Barry et al. 2005), MERET has reached nearly 1.3 million people in five regions. It operates in 74 woredas covering more than 600 sub-watershed administrative sites-with between 300 and 2,000 participating households in each site. It has rehabilitated over 300,000 ha and enhanced the institutional and technical capacities of participating rural communities in those areas to plan and implement programs centered on their own human resource contributions. These sub-watersheds were planned using LLPPA and implemented according to the plan. Every year the achievement and the plan are evaluated by communities using the participatory evaluation and planning (PEP) approach. The later ensures ownership, helps to disseminate good practices, allows community members to learn from each other and adopt new technologies, and it helps them to look back and see differences and benefits. Both the planning and implementation process as well as the above mentioned evaluation systems are the key to the success of the project and its wide coverage.

Some of the strengths of the project are the use of various resources, including the (FFW), systematically following the action plan developed by the community. Except in few areas where it is possible to make clear distinction between the most vulnerable and better off farmers, members of the watershed community are entitled to benefit from the FFW The original approach was also designed to include both private and communal lands within the catchments, the only major distinction being the type of treatment needed. However, the individual farmers are obliged to contribute free labor, in most cases 20 days in a year but vary depending on local level decisions, and take responsibility for managing public investments undertaken on their plot of land.

The major achievements of the project since the phase commenced have been the terracing of 130,000 ha of farmland and 11,500 ha of hillsides and the stabilization of 3,500 km of soil and stone terraces and 2,700 ha of gullies with vegetative measures. Some 317 million seedlings have been produced, 11,705 ha of trees planted and 26,843 ha of land closed to grazing or browsing animals. Survival rate of tree seedlings and regeneration of closed areas showed significant improvements because of the use of the application of different moisture harvesting structures (Trenches, Eyebrow-basin, Half-moon Micro basins, etc), which was not the case in the past. These achievements were also made possible by major physical asset construction: cutoff drains, waterways, access roads and road maintenance. Efforts have been taken to address the severe problem of water shortage and lack of access for household and livestock uses. Ponds and springs, minor farm dams, and sediment storage dams have also been constructed. The project has expanded its activities and has introduced water-harvesting structures for crop production and to improve the survival rate of trees planted. Forage seeds, of local and improved varieties, have been produced in seed multiplication sites and distributed to farmers in project areas. Homestead development has been piloted and scaled up. Seed networking and diversification initiatives have started in all regions, and increased attention has been placed on watershed interactions. Community-wide activities have been initiated on a wide scale for the development of nurseries.

A major benefit attributed to MERET has been an increase in agricultural production because of improved soil depth, increased water availability, and land reclamation. Another benefit has been improved soil fertility and productivity resulting from improved moisture retention and nutrient recycling. Moreover, it should be realized that without the introduction of the conservation measures, returns to agricultural production would have gradually declined. Therefore, the conservation of the natural resource base by itself has also value.

Another benefit has been the production of forage which, together with the availability of water, has resulted in improved livestock productivity and reduced labor demands in water and forage collection. The project is also helping diversify household incomes through the pilot homestead development program where various income generating activities linked to the natural resources conservation and development effort were introduced on selected project sites. These activities include compost making, bee keeping, vegetable and fruit production, multiplication and sale of grafted fruit and tree seedlings, backyard forage development, and small-scale fattening. These economic and environmental benefits need to be assessed properly to evaluate the full social impacts of the project.

The project has placed special focus on capacity building of regional and woreda technicians and DAs. Staff members have been trained in local level participatory planning (LLPPA), soil and water conservation, NRM, community infrastructure and participatory monitoring. From the outset, the project has considered capacity building as an essential, and central element in the rehabilitation of rural lands. Training has also been conducted for farmers and community members.

In general, a cost-benefit analysis conducted early in 2005 indicated an economic rate of return in the MERET activity of 13.5% over a 25-year time frame. The figure strongly suggests that the project as a whole is economically viable. At farm level, the results were also positive, showing that many of the soil and water conservation measures on cultivated land were profitable from the farmers' perspective (FAO/WFP 2004). Moreover, the analyses also showed positive environmental impacts in terms of reduced soil erosion rates (and hence deeper soils) on cultivated and communal marginal lands (Figures 3 to 5).

Although MERET is successful in most of the project sites, it needs to be viewed against the complex nature and overall scale of the food insecurity

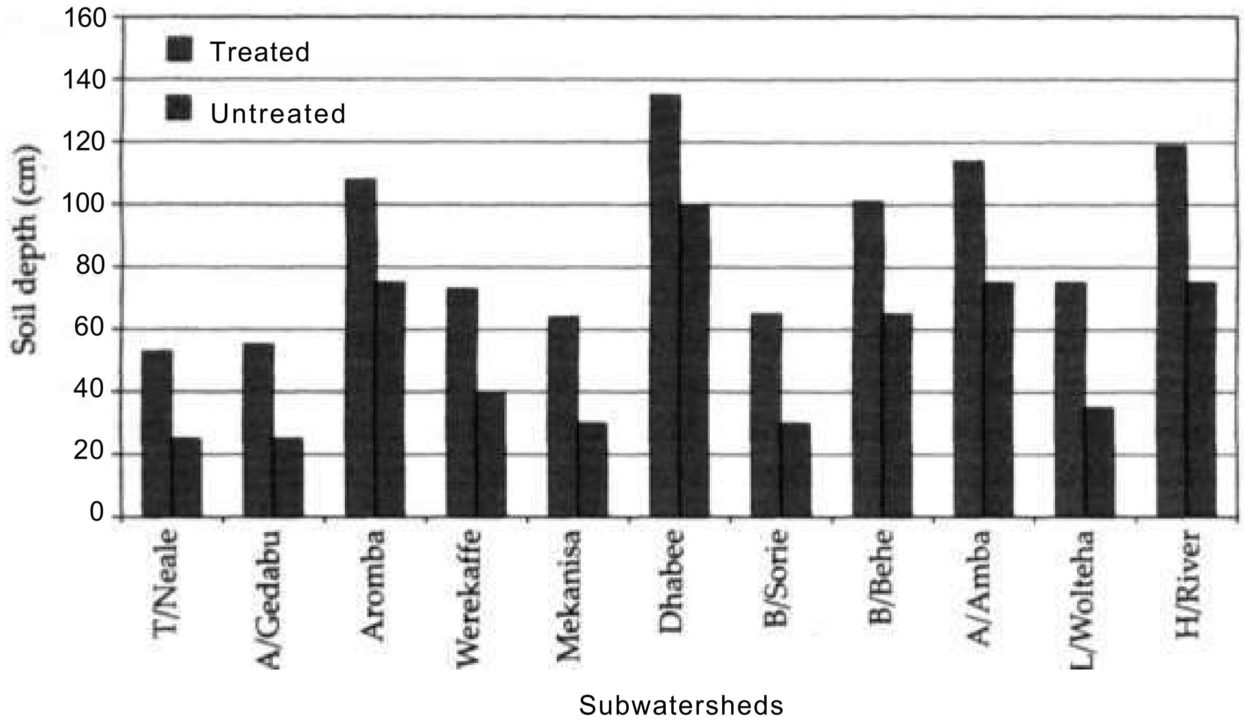

Figure 3. Soil depth as a function of SWC measures in 11 watersheds of the MERET project covered by the CBA study. Source, FAO/WFP, 2004.

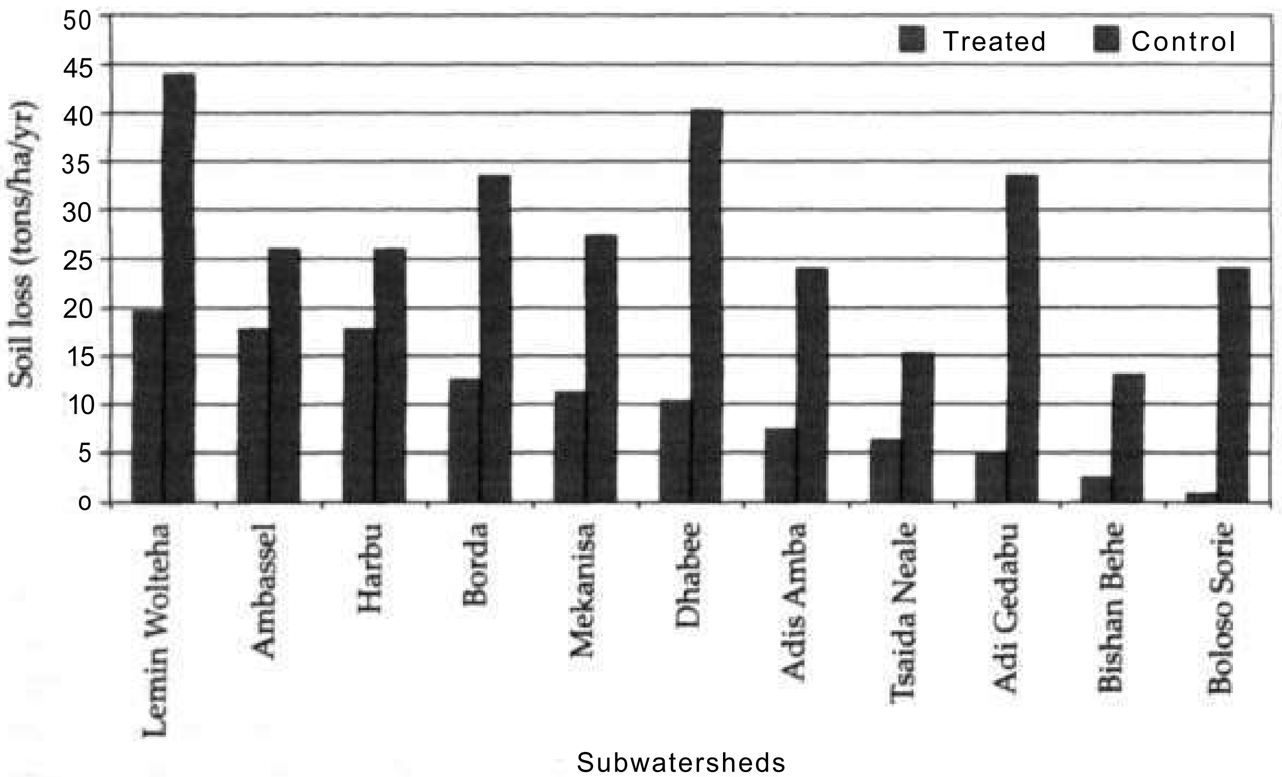

Figure 4. Estimated annual soil loss on treated and untreated cultivated lands in the 11 watersheds covered by the CBA study. Source, FAO/WFP, 2004.

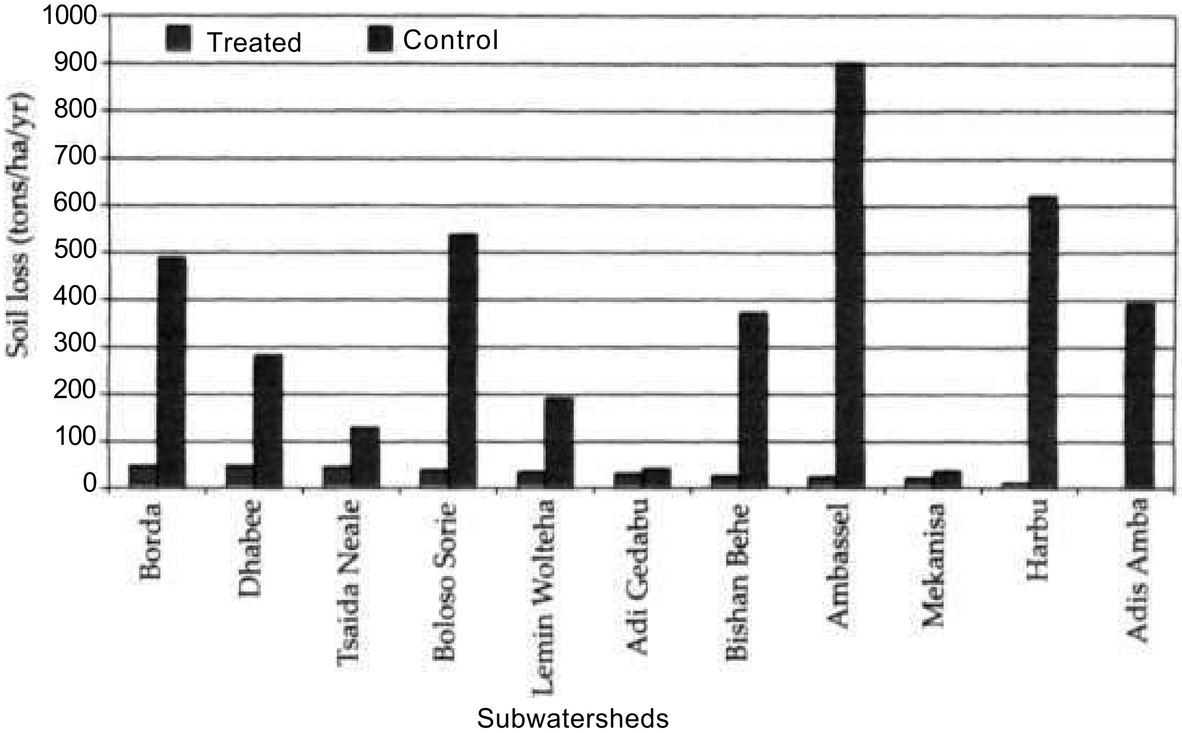

Figure 5. Estimated annual soil loss on treated and untreated marginal lands in the 11 watersheds covered by the CBA study. Source, FAO/WFP, 2004.

and environmental degradation problems in the country. MERET activities are limited to covering only 28% of the food deficit woredas, 9% of the kebeles (local administrative units) and only 4% of the chronically food insecure households. Apart from this, none of the high potential areas is covered by this project. Accordingly, the magnitude of the task in arresting land degradation at national level is still enormous. The size of the problem and the rate at which it is growing, taken within the context of the resource constraints in Ethiopia, implies the need for massive external assistance and scaling up of MERET's IWM experience to the rest of the country.

Moreover, looking into those watersheds where MERET is not so successful one finds the following reasons: (1) lack of institutional commitment (the implementing office at region and woreda level), (2) staff instability and frequent restructuring of agricultural offices, (3) limited capacity at woreda level which lead to improper application of the methodology, and (4) lack of sufficient community participation and the top-down culture in the extension system. In some cases, high levels of environmental degradation and recurrent droughts also contributed to the failure in some of the conservation measures.

Experiences of research on IWM in Ethiopia

Although the experience of research on IWM has not been as extensive as development, there are some efforts in the country. Some of them, in this case, the soil conservation research project (SCRP) were designed only to provide appropriate information on the process of land degradation, biophysical and socioeconomic processes, impact of conservation measures and their appropriate design under the different ecological settings, but had few elements of community participation in the research set-up. However, the SCRP had wider coverage and huge experience in the country. Others tried to combine both but have very little experience and coverage, such as the initiatives by EARO, ILRI and AHI. Therefore, this paper will provide brief accounts of the experience of SCRP and others on IWM in the following section.

Experiences of SCRP on IWM

As mentioned above, the extent of the impact of land degradation on soil productivity in Ethiopia was fully realized after the 1973/74 drought-driven famine. To reverse the situation, and thereby to rehabilitate degraded areas, the government launched very extensive soil conservation programs throughout the country. In light of this program, the soil conservation research project as initiated at the national level, with the objective of supporting the national effort by providing the necessary data for the proper implementation of soil and water conservation measures and building the national capacity to undertake research in the area of soil and water conservation.

The project was initiated by the Institute of Geography at the University of Berue (Switzerland) in close collaboration with the Ministry of Agriculture (Ethiopia). In 1981, the first research site was established at Maybar in South Wollo Zone in the northern highlands. Since then, SCRP has expanded its horizons and a number of research units reached seven by 1988, distributed over the highlands of the country. Each research unit was selected to represent an agroecological zone in the highland of the country and comprises a small catchment typical of the agroecological zone.

Although the project has very little element of community participation in the planning process, which is one of the very important elements of IWM, it provided extremely useful information on the biophysical and socioeconomic process in the country to help informal decision-making in conservation planning and implementation. The following are some of the major tasks undertaken by the project:

1. Monitoring of erosion processes: erosion processes under different soil, slope and traditional management conditions were monitored by installing Test Plots (hereafter TP) and Micro Plots (hereafter MP) of 30 m^2 (2 m x 15 m) and 3 m^2 (1 m x 3 m), respectively. Using these plots soil loss and runoff were measured based on standard criteria. Hurni (1984) has provided in-depth discussions of the research set-up and measurement procedures.
2. Measurement of catchment discharge and sediment yield: the amount of runoff and sediment leaving the catchment was monitored using a

combination of methods at the outlet of the small catchment. Detailed procedures of sampling and data analysis are described in Hurni (1984) and Bosshart (1997).

3. Monitoring the impacts of soil and water conservation measures: the impacts of different soil and water conservation measures were monitored on 6 m x 30 m (180 m^2) plots. The main goal was to select technologies that perform best in the agroecological zone under consideration. The impact of these measures on reducing soil loss and runoff, on production and biomass, and soil depth and fertility together with their cost effectiveness was monitored on a continuous basis. In most of the stations, level and graded bund, level and graded *Fanya Juu,* and grass strips were installed at all stations. At Anjeni, since it is a high rainfall area, only graded structures and grass strips with a control plot were installed. Whereas in Afdeyu, which is a low rainfall area, only level bund and level Fanya Juu and a level double ditch were used. During that period, only level soil and stone terraces were implemented all over the country and the project was trying to support the effort with scientifically checked designs and impacts for the different agroecological zones.
4. Recording climate variability: Each station was equipped with a small climate station and supplementary observation points. Rainfall, temperature (air and soil), wind (strength and direction), radiation, humidity, evapo-transpiration, and other additional climate variables have been continuously monitored in each research unit.
5. The data were collected under two conditions; the first was through the standard program, where demographic data focusing mainly on age, sex and herd size of the household were collected. The second was through supplementary programs where the socioeconomic and cultural background of some of the stations and the areas around are addressed in various studies.
6. Monitoring land use and land cover changes: spatial and temporal land use and land cover changes at catchment level (1:5000 scale) have been monitored annually for unimodal rainfall areas and twice a year for bimodal rainfall areas.

The project was operational from 1982 to 1996, with some minor discontinuities in 1990/91 due to social unrest. After 1996, the project was formally closed but the government took over and continued the monitoring process.

Other experiences (EARO, ILRI, AHI, etc)

It is difficult to provide a comprehensive review of the activities of several agencies. However, an attempt is made to highlight some of the ongoing and completed activities undertaken by the major organizations. The group tried to integrate research and development within a smaller watershed and tried to monitor progress, both biophysical and socioeconomic changes. They set a procedure to identify problems and priorities together with communities within the watershed. The identified problems are also clustered based on similarities and development intervention as well as research areas identified from each cluster (Ginchi Site Team 2004). This is an ongoing process where the group tried to develop a system to use a watershed (landscape) as a research unit unlike the previous plot-level research approach.

Some agencies use the 'entry point' concept to enhance participation and confidence building within local communities on technologies and approaches. This is a kind of step-by-step approach where the research group together with communities tried to identify immediate needs and jointly test and adopt entry point technologies and innovative ideas in response to their immediate needs and priorities. This approach resulted in the uptake of system-compatible technologies aimed at boosting agricultural productivity in the watersheds and encouraged farmer participation in solving more complex problems (Mazengia et al. 2005). The whole process of technology adoption, and changes on the ecosystem and socioeconomic conditions are investigated - one of the strengths of the approach. The lessons learnt from these approaches hopefully will be transferred to the extension and development sector of the government and offer development partners (eg NGOs) for wider application.

Although the effort applied by the researchers to understand the IWM process right from the planning process is important, it would have also been used to focus on understanding the integrated watershed development processes within the country by different actors. That would have helped to identify the limitations and potentials of different approaches to build on positive results and up-scale successful practices.

Constraints

Lack of experience in good practices

The country was exposed to serious famine and high population pressure while the attention accorded to land degradation and the national capacity to address the problem was very low. Apart from some traditional conservation measures, there was little or no effort in applying proper soil and water conservation measures in the country. When it was realized that one of the major causes of the 1974 famine was land degradation, the government initiated a massive campaign on soil and water conservation throughout the country. However, both the experts and the community lacked experience in effective methods and greater damage was made on the landscape by adopting conservation measures that were not properly designed. The IWM concept was introduced lately after realizing the failures of the past technocratic approach. Even to date, one of the major constraints is that much of the focus by different actors (donors, government and NGOs) in relation to arresting land degradation through IWM is concentrated mainly on already degraded parts of the country. Because of this, the experience of planners and communities to prevent excessive degradation on better off areas, called 'high potential areas' is still very low.

The relative neglect of high potential areas on land management

Land degradation is not a problem only in chronically food insecure districts. The rate of soil loss and runoff in high potential areas like Anjeni (Gojam) is very high (Figure 6). The long-term annual soil loss rate from cultivated lands in these areas reached up to 170 t ha^{-1} (Zeleke and Hurni 2001), which is one of the highest rates in the world and threatening the future of agriculture and livelihoods in these areas. Nearly 50% of the rainfall is lost as a runoff along with a huge suspended sediment load. As much of the land in high potential zones, is cultivated without proper soil and water management practices. These areas will soon become degraded and could very rapidly become food insecure.

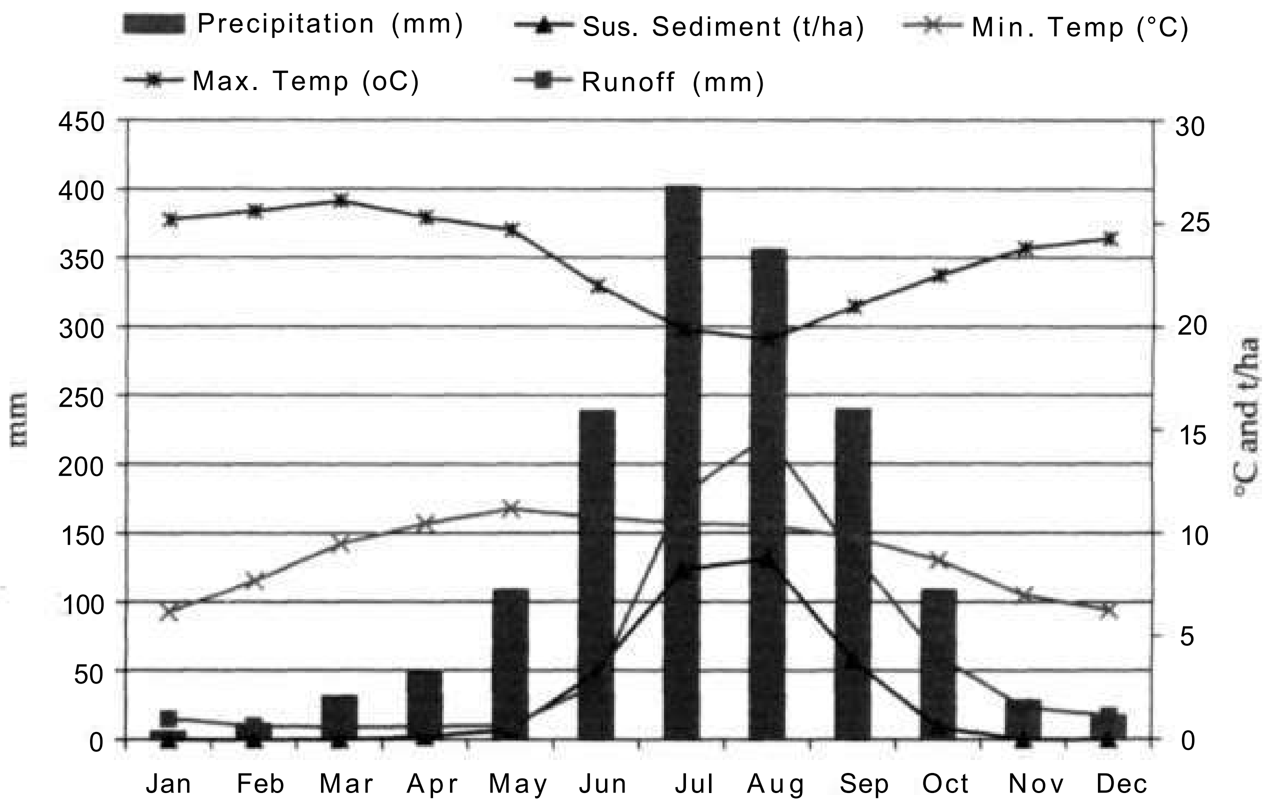

Figure 6. Average monthly precipitation (10 years), catchment runoff and suspended sediment yields in Anjeni watershed, Gojjam (Zeleke 2000).

From an economic perspective a strong argument can also be made for investing public funds in these areas as the returns from investment are likely to be high while maintaining the capacity of the major grain baskets for food security in the country. The need for conservation-agriculture is just as relevant in these areas as they are in the food deficit woredas. Some of the better and more productive lands in watersheds may need lower levels of external donor support whilst the impact and benefits could be high. Efforts should be directed towards areas where timely intervention can arrest the ongoing degradation before it becomes irreversible, or, where land use practices are clearly non-sustainable prevent it from occurring in the first place. Attention here could be placed on strategies that are more protective.

Lack of a more holistic and participatory extension approach

The agricultural extension system in the country has been highly biased towards crop production and emphasis given to natural resources in general has been very low. Except in areas assisted by projects, very little consideration has been given to soil and water management as part of the agricultural production system. Moreover, the extension system has been continuously modified or entirely changed with very little consideration or total neglect to the lessons from the past. Together with this, the institutions responsible for agricultural extension have also been frequently restructured leading to lack of continuity in long-term impact NRM activities and projects, and instability in the trained manpower. Moreover, the extension systems that have been pushed so far in the country are top-down in nature where the quota system plays a more significant role rather than participation and community ownership. The reporting system itself focuses on what was planned and proportion of achievements rather than on impact and sustainability.

Weak linkage between research and extension

In addition to the very weak emphasis given to IWM by the research system, the linkage between research and extension has been very weak. The national agricultural research like that of the extension system has been very much crop biased. It focused more on plot-based research and few examples exists where watersheds were taken as a research unit. Because of this there was very little results or experience on IWM that could be transferred from the research to the extension system. The lessons from the few successful pilots have not also been synthesized and communicated to policy makers to form part of the agricultural development and recovery strategy.

Government policies and strategies

The land tenure system has been and is still a major setback in enhancing proper land management in the country. Since land belongs to the state, there has been frequent redistribution and lack a sense of secure system of rights, which deters long-term investments in tree planting, land and water management. Moreover, the frequent land redistribution and lack of a clear land use policy in the country, pushed farmers to cultivate marginal areas without any protection measures. On top of this, implementation of policies and strategies designed to protect natural resources and the agroecosystem have been very low. In general, one would conclude that the level of attention given to natural resources compared to the level of ongoing degradation in terms of policy and strategy, is very low. This could be partly related to lack of knowledge on the rate of land degradation and its consequences in the country at different levels.

The way forward

The review has shown that despite its shortcomings, there are considerable long-term experiences from IWM in Ethiopia. Some of the watershed management projects and programs are exemplary. However, compared to the level of agroecosystem degradation in the country, the area covered by such watersheds is insignificant. Moreover, learning from successful examples and scaling up of these successful pilots to relevant areas in the rest of the country has been very limited. The successful examples have shown the unexploited potentials from strategic public investments in IWM in terms of improved food security, income diversification, environmental recovery and sustainable livelihoods of the people in the affected areas.

In order to learn from experiences and widely exploit the full benefits from IWM, the following are recommended as the way forward:

a) Innovative strategies and mechanisms for sharing experiences, materials and information related to IWM among different stakeholders should be designed and implemented. Quite often different actors prefer to start from zero instead of building on successful experiences that already exist. This has been a damaging trend in the country and has to be corrected. Accordingly, those successful experiences in different parts of the country, mainly in MERET project sites, need to be scaled up to the rest of the country and it is advisable to build on this and other successful experiences.

b) Adopt the three major stages of IWM as a strategy, ie, planning, implementation and sustainable management, and clearly define the roles and responsibilities of the different actors at each stage in the process. Since the level of land degradation in the country is beyond the capacity of the smallholder farmer, government and other non-state actors should play significant role in the planning and implementation stages. The sustainable management part could be delegated to the smallholder farmer (private lands) communities (community lands), although continued strategic investment and support by the government is crucial to leverage private and community efforts.

c) Research and extension efforts should adopt a balanced and holistic approach towards IWM and link such interventions to livelihoods through conservation-based productive activities, diversification into high-value products and market development.

d) Landscape and community-based integrated strategies should be taken as a major approach for conservation-based agricultural development in all parts of the country. Lack of sufficient attention to improved NRM in the so-called 'high potential areas' is contributing to serious degradation and declining productivity in such areas where current and future food security of the country depends. Moreover, the current trend of giving high emphasis to communal areas in watershed management as compared to private lands is another faulty approach that will seriously undermine private incentives for conservation-based development.

e) The current attempt by the government in relation to land certification, provision of long-term land use rights and setting land use policies should be strengthened with appropriate capacity building at the community level and the provision of low-cost technical options for improved land, water, forest and biodiversity management.

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Session 3:

Conclusions and Directions for Future Research

Conclusion and future directions

Bekele Shiferaw[1], Nuhu Hatibu[2] and KPC Rao[1]

Poverty, malnutrition, food insecurity and degradation of the natural resource base are major problems afflicting many countries in Eastern and Central Africa (ECA). Over the last decade, the sub-region has witnessed increasing incidence of poverty through its various manifestations including an increase in the number of hungry and malnourished people. The ECA sub-region constitutes some 10 countries with a population of over 280 million people, more than half of whom live in extreme poverty, making the sub-region one of the highest concentrations of poor people in the world. About 75% of the population lives in rural areas that account for over 80% of the total extreme poor. Unless interventions are designed to reverse the situation, this trend is projected to continue into the coming decades, making it impossible even to come closer to (much less to meet) the Millennium Development Goals (MDGs) of halving the number of people in absolute poverty and hunger between 1990 and 2015.

The incidence and severity of deprivation is highest in the less-favored semi-arid and marginal areas that suffer from poor infrastructure, geographical isolation, poor market access, and vulnerability to climatic variability and drought. High levels of soil erosion, nutrient depletion and degradation of agroecosystems contribute to low productivity and declining livelihood resilience in many areas. The magnitude of soil fertility depletion on arable lands is one of the highest in the world and by far exceeds the rates of nutrient replenishment through application of organic and commercial fertilizers. Despite the potential for expanding irrigation, agriculture remains predominantly rainfed, making livelihoods largely dependent on the vagaries of climatic variability. Less than 3% of the cultivated area is irrigated compared with about 38% in South Asia, and much of this is in two countries (Sudan and Madagascar). Except in these two countries with a relatively well-developed irrigation infrastructure, less than 10% of the irrigation potential has yet to be developed.

Despite its dominant role in the economy, agricultural productivity has however been either declining or stagnating behind population growth in several countries. Efforts to revitalize agriculture through investments in improved soil and water management have produced mixed results. While initial efforts inspired by the colonial top-down planning and technocratic approaches have largely failed to stimulate private conservation investments, new approaches

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that are based on participatory planning and implementation and that interlink conservation with livelihood objectives of the communities have shown promising results in a number of countries. Addressing the multiple constraints requires integrated technical and institutional innovations and building of local capacity to provide smallholder farmers with demand-driven and scientifically tested and knowledge-based options to improve productivity and enhance natural resource management (NRM).

In terms of development of such integrated technical interventions to improve rural livelihoods and natural resources in drought-prone areas, South Asia (especially India) has amassed extensive experience and lessons that would be beneficial to the ECA countries. Enabling policies and strategic public investments for integrated watershed management (IWM) have contributed towards diversification of production into high-value products, reversal of resource degradation, growth in the incomes of the poor, and have enhanced the ability to mitigate the effect of drought. Along with innovative institutional arrangements and local capacity building, these landscape and community-based technical and institutional innovations have stimulated community watershed investments for soil and water conservation, rehabilitation of degraded lands and private investments in water harvesting for supplemental irrigation. When coupled with other infrastructure development initiatives (eg, rural roads and electricity) and innovations for creating market linkages, such natural resource investments have accelerated diversification of production into market-led high-value products, thereby allowing smallholder producers benefit from emerging market opportunities through better integration of production into the market economy.

However, the experiences in Asia have shown that watersheds are indeed complex biophysical and socioeconomic units that require innovative policy options and institutional arrangements to stimulate and sustain local collective action. The lateral flows and interdependence of natural resources in a watershed context require community action to internalize externalities and create incentives for individuals to participate in such group action. As watersheds are also inhabited by diverse groups with diverging rights for access, utilization and control of resources, such group action however requires innovative approaches and strategies that enhance both efficiency, equity and sustainability When property rights for collective investments such as groundwater recharging or community forests are clearly defined, smallholder farmers in drought-prone areas can benefit from increased availability of drinking and irrigation water, improved availability of fodder for livestock, reduced soil erosion, enhanced sustainability and improved environmental quality. On the other hand, experiences in South Asia have shown that governments and other stakeholders have a unique role to play in kick-starting the process through strategic natural resource investments that enhance local capacity for collective action and generate local public goods. Once stimulated through strategic public and other initiatives, such collective investments serve as building blocks for private productivity-enhancing investments as they enhance the profitability of divisible inputs (such as fertilizer and improved seeds) and encourage farmer adoption of innovations for conservation-based agriculture. The lessons and experiences from Asia also show that integrating interventions along biophysical, agricultural and socioeconomic dimensions in the context of multiple sources of livelihoods and NRM problems in watersheds would require a flexible learning alliance of institutions and cross-disciplinary teams with complementary skills and competencies.

In retrospect, several papers presented in the workshop and the chapters in this book have shown that technologically, countries in SSA have attempted almost similar interventions for soil and water conservation as those implemented in South Asia. What has been different is (a) lack of an integrated and participatory approach that builds on people's livelihoods and makes conservation beneficial to the poor; (b) lack of a strong commitment from governments and various stakeholders in terms of strategic investments for empowering resource users and communities to undertake resource-conservation or enhance private and collective investments; and (c) lack of enabling policy and institutional frameworks in terms of clearly defined resource rights and policies that provide proper incentives and encourage equitable sharing of costs and benefits of resource development. Reflecting on these differences in each of the ECA countries and building on successful experiences will be a good entry point for formulating strategic development pathways for integrated management of watersheds in the sub-region. Equally important, many years of experience in NRM and conservation in the region may also contribute to further development and refinement of strategies being pursued in South Asia.

Therefore, collaboration and partnership between ECA (or SSA at large) and South Asia in the area of integrated management of watersheds' for sustainable agricultural development is a strategic necessity that would generate high payoffs for both parties. As many countries of ECA liberalize their economies and adopt market-led policies for agricultural development, it is necessary to also adopt an important strategy for revitalizing agriculture and rehabilitating stressed agroecosystems in the sub-region. This must include integrated and landscape based approaches that stimulate sustainable intensification of smallholder agriculture and diversification of production into tradable products.

The workshop reflected on these experiences through plenary presentations and group discussions, and provided directions for future research in three priority areas.

Future directions and priorities

Following the plenary presentations in two sessions, workshop participants formed three groups to discuss and define broader research and development priorities for IWM in drought-prone regions of Eastern and Central Africa (ECA). Each group focused on one of the following themes:

- Technological needs and adaptation strategies
- Markets and policy issues
- Farmer participation, outreach and capacity building

More particularly, groups were asked to

1. deliberate on the region-wide issues in ECA around each of the themes and identify the key intervention priorities for investment in development research and capacity building to harness the potential of IWM;
2. identify the challenges and opportunities that exist in the region to make the watershed approach an effective instrument for livelihood protection and sustainable ecosystem health;
3. discuss and identify the goals (higher level social objectives) and purpose statements (how users will be enabled to implement innovations) for the proposed intervention;
4. brainstorm and identify the key attainable objectives for proposed interventions;
5. reflect on the objectives and identify the major deliverables (outputs) for each of the objectives;
6. identify the key activities for each of the proposed outputs that will move the interventions towards attaining the stated objectives.

Results from breakout sessions as presented and modified through plenary discussions are described below.

Theme I: Technological needs and adaptation strategies

Focal areas and issues identified

- Land degradation
- Low soil fertility
- Drought
- Pests and diseases
- Low productivity of land and water
- Poor crop management practices
- Poor soil and water management practices
- Limited use of improved technologies and yield-enhancing inputs.

Key interventions

- Selection, adaptation and introduction of appropriate soil and water management techniques
- Pilots for identifying best practices and strategies for integrated community management of catchments and watersheds
- Selection, adaptation and introduction of high yielding and marketable varieties that are drought tolerant, and are resistant to the most threatening pests and diseases.

Challenges

- Assuring adequate benefits of improved technologies to farmers
- Limited commercialization of small-scale farming
- Building capacities of farmers and communities to use proposed technologies and to effectively manage their natural resources
- Assuring the availability of support services required by farmers adopting improved technologies.

Opportunities

- Availability of land, water, soil and biodiversity resources for sustainable intensification
- Increasing population density that ensures availability of labor and demand for agricultural products
- Positive attitude of small-scale farmers towards NRM as long as benefits are assured
- Climatic diversity that favors a variety of agricultural enterprises
- Globalization that facilitates market linkages and access to information
- Relevant technologies and experiences from Asia and Africa.

Goal

Improved rural livelihoods in ECA through technology generation, adoption and sustainable use of NRM.

Objective

- Increase productivity and reduce land degradation through technology development and exchange of experiences and knowledge
- Identify and adapt best practices and technological needs for IWM.

Outputs

- Effective technologies for IWM in different agroecological zones in ECA identified and promoted
- The productivity of smallholder resource-based enterprises (crop, tree and livestock) enhanced through application of integrated genetic and NRM strategies

- Strategic partnerships for effective technology exchange within and outside ECA established
- Joint planning, implementation and evaluation systems between research and development partners established
- Functional linkages along the product market chain that enhance sustainable management of land and water resources established
- Common IWM guidelines and technical principles prepared and promoted.

Theme II: Markets and policy issues

Focal areas and issues identified

- Insufficient understanding of the links between improved NRM and commercialization of smallholder agriculture
- Low profitability of natural resource investments
- High transaction costs
- Low marketable surplus of agricultural and other natural resource based commodities
- Poor access to markets and market information
- Inappropriate tenure arrangements for land, water and tree resources
- Lack of incentives to invest in crop management, water and soil conservation
- Lack of collective action and coordination of efforts by small-scale producers and resource users
- Weak, dysfunctional or non-existent institutions (norms, rules and regulatory systems) and organizations for service delivery for IWM at different levels
- Insufficient public investment in developing local public goods for IWN.

Key interventions

- Promote IWM to enhance profitability of smallholder enterprises, reduce production risks and accelerate commercialization of smallholder agriculture
- Promote appropriate tenure arrangements and policies to enhance smallholder investments for IWM (high yielding varieties, crop management and soil and water conservation)
- Promote public investments in enhancing ecosystem services and developing public goods for IWM
- Strengthen capacity of farmer organizations to implement IWM interventions.

Opportunities

- Increasing acceptance of market-led development polices
- Market liberalization and privatization of the agricultural sector
- Increasing interest of large-scale investors in African agriculture to operate in socially and environmentally responsible ways

- Positive attitude of farmers for increasing investments as long as benefits are assured and appropriate mechanisms exists for delivery of essential services.

Objectives

- Facilitate the establishment of a coalition of partners from the public/private sector and farmer groups providing enabling conditions for IWM and market opportunities for agricultural and natural resource based products
- Undertake problem-solving research on how IWM can support market-led development and provide advice directly addressing market, policy and institutional constraints arising from the process of implementing IWM
- Develop decision support tools and methods for evaluating the impact of IWM partnerships and activities on livelihoods and the environment, and draw lessons for scaling up successful pilots.

Outputs

- Innovative institutional arrangements and organizations for enhancing social capital and collective action for IWM established and promoted
- Marketing cooperatives organized and networking mechanisms between major economic agents involved in production, marketing and NRM created to improve sustainability and performance of agricultural markets
- Improved knowledge on market, policy and institutional factors that foster the full exploitation of IWM potentials
- Experience and public knowledge about mechanisms and effects of such institutional innovations, which provides useful insights and entry points for further intervention and better institutional design.

Theme III: Farmer participation, outreach and capacity building

Focal areas and issues identified

- Lack of farmer participation in designing and implementing IWM programs
- Insufficient understanding of how poverty, food security and poor health of rural families affect incentives for IWM
- Lack of knowledge and awareness among stakeholders on IWM
- Lack of coordination among key players
- Inadequate government support for IWM
- Weak institutional capacity to implement policies and create enabling socioeconomic and market conditions for IWM
- Insufficient resources for adopting IWM at country level
- Delayed benefits from interventions that reduce farmer incentives.

Key interventions

- Enhancing ability of key stakeholders and organizations to support communities in the process of IWM
- Strengthening community capacity and participation in designing, developing and managing watershed interventions
- Establishing regional level advocates to mobilize support for IWM in ECA.

Goal

Improved livelihoods of rural people in ECA through sustainable use of natural resources by adopting integrated approaches and principles for sustainable management of watersheds.

Objectives

- Create awareness and sensitize governments and other stakeholders on the role of IWM for diversifying income sources and enhancing sustainable intensification of production
- Enhance the ability of key stakeholders to support communities in designing and implementing IWM interventions
- Develop strategies and principles for strengthening community capacity and local institutions to manage watersheds
- Provide regional level advocacy and support for mainstreaming IWM in ECA.

Outputs

- The priority needs and capacity of national and region level advocates to mobilize support for IWM in ECA identified and strengthened
- The ability and capability of key national and local stakeholders that support communities in IWM enhanced
- Best practices and approaches for enhancing the capacity of farmer groups and communities for collective watershed management developed and strengthened through proper training and strategic public investments.

Annexes

Annex 1: Workshop agenda

ICRISAT-SWMnet/ASARECA Planning Workshop on Integrated Management of Watersheds to Promote Market-Led Smallholder Agriculture and Natural Resources Management in the Semi-Arid Areas of Eastern and Central Africa, 6-7 December 2004, ICRAF Campus, Nairobi, Kenya.

6 December 2004

Session 1: Welcome and opening

Chairperson: Said Silim	**Rapporteur:** Gete Zeleke
08:30 Welcome remarks	Nuhu Hatibu (SWMnet)
08:40 Workshop objectives	Bekele Shiferaw (ICRISAT)
08:50 Opening remarks	Said Silim (ICRISAT, Regional Rep)
09:00 Coffee/Tea break	

Session 2: Review of concepts and enabling conditions

Chairperson: Peter Cooper	**Rapporteur:** KPC Rao
09:15 Issues, concepts, approaches and practices in integrated watershed management: Experience and lessons from Asia	SP Wani (ICRISAT, Patancheru)
10:00 Markets policy and institutional issues as critical components of integrated management of watersheds: needs for research, outreach and capacity building	Bekele Shiferaw (ICRISAT, Nairobi)
10:45 Health Break and Group Photo	
11:00 ICRISAT research on integrated soil and water management in Eastern and Southern Africa: past experiences and future thrusts	Steve Twomlow (ICRISAT Bulawayo) and KPC Rao (ICRISAT/ ICRAF, Nairobi)

11:30	ECA regional and national research priorities in watershed management and future directions	Nuhu Hatibu (Regional Coordinator, SWMnet)
12:00	An example of watershed management experiences in ECA: Lessons from Ethiopia	Gete Zeleke (NRM Advisor to WFP Development Unit, Ethiopia)
12:30	Discussion and TOR for group work: • Technological needs and adaptation strategies • Markets, policy and institutional issues • Outreach and capacity building issues	Bekele Shiferaw
13:00	Lunch	

Session 3: Planning for the future: breakout sessions

14:00	Breakout sessions to define objectives, outputs and activities for priority intervention issues under the proposed themes	Group chairs and rapporteurs
15:30	Coffee/Tea break	
16:00	Breakout sessions continued	
17:00	Bus leaves for hotel	

7 December 2004

Session 4: Review of progress of group discussions

Chairperson: Paulos Dubale   **Rapporteur:** Sarah Kayanga

08:30	Group reports/discussion	Group rapporteurs

Session 5: Planning for the future continued

09:00	Breakout sessions continued	Group chairs and rapporteurs
10:30	Coffee/Tea break	

10:45	Breakout sessions continued	Group chairs and rapporteurs
13:00	Lunch	

Session 6: Directions for future research

Chairperson: SP Wani **Rapporteur:** Bekele Shiferaw

14:00	Presentation and discussion of detailed reports on Theme 1: Technological needs and adaptation strategies	Group 1: Rapporteur
14:45	Presentation and discussion of detailed reports on Theme 2: Markets, policy and institutional issues	Group 2: Rapporteur
15:30	Coffee/Tea Break	
15:45	Presentation and discussion of detailed reports on Theme 3: Farmer participation, outreach and capacity building	Group 3: Rapporteur
16:30	Summing up and strategies for follow up and collaboration	B Shiferaw and N Hatibu
17:00	Vote of thanks	N Hatibu and S Silim

Annex 2: Terms of reference and issues for group discussions

Based on the background presentations, three thematic areas for group discussion have been identified. The participants will be assigned to one of these themes. The groups will then meet separately to discuss the key issues and to develop the priority interventions under each theme. The groups will need to form a Task Force with a chair and rapporteur as the key members to lead the discussion and help define the research and development priorities for integrated watershed management in the drought-prone eco-regions of Eastern and Central Africa. The chairperson will lead and facilitate the discussions. The rapporteur will document the deliberations and present the results of the discussion on a plenary session on the last day.

The three proposed themes are:

- Technological needs and adaptation strategies
- Markets, policy and institutional issues
- Outreach and capacity building issues.

Terms of reference

In order to achieve the workshop objectives, the group discussions for each of the themes will need to adopt the following TOR:

1. Deliberate on the region-wide issues in ECA around each of the themes and identify the key intervention priorities for investment in development research and capacity building to harness the potential of integrated management of watersheds
2. Identify the challenges and opportunities that exist in the region to make the watershed approach an effective instrument for livelihood protection and sustainable ecosystem health
3. Discuss and identify the goals (higher level social objectives) and purpose statements (how the users will be enabled to implement the innovations) for the proposed interventions
4. Brainstorm and identify the key attainable objectives for the proposed interventions
5. Reflect on the objectives and identify the major deliverables (outputs) for each of the objectives
6. Identify the key activities for each of the proposed outputs that will move the interventions towards attaining the stated objectives.

With the support from ICRISAT-SWMnet, the Task Force will be mandated to further develop this into a full-fledged proposal by incorporating the comments and suggestions provided on the presentation during the plenary session.

Insights and Questions to Guide Group Discussions

Theme 1: Technological needs and adaptation strategies

- Multi-faceted production and resource management constraints (eg, drought, pests and diseases, low soil fertility, etc) in the semi-arid areas require an integrated genetic and natural resource management (IGNRM) approach. Integrated watershed management is a platform for implementation of IGNRM at a hydrological landscape level through farmer and community-led interventions.
- At the minimum this approach requires improved germplasm (eg, adaptable and high yielding varieties) along with technologies for combating the biotic (pest and disease management) and abiotic (low fertility, drought) constraints.
- Which of these technologies are already available for adaptation or have already been adapted within the ECA region?
- Do these technologies address the major production and resource management constraints of smallholder farmers?
- The primary rationale for farmers to adopt a new technology is the relative gain in terms of profitability or risk management of the new technologies vis-a-vis the existing options. How attractive and profitable are existing IGNRM technologies for small farmers in the semi-arid areas of ECA?
- Do these technologies help mitigate the risks of smallholder rain-fed agriculture in semi-arid areas?
- If their profitability is low or if the technologies are risky, how can research contribute to address these concerns in the future?
- If there are technological limitations for addressing low productivity drought, pest/disease and soil fertility management problems, which ones need to be prioritised for research in the next five years?
- Why has farmer adoption of improved germplasm and NRM technologies been generally limited in the region?
- If some appropriate (profitable and/or low risk) technologies are not currently utilized by farmers, what kinds of interventions are needed to address this inefficiency?
- How can farmer investment in water harvesting and small-scale supplemental irrigation be enhanced?

- How does improved water management at the watershed level affect production and livelihoods in other lower-lying areas? Can water productivity be improved at the larger spatial scale?

Theme 2: Markets, policy and institutional issues

- Market access is central for farmer adoption of high-value crops and enterprises. Watershed management also makes it possible to intensify production, reduce risk, and increase marketed surplus. This encourages private sector participation and emergence of entrepreneurs in provision of key inputs and marketing of outputs. How can market access for small farmers be enhanced to encourage investment in new IGNRM technologies? How can watershed management facilitate this process of market development and commercialisation of production? How can IGNRM be tailored to be responsive to changing market conditions? What are the tradeoffs and complementarities between market development and collective management of watersheds? Does community action and inter-personal ties and reciprocity decrease with market development? If so, how can community action be sustained as off-farm opportunities expand?

  Integrated watershed management provides non-marketed environmental services that increase sustainability and improve livelihood protection for the poor. These social benefits are not fully captured by individual farmers that invest in watershed management. As a result, individually rational farmers may invest less in socially beneficial watershed management - which justifies some form of government support/subsidies for watershed programs. How can governments provide the basic infrastructure (eg, building terraces, check dams, community organization) for integrated management of watersheds? What is the optimal and politically acceptable level of financial and material support to motivate community-based watershed development? Under what conditions can communities and farmers establish these basic infrastructures on their own initiative without government or external support/subsidies?
- How can the benefits and costs of investments in watershed management be equitably distributed across the community? How can livelihood opportunities (new watershed-linked enterprises) be created for women, the landless and poorest households in watersheds?
- How can watershed management primarily bring economic benefits on private land so that farmers will develop the interest to participate in collective action? Which types of knowledge-based entry point activities provide immediate private benefits (eg, micro-nutrients and water-harvesting in India)?
- What kinds of farmer organizations are more effective in reducing transaction costs for collective action? What is the best strategy to organize farmers and build the capacity for governance of CPRs in watersheds?

- What are the enabling legal and regulatory frameworks needed to empower communities and enhance collective resource management?
- What is the best strategy to counter depletion of groundwater and how can tradable water markets and licensing systems be established to enhance water productivity as scarcity increases?
- What kind of policy incentives and institutional arrangements are needed to promote farmer investment in water saving and productivity enhancing IGNRM options?

Theme 3: Farmer participation, outreach and capacity building

- Given that natural resource management has often been considered in isolation from crop-livestock production, how can the concept of IGNRM become the principal strategy for agricultural research and development in ECA?
- Given that NRM technologies are sensitive to changes in biophysical conditions, how can the islands of success be replicated in wider eco-regions?
- What are the key weaknesses in technology delivery and knowledge management systems (eg, lack of credit, weak extension systems) and how can policy and institutional reforms assist in wider dissemination of IGNRM innovations?
- What are the most urgent investment needs for building human and organizational capacity and competence to harness the potential of integrated watershed management? Who are the strategic partners in strengthening such capacity?
- What are the optimal roles for governments, civil society, IARCs, SROs, development partners, farmers and community organizations in technology exchange and in implementation of integrated watershed management options?
- What are the options for south-south collaboration within the region, especially in terms of technology exchange among countries in the region? ICRISAT and SWMnet can serve as a neutral bridge and broker in facilitating regional technology exchange and sharing of knowledge and experiences
- How can community organizations transform themselves into viable and self-reliant organizations for better governance and sustainability of local public goods and resource-improving watershed investments?

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RA-00405

About ICRISAT®

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Future Harvest Centers of the Consultative Group on International Agricultural Research (CGIAR).

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ISBN 92-9066-487-8 Order code CPE 158 643-2005