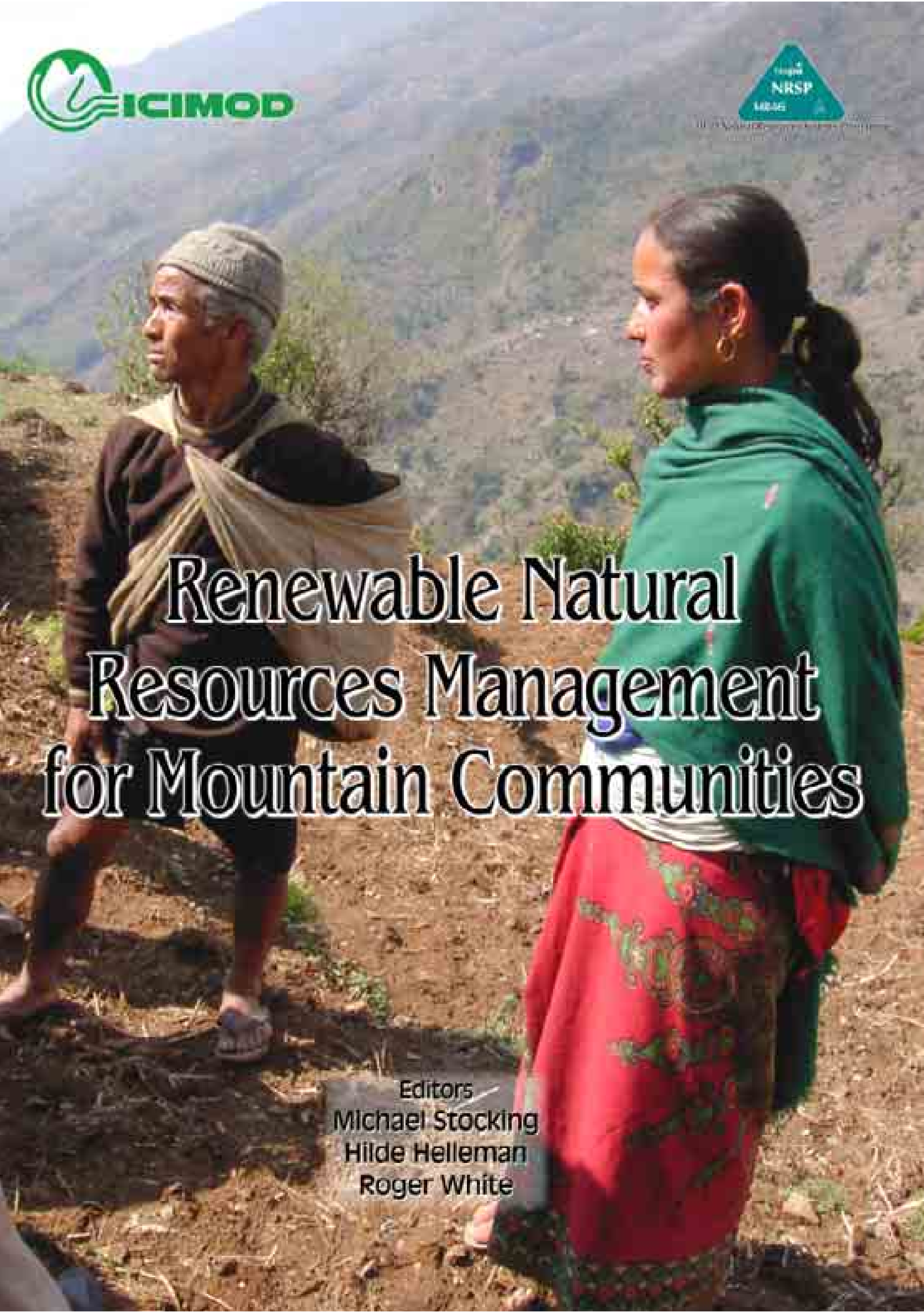

Renewable Natural Resources Management for Mountain Communities

Editors
Michael Stocking
Hilde Helleman
Roger White

About the Organisations

The **International Centre for Integrated Mountain Development** (ICIMOD) is an independent 'Mountain Learning and Knowledge Centre' serving the eight countries of the Hindu Kush-Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and the global mountain community. Founded in 1983, ICIMOD is based in Kathmandu, Nepal, and brings together a partnership of regional member countries, partner institutions, and donors with a commitment for development action to secure a better future for the people and environment of the Hindu Kush-Himalayas. The primary objective of the Centre is to promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations.

The **Natural Resources Systems Programme** (NRSP), of the UK Department for International Development, undertakes research on the integrated management of natural resources. This encompasses the social, economic, institutional and biophysical factors that influence people's ability to both use and maintain the productive potential of the natural resource (NR) base over a relatively long timeframe. The intended outcome of the research is that NR-related strategies for improving people's livelihoods, that are of proven relevance to poor people, will be delivered in forms that could be taken up by the poor themselves and/or by the development practitioners operating at a range of levels, from grassroots to senior policy level.

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International Centre for Integrated Mountain Development
Kathmandu, Nepal
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Back: Landruk research site – Hilde Helleman

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Foreword

This book presents the findings of a Symposium and Research Workshop on Renewable Natural Resources Management for Mountain Communities held in Nepal in February and March 2003.

The papers presented at the Symposium in Kathmandu (24-25 February) describe renewable natural resources research undertaken by ICIMOD's People and Resource Dynamics in Mountain Watersheds Programme (PARDYP) and the Hillsides system of the Natural Resources Systems Programme (NRSP). About 70 persons attended the symposium from a wide range of organisations in Nepal, countries in the Hindu Kush Himalaya region, and from Bolivia, Kenya and Uganda. The Research Workshop was held in the mid-hills of Nepal near Pokhara (26 February-1 March) with 37 participants.

The management of renewable natural resources in hillside and mountain areas is intricately linked with livelihood opportunities and sustainable development. The goal of the PARDYP and NRSP Hillsides research is to enable improved and more sustainable livelihoods for communities and individuals. Their research emphasises the role of the management of soil, water and land resources in improving livelihood opportunities and human well-being. PARDYP and the NRSP Hillsides system have complementary research programmes and while PARDYP has a regional mandate, NRSP Hillsides works in Nepal, Bolivia and Uganda.

This Symposium and Research Workshop was developed in recognition that the valuable experience gained and information held by ICIMOD and NRSP should be shared with stakeholders, nationally, regionally and internationally. The discussion during the Symposium and Research Workshop will help develop the research agenda in the management of renewable natural resources and inform the debate on sustainability, livelihoods, poverty reduction and environmental issues in hillsides and mountain areas.

The sponsors of this Symposium and Research Workshop were PARDYP, on behalf of ICIMOD, and NRSP on behalf of the UK Government's Department for International Development (DFID) and the Nepal Agricultural Research Council (NARC). PARDYP is co-financed by IDRC, Canada; SDC, Switzerland; ICIMOD; and the countries participating in the project. NRSP is funded by DFID.

Dr. J. Gabriel Campbell
Director General
ICIMOD

Dr. Christopher Floyd
Programme Manager
DFID – Natural Resources
Systems Programme

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The editors wish to acknowledge the many people without whose support this publication could not have been completed.

- The people of mountains and hillsides in the Hindu Kush-Himalayas, Bolivia and Uganda, without whose contribution the research described here would not have been possible. This book is dedicated to them in the hope that, even in a small way, it will contribute to a betterment of their livelihoods.

- The contributors to, and the participants of, the symposium and workshop for their participation, papers, discussions, and delivery of manuscripts on time and to specification.

- ICIMOD's People and Resource Dynamics in Mountain Watersheds Project (PARDYP) and DFID's Natural Resources Systems Programme (NRSP) and their donors for supporting the symposium, the workshop and this publication.

- The staff at the two venues for the meetings, the Himalaya Hotel (Kathmandu) and the Bluebird Hotel (Pokhara), and the people and guesthouses of Landruk for their time and hospitality.

- Finally, the ICIMOD publications section for editing and technical support in preparation of this manuscript and Melvyn Kay for editorial support.

Acronyms and Abbreviations

AGREN	Agricultural Research & Extension Network
AFRENA	Agroforestry Research Network for East and Central Africa
A2N	Africa 2000 Network
AHI	Africa Highland Initiative
AKIS	Agricultural Knowledge and Information Systems
AKT	Agro-ecological Knowledge Toolkit
APP	Agricultural Perspectives Plan
ARS	Agricultural Research Station
BCF	buffer zone community
BZ	buffer zone
CBO	community-based organisation
CDE	Centre for Development and Environment
CF	community forest
CFU	colony-forming units
CGS	competitive grant system
CI	collaborating institutions
CIAT	International Centre for Tropical Agriculture
CIDA	Centre for International Development Assistance
CIMMYT	International Maize and Wheat Improvement Centre
CPR	common pool resources
DADO	District Agricultural Development Office
DAO	District Agricultural Office
DAP	diammonium phosphate
DEM	digital elevation model
DFI	District Farming Institute
DFID UK	Department for International Development (Head office)
DFID-Nepal	Department for International Development (Nepal office)
DFO	district forest officer
dpi	dots per inch
DPTF	district policy task forces
ELF	experienced leader farmer
EU	European Union
FAO	Food and Agriculture Organization
FECOFUN	Federation of Community Forest Users in Nepal
FFS	farmer-field school
FLE	farmer-led experimentation
FP	farmer's practice
FRG	farmer research groups

FTF	farmer-to-farmer
FUG	forest user group
FYM	farmyard manure
GBPIHED	G.B. Pant Institute of Himalayan Environment and Development
GCP	ground control points
GEF	Global Environment Facility
GF	group farmers
GIS	geographical information system
GLASOD	Global Assessment of Land Degradation
GPS	global positioning system
HARP	Hill Agriculture Research Project
HH	household
HKH	Hindu Kush-Himalayas
HMGN	His Majesty's Government of Nepal
HRP	Hill Research Programme
HS	hillsides
HSPS	Hillsides Production Systems (NRSP)
HYMOS 4	Hydrological Modeling System 4
IC	Indian currency
ICIMOD	International Centre for Integrated Mountain Development
IDRC	International Development Research Centre (Canada)
ICRAF	International Centre for Research in Agroforestry
IIED	International Institute for Environment and Development
IFPRI	International Food Policy Research Institute
IGCEDP	Indo German Changar Ecological Development Programme
IIRR	International Institute of Rural Reconstruction.
IISD	International Institute for Sustainable Development
INRM	integrated natural resource management
IPCC	Intergovernmental Panel on Climate Change
IPM	integrated pest management
IPNS	integrated plant nutrient management system
IRRI	International Rice Research Institute
ISCO	International Soil Conservation Organisation
ISRIC	International Soil Reference and Information Centre
IVI	importance value index
LADA	Land Degradation Assessment in Dryland Areas
LARC	Lumle Agricultural Research Centre (now ARS/Lumle)
LC	local councils
LF	leader farmers
LMS	land management strategies
LPs	local professionals
LRMP	Land Resources Mapping Project
M&E	monitoring and evaluation
masl	metres above sea level
MECDP	Mt. Elgon Conservation and Development Project

MFPED	Ministry of Finance, Planning and Economic Development
MoAC	Ministry of Agriculture and Co-operatives
MOV	means of verification
NAADS	National Agricultural Advisory Development Services
NARC	Nepal Agricultural Research Council
NARDF	National Agriculture Research and Development Fund
NAREB	Nepal Agricultural Research Executive Board
NARO	National Agricultural Research Organization
NGO	non-government organisation
NORMs	Natural and Resource Management Services
NPC	National Planning Commission
NPI	national partner institute
NR	natural resource
NRM	natural resource management
NRSP	Natural Resources Systems Programme (DFID)
NTFP	non-timber forest product
O.C.	organic carbon
ODA	Overseas Development Administration (now DFID)
ODG	Overseas Development Group
ODI	Overseas Development Institute
OPR	output-to-purpose review
PAM	participatory agro-ecosystem management
PAR	participatory action research
PARDYP	People and Resource Dynamics in Mountain Watersheds of the HKH Project
PCN	project concept note
PCR	project cycle results
PLEC	People, Land Management and Environmental Change
PMU	pogramme management unit
POA	annual operation plan
PP	project proposals
PPME	participatory planning, monitoring, and evaluation
PRA	participatory rural appraisal
PRAP	participatory research action plans
PTD	participatory technology development
PTF	policy task force
QA	questionnaire on SWC approach
QM	questionnaire on SWC mapping
QT	questionnaire on SWC technologies
RAPID	Research and Policy in Development
R&D	research and development
RMA	research management adviser
RRA	rapid rural appraisal

RS	remote sensing
RWSSSP	Rural Water Supply and Sanitation Support Project
SALT	sloping agricultural land technology
SDC	Swiss Agency for Development and Co-operation
SL	sustainable livelihood
SLM	sustainable land management
SMP	soil management practice
SOWAP	soil and surface water protection using conservation tillage
SRL	sustainable rural livelihoods
SSM	sustainable soil management
SSMP	Sustainable Soil Management Programme (Helvetas)
STSS	Soil Testing and Service Section
SWC	soil and water conservation
TIN	triangulated irregular network
TORA	Theory of Reasoned Action
TSC	technical sub-committee
UBC	University of British Columbia
UNCCD	UN Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UoB	University of Berne
UP	uptake pathways
VDC	village development committee
VPTF	village policy task force
WHO	World Health Organisation
WOCAT	World Overview of Conservation Approaches and Technologies
WRI	World Resources Institute

Contents

1

Managing Renewable Natural Resources in Mountains – Generic Issues and Programme Approaches

Photo:

Woman carrying manure

Hilde Helleman, 2003

1 RENEWABLE NATURAL RESOURCES MANAGEMENT FOR MOUNTAIN COMMUNITIES – Editors' Introduction

Hilde Helleman[1], Michael Stocking[2], and Roger White[1]

Introduction

The renewable natural resources of mountains and hillsides are fragile and precarious and this makes them sensitive to changes imposed by human land use, local environmental conditions, and external factors such as conflicts and political instability. The Hindu Kush-Himalayas (HKH) is a prime example of how harsh biophysical conditions combined with political uncertainty and poverty can create significant challenges to development.

In Nepal, more than 12 million people in the mid-hills subsist on hillside-terraced land-holdings of less than 0.5ha. Heavy rainfall and poor soil and water management practices are eroding the soil and soil fertility is declining as nutrients are lost through leaching. If farming livelihoods are to be protected then alternative farming practices are urgently needed that help to conserve water, soil and fertility in these marginal and fragile hillside environments. These are not new problems, yet current research, knowledge and practices have not solved them. The technologies are available but many farmers have not adopted them in spite of their demonstrated effectiveness in reducing runoff and controlling erosion.

These challenges are not insurmountable. A conference[3] on natural resources management on hillsides in 1999 helped to set a new agenda for research. It laid the foundation for a major change in emphasis from developing new technologies to understanding and promoting the conditions for their uptake and impact on livelihoods and poverty through better management of natural resources. There is now a growing body of research experience in the HKH to show that renewable natural resources on mountains and hillsides can be managed effectively and sustainably and this is supported by comparative research in the Andes and the African highlands.

To address these issues, the Natural Resources Systems Programme (NRSP) of the Department for International Development (UK) (DFID) and the People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas Project (PARDYP) of the International Centre for Integrated Mountain Development (ICIMOD), based in Kathmandu, organised two events.

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2 School of Development Studies, University of East Anglia, Norwich NR4 7TJ, UK (m.stocking@uea.ac.uk)

3 Hillsides Conference at Silsoe College, Cranfield University, UK in 1999. The proceedings were published in *Mountain Research and Development* 19(4).

The first event was a 2-day public symposium on Renewable Natural Resources Management for the Hindu-Kush Himalayas held on 24-25 February 2003 in Kathmandu, Nepal. The objectives were to:

- bring together key stakeholders (policy makers, aid agencies, researchers and related professionals) in renewable natural resources research in Nepal from various agencies and institutions and to provide a forum for comparing experiences in other countries;
- disseminate the major findings and policy implications of renewable natural resources management investigations conducted in the HKH region from ICIMOD and NRSP sponsored research; and
- compare the findings with those from hillsides research undertaken in mountainous areas in Africa and South America.

The second event followed immediately after the public symposium. This was a 3-day research workshop on Natural Resources Management for Mountain Communities held in Pokhara, close to the Nepal Agricultural Research Council Agricultural Research Station at Lumle. The objectives were to:

- examine the ICIMOD and NRSP research agendas for mountains and hillsides;
- present and compare research methodologies and results related to renewable natural resources management; and
- identify further investigations needed to deliver outputs that meet the needs of all stakeholders.

Hanspeter Liniger

Sheep on hillside terraces

This workshop was primarily for researchers interested in sharing experiences and discussing a new agenda for research. The core of the workshop was a 2-day visit to sites in the western mid-hills of Nepal where participants interacted with local villagers and were able to see the results of a NRSP funded project on soil and water management on land terraces at Bandipur and Landruk.

Symposium and Workshop

The symposium and research workshop provided opportunities to disseminate key research findings to interested stakeholders, nationally, regionally, and internationally, and to discuss future agendas in renewable natural resource management with a view to informing current developmental debates on sustainability, livelihoods, poverty reduction, food security, and environmental change. These are not only biophysical problems but also challenges to society to promote the social and economic conditions whereby local people can manage their resources more effectively.

The papers and subsequent discussions presented in this publication therefore, feature a wide range of issues from the generic and programmatic through to techniques and tools arising from natural resources management research. The publication is divided into three parts.

Part 1 Generic issues and programme approach

This part sets out the programme mandates of PARDYP-ICIMOD (Chapter 2) and NRSP Hillsides (Chapter 3) and develops their core generic issues.

Part 2 Case studies and thematic topics

The case studies presented in Chapters 4-7 focus on the role of participatory decision-support systems for developing and promoting improved hillside farming strategies relevant to the needs of marginal farmers. They describe the substantial research work undertaken on soil and water management in the mid-hills of Nepal and the participatory techniques for developing more appropriate technologies. Some of this work was pioneered at Bandipur and Landruk – the sites visited during the research workshop.

Chapters 8-10 address thematic topics that come principally from PARDYP and examine a range of natural resource management issues such as water management, common property management, and land rehabilitation. These illustrate both the range and the depth of the research undertaken in the PARDYP research watersheds; although the papers are country specific the aim was to draw conclusions relevant to the HKH region as a whole.

Chapters 11-15 address techniques, tools, and intervention methods used to deal with declining soil fertility as a means for local professionals and rural communities to identify 'best bet' and 'win-win' natural resources-related techniques and target them to poor households. This includes experiences in hillside research from Nepal, Bolivia, and Uganda.

Hanspeter Liniger

Orchard terrace

Chapters 16-19 investigate approaches and the issues of scaling up pilot research experiences to the wider community and links to policy. This draws on experiences from Nepal, Bolivia, and Uganda.

Part 3 Synthesis and looking ahead

Chapter 20 draws together the main findings of the case studies and the thematic contributions. Chapter 21 looks ahead. Its purpose is to provide a platform for a new generation of research projects devoted to bridging the gaps in the current projects.

The Sponsors

The symposium and research workshop were sponsored by NRSP and ICIMOD.

The Natural Resources Systems Programme (NRSP)[4] is one of the ten research programmes funded by the British Government's Department for International Development (DFID) in its renewable natural resources research strategy. This strategy aims to generate benefits for poor people by the application of new knowledge to natural resource systems; knowledge which will enable poor people, who are largely dependent on natural resources, to improve their livelihoods and move out of poverty in a sustainable way. NRSP's research covers the social, economic, institutional, and biophysical factors that influence people's ability to use and maintain the productive potential of the natural resource base over a relatively long timeframe.

[4] www.nrsp.org.uk

The International Centre for Integrated Mountain Development (ICIMOD) is devoted to the development of economically and environmentally sound mountain ecosystems and to improving the living standards of mountain populations, especially in the HKH region. ICIMOD and NRSP work together on the People and Resource Dynamics in Mountain Watersheds of the HKH Project (PARDYP), whose goal is to contribute to balanced, sustainable, and equitable development of mountain communities and families in the HKH region. PARDYP is funded by the Swiss Agency for Development and Cooperation (SDC), the International Development Research Centre (IDRC) (Canada) and ICIMOD.[5]

ICIMOD and NRSP have complementary interests in promoting sustainable development and tackling poverty and related livelihood issues through the better management of natural resources. ICIMOD has a regional mandate for integrated mountain development and NRSP, within its Hillsides systems project portfolio has an emphasis on Nepal, Uganda and Bolivia. ICIMOD and NRSP have accumulated substantial research experience and findings on renewable natural resources management in the HKH region, which includes soils, water, land and associated aspects of people's livelihoods. Similarly, PARDYP focuses on people and their interaction with natural resources, networking and learning from regional experiences.

5 www.pardyp.org and www.icimod.org

2 PEOPLE AND RESOURCE DYNAMICS IN MOUNTAIN WATERSHEDS OF THE HINDU KUSH HIMALAYAS PROJECT – A Research for Development Network

Roger White[1], and Juerg Merz[1]

Abstract

This paper describes the aims and activities of the People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas Project (PARDYP), a regional research-for-development network operating in five mountain watersheds in four countries. It describes the lessons learned and the strengths and weaknesses of regional research projects. The use of a common framework greatly enhances the value of the information obtained. By agreeing and sharing common approaches to both monitoring and analysis and sharing the data generated, research costs can be reduced. Some findings are grouped together and the first steps towards a regional comparison or synthesis of the research watersheds are outlined.

Introduction

The People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas Project (PARDYP) is a regional research-for-development project looking at people and natural resource interactions in a meso (50-100 sq.km) watershed context. The work is funded by the Swiss Agency for Development and Cooperation (SDC) and the Canadian International Development Research Centre (IDRC). All PARDYP project components are carried out in each of five watersheds in the middle mountains of the Hindu Kush-Himalayas in China, India, Nepal (2), and Pakistan (Figure 2.1).

The national partner institutes (NPIs) conducting the research at the field level are for Pakistan, the Pakistan Forestry Institute, Peshawar; for China, the Kunming Institute of Botany; for India, the GB Pant Institute for Himalayan Environment and Development; and for Nepal, the International Centre for Integrated Mountain Development (ICIMOD) together with the Department of Forest and the Department for Soil Conservation and Watershed Management. These national focal research institutions implement, manage, and supervise the activities with the assistance of national and international partners and collaborators. The two main international partners are the Institute for Resources and Environment, University of British Columbia, Canada, and the Hydrology Group, Department of Geography, University of Berne, Switzerland. Overall coordination, guidance, and administration is provided by ICIMOD. From 2003, the Department of Geography, University of Zurich, joined the international partnership and will collaborate on research into access to common property resources.

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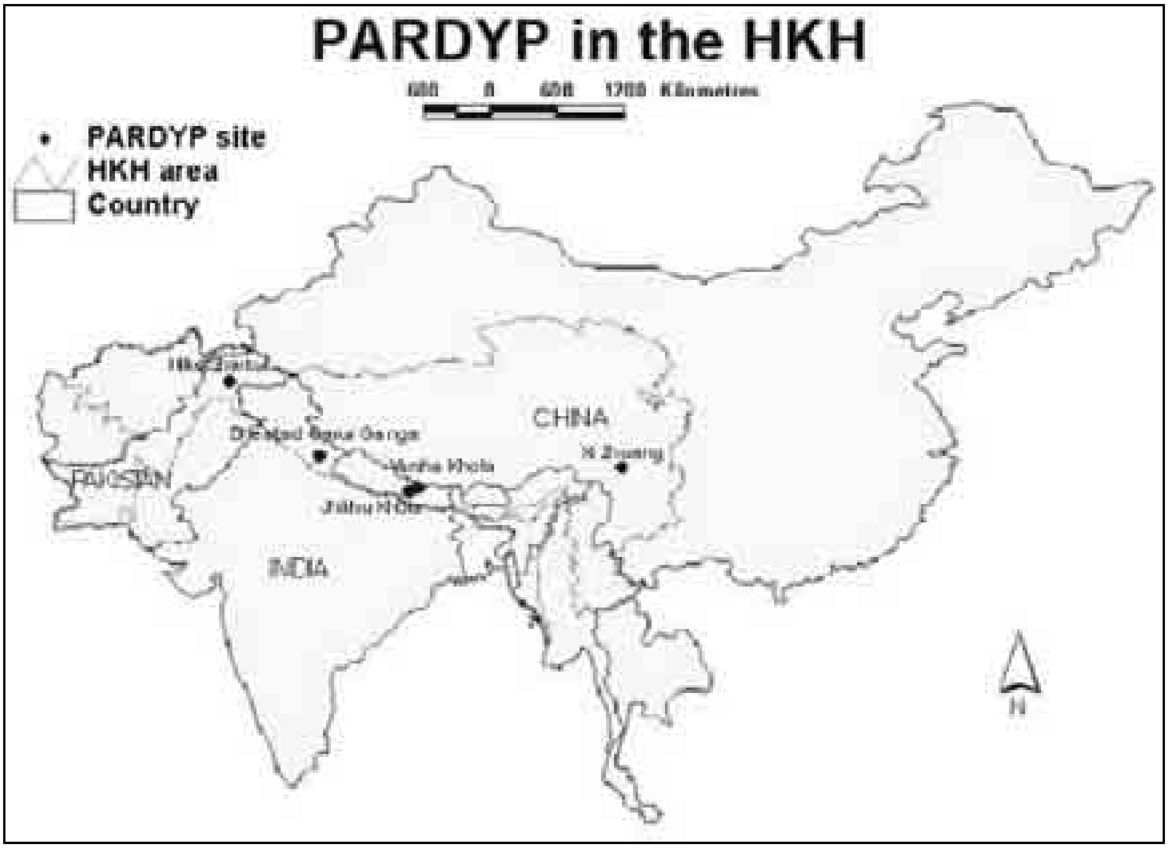


Figure 2.1: **Location of the PARDYP watersheds**

PARDYP has its origin in the Land Resource Mapping Project (LRMP) funded by the Canadian International Development Association (CIDA) in the 1970s and 1980s. LRMP mapped Nepal's land resources. Similar mapping and natural resource inventories were conducted in other countries, pilot provinces, and districts. During this period, lack of understanding of the natural resource base was seen as a major limiting factor to development. In the 1980s many large integrated rural development projects and agricultural development projects either expanded this type of mapping and inventory work or tried to use it, but with limited success. Initially, the IDRC funded two projects, the 7-year 'Mountain Resource Management Project', which undertook resource dynamic studies in the Jhikhu Khola watershed of Nepal (1989-1996) and the 'Rehabilitation of Degraded Lands in Mountain Ecosystems Project' (1992-1996) in China, India, Nepal, and Pakistan. The latter project involved research on the rehabilitation and re-greening of small patches of degraded land in middle mountain landscapes. PARDYP combines the regional and the integrated approaches of its two predecessors. PARDYP phase 1 ran from 1996 to 1999 and phase 2 from 2000 to 2002. Phase 3 started on the 1 January 2003 and will run to the end of 2005.

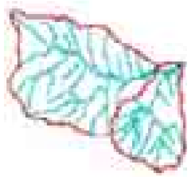
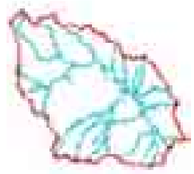
The phase 3 project objective, as it appears in the project log frame, is "Sustainable options applicable at household, community and policy level with proven impact potential for improving food and water security and income of rural households are developed through applied interdisciplinary research."

The Research Watersheds

The PARDYP network looks at watersheds of similar size (50-100 sq.km) and similar elevations (800-3,000m) and in each watershed carries out similar activities, surveys, and questionnaires, uses similar instrumentation, and furthermore uses the same software, so that results are directly comparable. The main cropping systems in the studied watersheds are broadly the same: rice and wheat in the irrigated valley bottoms and maize in the rain-fed upland areas (see Table 2.1).

Research in the Jhikhu Khola watershed, Nepal, started in 1989 and has continued to date without a break. Now 13 years of data on soil and water dynamics are providing new insights into both intensification and degradation processes. The lessons learned in the Jhikhu Khola continue to be adopted and guide the current phase of PARDYP in watershed management research across the Himalayas. For the other four watersheds data collection started in 1996.

Table 2.1: **Characteristics of the PARDYP watersheds**

	Xi Zhuang (China)	**Bheta Gad Garur Ganga (India)**	**Jhikhu Khola (Nepal)**	**Yarsha Khola (Nepal)**	**Hilkot-Sharkul (Pakistan)**
Physiography (maps at different scales)					
Total area (ha)	3,456	8,481	11,141	5,338	5,230
Elevation range (masl)	1700-3075	1090-2520	800-2200	1000-3030	1448-2911
Climate	wet and dry seasonal variation	sharp wet and dry seasonal variation	humid sub-tropical to warm temperate	humid sub-tropical to warm temperate	humid sub-tropical to cool temperate
Dominant geology	limestone and sandstone	schists and gneiss	mica schist and limestone	gneiss, slate, and graphitic schist	micaceous schist, and slates
Total population	4,016 (1997)	14,524 (1998)	48,728 (1996)	20,620 (1996)	11,322 (1998)
Population density (people/km^2)	116	171	437	386	62
Av. family size	4	7	6	5	8
Dominant ethnicity	Han Chinese	Brahmin, Rajput, Scheduled Castes	Brahmin, Chettri, Tamang, Danuwar	Brahmin, Chettri, Tamang	Gujar, Swati, Syed
Major cash crops	tea, tobacco, fruits	winter vegetables, fruits, tea, fodder	potatoes, tomatoes, rice, fruits, vegetables	seed potato, some fruits	fruits, fodder
Main staple crops	maize, wheat, beans, potatoes, rice	mixed cereal, grains, rice, wheat	rice, maize, wheat, potatoes, millet	maize, rice, millet, potatoes, wheat	wheat, maize, rice

Project activities range from agronomic and horticultural initiatives, socioeconomic and market studies, rehabilitation of degraded lands and forestry, soil fertility studies, and participatory conservation activities, to water and erosion studies. PARDYP encourages regional data exchange, and generation and dissemination of knowledge.

The research teams work closely with farmers and are able to observe what works and what does not. The approach is that farmers who are employed as erosion plot or hydrometeorology readers are also the project's point of contact with farmers for research and demonstration trials and dissemination of findings. This is a cost effective approach. PARDYP is a little different from many other donor-funded research initiatives in that the researchers are full-time employees of the project and are generally recent graduates with often limited experience. Guidance and staff development are provided by the Country Coordinator, a full-time employee of the NPI.

Research Approaches

During PARDYP phase 1 the emphasis was on improving the understanding of environmental and socioeconomic processes associated with degradation and rehabilitation of mountain ecosystems and on generating wider adoption and adaptation of proposed solutions by stakeholders in the Hindu Kush-Himalayas (ICIMOD 1996).

The first phase focused on six components:

- water balance and sedimentation;
- soil fertility improvement and soil erosion control;
- socioeconomic factors in terms of resource management;
- natural resource management strategies;
- capacity building of project partners;
- dissemination of knowledge.

Achievements in this phase were primarily to set up the research network, to set up the gauging stations and the meteorology stations, and to recruit staff and train them in research methodologies.

The results from phase 1 (1996-1999) clearly showed the need to adopt a much broader and more inclusive approach to natural resource management research. Community institutions, common property resource management, issues of gender and equity, as well as livelihood potentials were considered to be important next steps for research and were, therefore, more prominent in phase 2.

In PARDYP phase 2 (1999-2002) the emphasis shifted more to research issues targeted at achieving balanced, sustainable, and equitable development for mountain communities and families in the Hindu Kush-Himalayan region (ICIMOD 1999). To achieve these aims, project activities were organised around six major components:

- understanding community institutions and their dynamics;
- social and gender inequity, marginalisation;

- water resources for irrigation and domestic use;
- on-farm resources
- common property resource management;
- livelihood potentials for mountain communities.

What worked in PARDYP Phases 1 and 2?

Project staff began to think in terms of watersheds. There was an improved understanding of the interactions between agriculture, forestry, and water, in particular the extent to which forests provide organic matter inputs into farming systems, the importance of these nutrient transfers, and how improved composting can help maintain soil fertility levels. Databases and data collection methodologies on water have been developed to an extent that they are regionally and probably globally significant. An initial synthesis of the water and erosion studies is adding value to the data from the four participating countries. The operational approaches developed in phases 1 and 2 have been assessed; so phase 3 will run based on the best practices developed in each of the watersheds. At an operational level, the regional annual meetings, where exchange of ideas, peer critique, and triggering of competitive behaviour among partners took place, were considered by all to be very useful. Similar conclusions, drawn from several sites across the watersheds, increased confidence in the results and conclusions. There is increased research capacity in the PARDYP teams through regionwide training and mutual exchange of skills and competences. All teams are now very much aware of the importance of sociopolitical issues, an important development for natural resource scientists to grasp.

What did not work in PARDYP Phases 1 and 2?

Data were not fully shared and the quality of the shared data was sometimes questionable. There was a lack of project ownership at the regional level, often teams felt they were collecting data for ICIMOD and generally there was not a feeling of being part of a regional project but of four country projects in competition. This was seen where country teams were reluctant to pay for regional activities out of their country budget and in a lack of peer feedback on publications and management suggestions. There was poor communication between and among countries, universities, and donors and some of the management meetings were not very effective. There was limited regional thinking, perhaps because project design assumed regional thinking would come about by merely linking four country programmes.

A New Approach

In PARDYP phase 3 (2003-2005) the intention is to build on the lessons learned and to develop a more effective regional synthesis of results. It is anticipated that this can be achieved through a new approach whereby team members based in each of the watersheds carry out 21 research sub-projects.

The 21 sub-projects of phase 3 (ICIMOD 2002) are grouped into four ‘expected results’. Each sub-project has its own log frame.

- **Improve farming systems productivity**
  Activities include: analysing the effect of land-use policies on systems to develop conducive policy options, participatory action research (PAR) for incorporating non-timber forest product species into farming systems; testing options for high-value cash crop-cum-irrigation using PAR; developing with women strategies for reducing their workload in common natural resource use and studying the impact; using a case study approach, further research on 'farmers' decision-making processes' in livelihood strategies of their farming systems through adoption studies; PAR with farmers in marginal lands to improve land management practices and linking to extension services; and organising farmer exchange programmes and training.
- **Increase productivity of agricultural land**
  Activities include designing an intervention and testing programme on sustainable soil management for possible replication in all PARDYP watersheds; conducting PAR in collaboration with appropriate partners on soil fertility covering a few topics (for example, biofertiliser, compost, vermiculture); analysing soil erosion data and identifying critical land practices; monitoring soil fertility dynamics in upland/lowland sites; looking at land use changes from high-resolution satellite imagery; and conducting repeat surveys and questionnaires from earlier research for reporting change.
- **Identify, test, and disseminate water management options for equitable access**
  Activities include continued monitoring and analysis of water data to detect dynamics and testing management options for water supply, quality, and demand at household level.
- **Optimise access to ensure sustainable, secure, and equitable use of resources**
  Activities include assessing access and use rights from gender and equity perspectives; carrying out livelihood analysis based on previous surveys; conducting institutional analysis for equity and access at macro, meso, and micro level; reviewing and recommending equitable options for water, land, and forest resources through policy briefs; and continuing dialogue with policy makers at multiple levels.

Studies of Dynamics

One of the main project outputs is the increased understanding of natural resource dynamics and changes in socioeconomic conditions. Hydro-meteorological monitoring provides the indicators at the watershed level as to how land-use dynamics and changes in farming practices are impacting on some of the natural processes in the watershed.

Water, erosion, and related matters

This group of activities specifically aims at the generation and exchange of information on water as a resource and its role in land degradation, and at identifying and testing options to enhance water management decisions. The main activities in this context are monitoring and collection of baseline information, water quality monitoring, soil conservation, and water management. The resource monitoring is mainly looking at the water resources from a biophysical point of view. The water management activities have people at the centre of the research. For understanding water quality issues and soil conservation approaches, the activities have to be addressed equally from biophysical and socioeconomic points of view.

The set-up of the station network in all watersheds followed the same principle of the nested approach. The nested approach is presented in Figure 2.2.

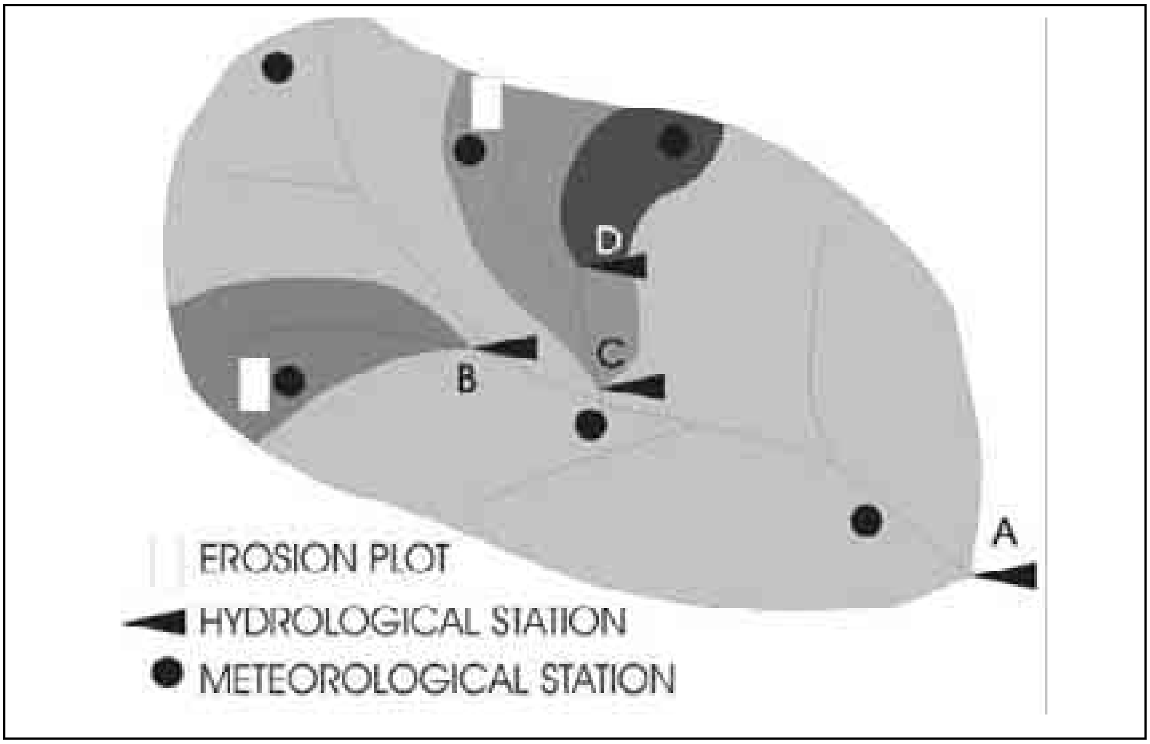


Figure 2.2: **Principle of the nested approach (schematic). Letters indicate sub-catchment gauging stations**

This nested approach allows us to investigate the processes from a micro- to a meso-level, that is from the plot to the watershed level, and subsequently to determine the scale dependency of these processes. Erosion plots and, more recently, surface flow collectors are used for the plot level investigations at $100m^2$ and $2{\cdot}5m^2$ respectively. Sub-catchments and catchments ranging from a few hectares to several square kilometres are monitored with hydrological stations equipped with different instruments. The watersheds range from 34 to 110 sq.km in size.

During the first three years, between 1997 and 1999, major emphasis was given to data collection. Long-term data collection was initiated with the set-up of a measurement network in five watersheds in the Hindu Kush-Himalayas. A total of 89 measurement sites were operational in June 2001 and were monitored by local residents who received annual training and new instructions if needed (Table 2.2).

The collected data are being thoroughly checked and then stored in a watershed database running on the hydrological software HYMOS 4. The use of the same software in all watersheds ensures the exchangeability of data between the different country teams. The final data are published annually in the form of a yearbook; the yearbooks for the Nepal watersheds have been compiled up to 2001 and are available on CD-ROM.

Table 2.2: **Measurement sites in the five PARDYP watersheds, June 2001**			
Watershed	**Hydrological stations**	**Meteorological stations**	**Erosion plots**
Xi Zhuang, China	4	10	6
Bhetagad, India	6	5	4
Jhikhu Khola, Nepal	5	10	7
Yarsha Khola, Nepal	4	11	4
Hilkot, Pakistan	4	6	3

Changes in land use

PARDYP produced land-use maps for 1972 and 1990 for the two research watersheds in Nepal from 1:20,000 scale aerial photographs. In brief, the major changes in the last 15 years in the Yarsha Khola occurred in the forest cover (increase) and the rain-fed agricultural areas (decrease). In the Jhikhu Khola both the forest cover and the rain-fed agricultural areas increased and shrub and grassland decreased. Shrestha and Brown (1995) and Shrestha (2000) discuss the results in detail. In Pakistan there has been little change in land use. In China there has been a big increase in tree cover as a result of government reafforestation programmes including aerial seeding of *Pinus yunnanensis.* The current upland conversion policy will also impact significantly on the study area as cultivation on steep slopes is to be replaced by perennial tree crops. In India, significant changes can be seen clearly, with decreased annual cropping and increased tree cover as perennial crops increase. There are significant increases in the area of tea plantations. High-resolution satellite imagery (IKONOS) will be used to update the land use in all the watersheds in 2003.

Soils and land systems

Maps have been produced for each watershed. Significant changes in soil nutrient levels, particularly in the heavily used valley bottom of the Jhikhu Khola watershed in Nepal, are apparent from the periodic surveys of soil fertility carried out. Of great significance is the way farmers have adopted new practices to overcome nutrient deficiencies. In the early 1990s nitrogen was limiting. This was compensated for by increasing the amount of farmyard manure applied as well as some use of nitrogen rice mineral fertilisers. In the mid 1990s phosphate deficiencies were observed and farmers compensated by increasing the use of phosphate fertilisers. Now potassium is becoming a limiting nutrient. Monitoring of soil fertility, particularly in the intensively cropped valley bottoms, will continue for the next three years.

Water demand

In 1999 a water demand and supply survey was conducted in the Nepal watersheds. This same survey collected information on agricultural production and agrochemical inputs as baseline information for water quality surveys. The results are presented in Merz and Nakarmi (2001) and Merz et al. (2002). For the allocation of water resources, a detailed public water resources survey was carried out in both Nepalese watersheds. A total of 319 springs in the Jhikhu Khola watershed (Shrestha et al. 2000) and 215 springs in the Yarsha Khola watershed (Shrestha et al. 2000) were mapped and basic physical parameters measured. Similar studies have been completed in the other watersheds.

Socioeconomics

Initial household surveys were conducted in 1998 and 1999 in all watersheds. It is intended to carry out repeat surveys in 2003. In Jhikhu Khola, Nepal, the initial surveys were carried out in 1993 and a repeat survey in 1998. Unfortunately the current instability in Nepal has prevented a repeat survey, but it is hoped that this can be carried out in 2004. One common thread, appearing to be increasingly significant, is the remittance economy. Overall, farm incomes have increased at a greater rate where there is access to (irrigated) valley bottomland than for farmers with only upland rain-fed land.

On-farm trials of promising technologies and new approaches

A network consisting of natural resource institutions from across the region can be an effective way of carrying out research, particularly by concentrating on the research strengths of the different institutes. For example the PARDYP team in China has particular expertise in fruit trees, in India bio-fertilisers and microbiology are strengths, and in Pakistan agroforestry research has been particularly successful. In addition, there are different pressing problems faced by the inhabitants of the different watersheds: water in the dry season in Nepal, poor planting material in Pakistan. This concentrates the efforts of different teams on different issues and the findings can then be shared with the other partners. However, it is very important to establish very clear research hypotheses at the start of any research and make sure that the results are related to these.

Regional Comparisons

In addition to the topical studies mentioned above, regional comparison and synthesis of the data collected is a significant activity and is becoming increasingly interesting as more data become available.

Attempts to integrate the results from each watershed using geographic information systems and other technologies in order to construct a picture of the behaviour of, for example, water and sediment in terms of time, season, land cover, and extremes are proving to be very interesting. The comparison of these results and key findings between the watersheds is being used to formulate and explain the main similarities and differences across the region and to model scenarios under given and changing conditions to predict flow regimes and sediment transport on an ‘if this, what then’ basis.

Three PARDYP watersheds were used as part of an even broader comparison between the Himalayas and Andes (see http://www.ire.ubc.ca/himal/index.htm) funded by IDRC.

In 2003 a major effort is underway to consolidate the data collected and analyse the information, and to provide position papers and next steps for further studies. In addition, the purposes for which the studies were initiated have also changed. For example, the information is now proving increasingly important as baseline data for measuring climate change. Cropping patterns and nutrient levels have shown great change and will continue to be monitored for the next few years. These studies in the Jhikhu Khola watershed are particularly relevant to the other PARDYP watersheds (and more widely in the region). The Jhikhu Khola watershed is near the big markets of Kathmandu and land use and crop production methods are very dynamic. The lessons learned and the strategies adopted by farmers to overcome the various nutrient deficiencies may help farmers who will face similar problems elsewhere as they too intensify crop production.

Conclusions

There are many benefits from conducting research on natural resources through a regional network approach, either by all participating groups conducting the same or very similar research and comparing the results or by partners taking on separate tasks and then sharing the results. Joint problem solving can clearly lead to economies of scale and enhanced South-South exchange and capacity building. There are also benefits from improved coordination of training, facilitating mutual learning, cost-effective support, and strengthened self-confidence of the partners. A regional network also ensures scaling up of positive experience. Such collaboration can also enhance mutual understanding that may lead to collaboration beyond the scope of a project, as well as mutual respect among competing partners.

However, such approaches are very time consuming to manage and often end up with methodological outputs and 'meta' products and can be more difficult to evaluate than stand alone projects. Watershed management research requires the understanding of many natural resource processes and functions, and how they interact. These interactions are complex and very dynamic and the results inevitably raise more questions. We can learn from farmers who have overcome pressing problems in one location and share the results across the region.

Acknowledgments

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3 LIVING AT THE MARGIN IN HILLS – People Building Sustainable Livelihoods Based on Renewable Natural Resources[1]

Michael Stocking[2]

Abstract

Since 1995, the Hillsides production system of DFID's Natural Resources Systems Programme (NRSP) has been developing and promoting improved hillsides farming strategies relevant to the needs of marginal farmers. This work has addressed three main questions, (1) What is the knowledge-base of relevance to the livelihoods of marginal hillside farmers? (2) What are the best means for local professionals and rural communities to identify the most appropriate means of natural resources management and target them to poor households? (3) How can pilot research experiences be accelerated and scaled up to the wider community? The experience gained by NRSP demonstrates how poor people can build sustainable livelihoods based on the management of renewable natural resources on hillsides.

Hillsides production systems are characterised by farming activities (crops, trees and livestock) on steep slopes where difficult terrain results in poor accessibility, limited infrastructure and markedly impoverished communities. Use of lands that are characteristically hillsides has led to their degradation with soil erosion, declining soil fertility, and deforestation all contributing to low productivity. In addressing these land management problems, NRSP adopts an integrated systems approach towards the development and promotion of improved farming strategies that meet the needs of marginal farmers. Current projects are in Bolivia, Nepal, and Uganda. All projects, in varying ways, emphasise the factors that limit the adoption of available technologies.

One way to understand the complexity of livelihoods in hillsides systems is to employ the Sustainable Rural Livelihoods (SRL) framework and conduct an analysis of how people develop their various capital assets. While financial, physical, and natural capital assets are extremely limited, social and human assets enable people to overcome the difficulties of their environment and secure their livelihoods. Social networks and reciprocal arrangements are especially important.

DFID and Hillsides Research on Renewable Natural Resources

The Department for International Development (DFID) is the UK Government department responsible for promoting sustainable development and poverty reduction.

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1 Case examples are drawn from the DFID Natural Resources Systems Programme (NRSP) for Hillsides Production Systems operating in Bolivia, Nepal and Uganda.

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DFID's mission statement includes addressing poverty reduction and sustainable development, especially in the poorest countries of sub-Saharan Africa and Asia (DFID 2004). Through DFID, the UK is committed to the internationally agreed Millennium Development Goals, to be achieved by 2015. In the context of natural resource (NR) systems, two MDGs are being supported: Goal 1 aims to eradicate extreme poverty and hunger and Goal 7 to ensure environmental sustainability. DFID contributes directly and indirectly to environmental sustainability through the integration of strategies for poverty eradication into efforts to combat NR problems such as desertification and drought. The UK commitment to development assistance is rising significantly, from approximately £3.4 billion in the financial year 2002/03 to £4.9 billion by 2005/06 in line with the UK Government's target to achieve a 0.4 percent of gross national income devoted to development assistance. One of the major pillars of this assistance is research. DFID's Renewable Natural Resources Research Strategy (RNRRS), covering the decade 1995-2005, focuses on the generation of new knowledge in natural and social sciences. It also emphasises the promotion and application of the use of this knowledge to improve the livelihoods of poor people in a sustainable way through better management of renewable NR systems. A key strategic requirement is that all research must be demand-led, with the needs of poor people clearly identified. As part of the RNRRS, the Natural Resources Systems Programme (NRSP) funds research with the goal of generating benefits for poor people by the application of new knowledge to NR systems.

NRSP is meeting this goal through delivering new knowledge that can enable poor people, who are largely dependent on the NR base, to improve their livelihoods. The central focus of knowledge generation is on changes in the management of the NR base that can enhance the livelihood assets of the poor over a relatively long timeframe. This will provide greater livelihood security and opportunities for advancement of poor individuals, households, or communities. Integrated management of natural resources is central to the research, where the "systems approach enables a better understanding of the actual situations of households in specified production systems in target countries" (DFID-NRSP 1999, p.4). Not only does the systems approach better define the NR base (landforms, soil, water, vegetation, and organic residues) but it also emphasises the integrated and dynamic nature of people's livelihood strategies and how these affect their decision-making and capacity to use and manage the NR base. Studies of the livelihoods of the poor and their interaction with other (less poor) sections of society are an important part of NRSP's research. They are a means of understanding what changes in the management of natural resources are feasible and how poor people's adoption of, or response to, these changes could assist them to secure and build their livelihoods.

One of the 'production systems' of NRSP is the Hillsides Production System (HSPS), to which historically NRSP has devoted about 15 percent of its budget. Hillsides and mountains tend to accommodate many of the poorest people. Land quality is poor, people are isolated, and literacy rates are amongst the lowest. In a study of NRSP's portfolio of production systems and target countries, HSPSs in Nepal, Bolivia and

Uganda recorded the lowest road density, the least literacy, and an average Gross Domestic Product of US$1556 per annum (Taylor et al. 2003). These are clear indicators that hillsides should receive priority attention to meet the MDGs.

HSPS has changed substantially since 1995. Initially there was a strong technical focus on developing new technologies on the assumption that development is limited on hillsides by lack of **knowledge** of appropriate techniques. That assumption was challenged as DFID increasingly turned its focus towards issues of poverty, livelihoods and **access** to knowledge. The current goal, purpose and output of HSPS are given in Table 3.1 and HSPS now adopts a more holistic systems approach, especially at Output level, with a specified focus on 'farming strategies' and the 'needs of marginal farmers'. Activities concentrate on the **application of technologies** and ways to **extend research benefits** to greater numbers of poor people. The three principal sets of activities are grouped around themes, namely:

a) Livelihoods of marginal hillside farmers;
b) Identification and matching of technologies to poor households;
c) Applying, extending and scaling-up results.

The first set of activities examines the means to achieve sustainable soil and land resource management in hillsides environments. It involves an understanding of the livelihoods base of marginal hillside farmers, including society, economy, and environment. The second concentrates on the analytical tools necessary for assessing soil and land resource management issues and targeting these to farming strategies that are relevant to hillside communities. The third set of activities holds the greatest challenge and is the current focus: how to benefit poor people well beyond the immediate target areas of the research projects. HSPS is doing this through assessing the possible ways to scale up, undertaking pilot examples of integrated soil and land resource enhancement, and funding uptake promotion through symposia, workshops, and new initiatives. NRSP-HSPS commissioned a review of scaling-up strategies for research in NR management (Gündel et al. 2001), which is intended to guide future projects in building wider impact and greater application to large numbers of poor people.

The Symposium of February 2003 held in Nepal on 'Renewable Natural Resources Management for the Hindu-Kush Himalayas' also forms part of this last set of activities, enabling the wider community of scientists in the region to consider the lessons learnt by nearly a decade of research on the natural resources of hillsides.

The objective of this paper is twofold. First, it is to describe some of the key livelihood characteristics of people living on hillsides in order to ascertain the characteristics that have led to their building of sustainable land use. Secondly, it is to provide researched examples of livelihood strategies that are enduring, have the ability to cope with external pressures, and demonstrate lessons that may be valuable more widely for sustainable development. Other chapters in this book present the progress made on specific activities of NRSP-HSPS work.

Table 3.1: DFID's Natural Resources Systems Programme – the Hillsides Production System Logical Framework

Narrative Summary	Objectively Verifiable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions
Goal			
Livelihoods of poor people improved through sustainably enhanced production and productivity of RNR systems	Measure of change in capabilities, assets and activities		
Purposes			
Benefits for poor people in target countries generated by applications of new knowledge to natural resources management in hillside production systems	By 2005 evidence of application of research products to benefit target communities by achieving one or more of: - Sustainable production increase - Less variable production - Productivity increase - Improved employment (numbers, income, quality) - Improved access by poor people to RNR outputs	DFID commissioned reviews Monitoring against relevant baseline data collated by the programme Reports of in-country institutions National statistics	Enabling environment (policies, institutions, markets, incentives) for widespread adoption of new strategies and practices exists Climatic conditions are favourable
Output			
Improved hillside farming strategies relevant to the needs of marginal farmers developed and promoted	• By 2000, knowledge base for soil and water conservation, and maintenance and improvement of soil fertility relevant to marginal hillside farmers developed in at least two target areas • By 2004 new approaches to enabling local professionals and rural communities, including the poorest individuals and households, in remote hillside environments to adapt relevant NR management knowledge to their circumstances and apply this knowledge developed and promoted • By 2005 this new knowledge incorporated into the development strategies of target institutions of at least two hillsides target countries	Reviews by programme manager Reports of research team and collaborating /target institutions Dissemination products Local national and international statistical data Data collected and collated by programme manager	Target beneficiaries adopt and promote systems and approaches Enabling environment exists Budgets and programmes of target institutions are sufficient and well managed

Society, Economy and Environment of Hillsides

People living on hillsides and mountain slopes are literally dwelling 'at the margin' of society, of the national economy and of the wider biophysical environment. NRSP-HSPS in its earliest set of activities sought to characterise society, economy and environment in terms of the livelihoods of people who dwell on hillsides. The following brief account of marginal hillside farming situations is based on a synthesis of NRSP-HSPS research and other studies, such as those undertaken for the UN International Year of Mountains in 2002.

Through their inaccessibility to the rest of society and their vulnerability to catastrophic environmental processes, hillsides provide a precarious future for local people. Risk and uncertainty characterise day-to-day living (Thompson et al. 1986) and there has been a long history of debate about the changing Hindu Kush-Himalaya environment especially (Blaikie and Muldavin 2004). The problems of the poor are generally more acute on hillsides. Because communities are poor, their strategies for coping have to be more complex and diverse in order to withstand a dynamic and unpredictable environment (Chambers 1997). They have to be involved in a large number of activities in order to survive and have to exploit fully their precarious biophysical environment. Especially vulnerable are the landless, the land-scarce, women, the elderly, and dependent children (Ellis-Jones 1999). They demand little attention and get even less from policy-makers and professionals. Their votes are sought for elections, but the services promised rarely materialise because pressing matters in the towns and affluent rural areas intervene. Conflict, political destabilisation, and policy confusion are especially prevalent in mountain areas (Blaikie and Sadeque 2000). Similarly, many of the world hot spots of land degradation are in poor areas that coincide with steep slopes (Scherr and Yadav 1996). Rates of degradation and environmental change are at a maximum in the steep terrain of hillsides (Messerli and Ives 1997), and change can be both incremental (soil erosion) and catastrophic (landslides).

Yet at the same time, societies who live in these challenging environments provide us with important lessons and empirical examples of how to survive, how to adapt and to adopt innovative ideas and technologies, and how to live sustainably in an uncertain world. However, this is a far different view of these societies than that which has pertained even up until very recently. As Ives (1999) describes:

> "The Nepali hill farmer was assumed to be responsible for massive deforestation, increased landsliding, soil erosion, and horrendous downstream effects through Gangetic India and Bangladesh, all the way to the Bay of Bengal..... the subsistent farmers were perceived as ignorant ... and reckless." (p.175)

Many of the elements of this assumption, subsequently known as the 'Myth of Himalayan Environmental Degradation', have come under scrutiny since the late 1980s. Although the 'myth' has been influential in the environmental policy process (Turner et al. 1995), most research, including that by NRSP-HSPS, has shown that environmental problems are not as intractable as first presented. Evidence has accumulated (e.g. Gilmour 1988) that the extreme statements were more the result of the prejudice of the observers than a real assessment of the state of hillslope environments. Hill people have typically been used as scapegoats for other problems such as land expropriation, corruption, and political intrigue, and for the failure of professionals adequately to understand the complexities and dynamics of mountain environments and societies (Forsyth 1998).

Notwithstanding predictions of disaster and collapse of hillsides society because of environmental degradation (e.g. UNEP 1984), most land use is remarkably enduring. For example, Sherpa village landscapes in the Mount Everest region have many planted trees and sacred forests, a product of centuries of evolution from original Tibetan beliefs of the spiritual power of trees. These are not only conservative of the landscape, but also critical to the preservation of the oldest and largest individual juniper, fir, birch and rhododendron trees in the region (Stevens 1993). Likewise, terrace systems in Nepal (Figure 3.1) have been maintained and have continued to produce for hundreds of years, even though stable and unstable political and social forces have come and gone (Wu and Thornes 1995). The people who have guarded such trees, structures, and practices are a repository of technical expertise from which the development community could derive vital answers to fundamental global concerns, such as how to conserve biodiversity, protect against soil erosion, and fashion a sustainable livelihood out of low-quality natural resources.

Michael Stocking

Figure 3.1: **Terrace systems below Annapurna – an enduring feature of the Himalayan mid hills of Nepal.**

Socially, hillsides provide the home for societies that have been able to preserve spiritual and cultural values which have been lost elsewhere. These values act to protect the environment (Bernbaum 1999). Traditional practice and ways of life based on these values can serve as models for lowland dwellers. In particular, the preservation of biodiversity is enhanced through sacred rights, religious observance, and spiritual worship, manifested by planting of trees, use of living fences, and keeping sacred groves or forests to bury the dead. Ethnic diversity is also important, maintaining a diversity of agricultural systems, conserving agro-biodiversity, and evolving complex landscapes that are linked to food security and livelihoods. In Xinjiang, the largest of the 27 provinces of China, Wenjiang and Yuhong (1999) suggest that the ethnic mix of about 47 different cultures is largely responsible for environmental protection. The climate is harsh, dry, and difficult. Most of these ethnic groups live in mountainous and steep areas, coincident with some biodiversity – over 3500 species of plants recorded and 608 species of fauna, including many on the national rarity list and many whose wild genotypes are cultivated and managed in situ. They question whether reserved areas could have achieved such protection.

Economically, hillside communities are amongst the poorest. Some opportunities for productive enterprises exist in some Andean communities, for example, but generally they are few and far between. Yet, natural resource management practices that maintain adequate depths of topsoil on steep slopes are frequent and justified locally for their economic potential. *Gliricidia sepium* contour hedgerows, typically planted by many farmers in the Hill Country of Sri Lanka, work by accumulating large amounts of sediment behind these living barriers of vegetation (Stocking and Clark 1999). They are relatively low cost, demanding an initial investment in labour and planting materials, as well as continuing maintenance and pruning of the plants – see Figure 3.2. However, the benefits for most land users lie in the multiple productive uses of both the hedgerow and the retained soil. The *Gliricidia* provides poles for sale, firewood, or the training of

Michael Stocking

Figure 3.2: ***Gliricidia sepium*** **hedgerows in the hill country of Sri Lanka – a locally adapted technology to create hillside terraces and greater production opportunities**

climbing beans. It also provides mulch and nutrient supply to the fields from the leaf litter. The hedgerow lines give a safe entry to fields, especially important on these exceptionally steep slopes. The accumulated soil not only gives greater fertility for the usual crops, but also provides planting spaces and soil depth for speciality and demanding crops. A study of the cost-benefit of the various soil conservation techniques shows that many practices have good financial viability for the small-farm household, provided that the complex and diverse aspects of the technologies are included in the analysis (Stocking 2001).

Biophysically, hillsides are vulnerable to soil erosion, land degradation, and their impacts such as loss in soil and plant productivity. In particular, accelerated soil loss and rapid depletion of soil fertility characterise steep slopes, making farming not only immediately risky but also potentially unsustainable without controlling interventions. Nevertheless, land users have inherited a wide array of techniques to manage these difficult circumstances, including bench terraces, sediment harvesting, and green cover and mulch crops. Ancient terraces and other land use systems that survive to this day are proof that these techniques are indeed sustainable. Much can be learned about the social, economic, and environmental conditions for the successful implementation of biophysical controls against land degradation on steep slopes. Development practitioners have a wealth of examples of sustainable rural livelihoods on mountainsides, a few of which will be cited in this paper. These broad aspects of living on hillsides can best be analysed in terms of livelihood capital assets and exemplified by some of the many examples of 'good practice' that are found world-wide on steep slopes.

Livelihood Characteristics of Hillside Communities and Environments

Hillside communities and environments present many challenges to development practitioners. The challenges are part of daily life for these communities and many have come to an accommodation with their situation, pointing to possible ways forward in solving problems elsewhere in the rural sector. The need to build upon farmers' practice and knowledge in hillsides has been ably demonstrated by Fujisaka (1989). A synthesis of the literature brings out the following attributes that lead both to problems on the one hand and to possible solutions on the other:

Inaccessibility

Hillsides are inaccessible and difficult to reach. This leads to physical isolation, poor communications, and weak infrastructure. Inaccessibility means lack of access to knowledge and ideas that lowlanders take for granted. It is also means poor markets, roads, credit facilities, services, and professional assistance. Chambers (1997, p. 80) identifies isolation and remoteness as one of the main features of the relationship between rural people and professionals, but instead of it being attributed to the peasantry, he features it as the characteristic of planners, economists, and professionals: "[they] are cocooned in comfortable (centrally heated, air conditioned) offices, with their exposure to the world of ordinary people largely limited to commuting, shopping, bars, tourism...... Their physical isolation is compounded by an illusion of instant contact through fax, e-mail, statistics and other proxies for people." If this is the gulf of understanding with poor people generally, how much more so is it with hillside dwellers?

However, this isolation may also mean the generation of local coping strategies. For example, in Tanzania ngoro is a local name for the pitting conservation system of the Matengo tribe in Mbinga District. Ngoro has been in use for over 200 years (Allan 1965; Malley et al. 2004). The system is an indigenous and ingenious means of soil, water, and nutrient conservation for land cultivation on steep slopes (Figure 3.3). Similarly, in Nepal one of the NRSP-HSPS projects has identified the inherent skills behind farmers' practices in the middle hills, including local soil names, measures to stem soil and nutrient losses, and management practices on bari land terraces (Desbiez et al. 2004).

Michael Stocking

Figure 3.3: **Construction and maintenance of ngoro ridges, south-west Tanzania. An example of sustainable soil management practices developed and practised locally**

Poverty

The quality, abundance, and accessibility of natural resources such as soil, water, and growing season are constraining issues in hillsides and mountain areas. Forests may, where ecologically possible, provide a buffer for poverty. However, such opportunities are getting rarer as forests are increasingly exploited. Hillsides communities, therefore, are often amongst the poorest and most dispossessed. It is difficult from official statistics to isolate the degree of poverty that prevails in hillside environments. However, poverty is linked to inequality (UNDP 1992), and inequalities promote environmental deterioration and contribute to conflicts. Messerli and Ives (1997) report that of 48 wars and conflicts in 1995, 26 took place in or directly affected mountainous regions.

Anecdotal evidence and news reports suggest that the situation is even starker today: Kashmiri separatist movements in India and Pakistan; Maoist insurgents in Nepal; and Taleban mountain retreats in Eastern Afghanistan.

However, out of poverty can come tested and verified indigenous technologies. These are practices that rely on the immediate natural resource base, rather than bought-in external inputs. For example, in Embu-Meru districts around Mount Kenya the poorest social groups also practice some of the most effective and low-cost soil conservation practices. Typically, these are trashlines made up of weeds, scraped together into contour ridges. Not only do these practices conserve soil, they also provide an extremely low-cost way of retaining water and nutrients. Studies of trashlines have shown their economic benefit, in contrast to the cost of many imported techniques (Kiome and Stocking 1995). Effective environmental protection and secure livelihoods have arisen out of necessity

Landlessness

Hillsides areas typically have large areas of open access or common land, or land that is nominally under state control as forest or reserve. NRSP has investigated the links in Nepal between social structure, livelihoods and common pool forest resources, for example (Seeley 2003). While in some benign political regimes in the Andes de facto access is not a problem, elsewhere it can be uncertain. Gaining title to land is difficult, if not impossible. Large parts of the Mahaweli Ganga catchment in the Hill Country of Sri Lanka has been kept as state forest land, although trees are only evident in plantations. When the Victoria Dam and several other reservoirs were constructed in the 1970s, some 40,000 small farmers were displaced. The more powerful and influential of these farmers gained places on the new Mahaweli irrigation schemes, though these had their risks and problems being out on the dry plains below the well-watered and fertile valleys. But the rising water displaced the majority of the poor, including those who rented or sharecropped land.

The only feasible place to go for many of these mainly landless people was to the upper catchment steep slopes, to earn a living illegally farming tobacco, vegetables, and, where possible, rice. These farmers were accused at the time of ruining the slopes and causing erosion and sedimentation into the reservoirs, and of damage to the electric turbines producing power for Colombo. Certainly, there was much erosion from the tobacco fields because of the poor cover. However, subsequent surveys revealed that none of this sediment reached the reservoirs; it was all trapped further down the slope where the farmers started to construct sediment traps and to make new fields. The legal status of some of these new farms has been settled and some have turned their enforced illegality into a viable production unit. Others still have to farm surreptitiously. In the majority of cases, these steep hillside fields are well conserved, stable, and viable. To an extent, this is an unplanned 'good news' story, but it can be replicated in many other places, where difficult economic and social situations, in this case landlessness, have turned out to be the forcing factor for good land management.

Fragility

This gives rise to vulnerability to catastrophic events, such as landslides, hailstorms, and loss of infrastructural assets. Fragility is related to sensitivity and resilience, and in both aspects, hillsides are exceptionally vulnerable. They are sensitive in the sense that only small 'shocks' or perturbations may have an exceptionally large effect, such as landslides or rockfalls. They lack resilience in the sense that these same shocks are far more common in their occurrence and hillside slopes will usually always suffer some consequence. Hillside farmers in Nepal use local terms for 'strength' and 'power' of their soils, which encapsulate notions of degree of fragility (Joshi et al. 2004). Unpredictable and severe disruption to livelihoods is endemic in mountain communities, because of the steep slopes and sudden storms, often of hail, which cause great damage to crops, houses, livestock, and communications. Landslides are an especial problem in hilly areas of south and Southeast Asia where terrace systems predominate – see Figure 3.4.

Michael Stocking

Figure 3.4: **Landslides cut through old terrace systems near Landruk, mid-hills of Nepal**

Some communities, however, manage this fragility with long-term benefit. In the steep valleys leading up from the north coast of Jamaica near Moore Town, old landslide scars are evident everywhere and occur regularly during 'hurricane season' when 100 mm of rainfall may typically fall in less than one hour. For individual farms and households along the line of disruption, a landslide is short-term disaster. Houses have collapsed, fields have slipped, and trees and perennial crops destroyed. However, over two or three years, the landslide scar is relatively quickly replanted, fields organised, and new homesteads built. Scars are recognised as relatively stable and unlikely to re-slide in the near future. Furthermore, the exposed soil has more weatherable minerals and is generally more fertile. The line of the scar is usually also better-watered, with springs and greater access to small-scale irrigation possibilities. These old landslides are clearly evident in the lush vegetation and greater production opportunities afforded by the new local environmental conditions.

Marginality

This affects hillside communities in most aspects – most obviously physically, but also socially, economically and politically. Physical isolation manifests itself in long distances, usually on foot, to the nearest town and source of information exchange. It shows itself also in communities that only visit each other occasionally for festivals and feasts. In so far as external relations are concerned, communities are often ignored, rarely prioritised in development plans, and infrequently involved in policy debates. They are separate from the mainstream economy, well away from markets, sources of credit, infrastructure, and advice on subsidies.

Nevertheless, such isolation appears to bring into operation a willingness and desire (and maybe a necessity) to innovate. It leads to traditional techniques to conserve, many examples of which occur in Andean communities. Quiroz (1999) recounts the richness of the knowledge and understanding shown in farmers' own experiments in the Venezuelan Andes. This is not to say that such innovation and expertise does not occur elsewhere. However, in marginal hillside areas most reports suggest that a far higher proportion of land users experiment (for example, 90 per cent of all settler farmers of the upper Chanchamayo in Peru were dedicated experimenters [Rhoades and Bebbington 1988]). It is difficult exactly to account for this phenomenon, but clearly the fact that marginality reduces the gaining of lessons and advice from elsewhere, throws farmers much more into gaining such knowledge directly by their own experimentation.

Diversity and complexity

Farmer experimentation reflects the great dynamism and change in hillside environments, but that same dynamism presents considerable challenges both to local people and to development practitioners. The dynamics extend to influences on the political system as described for the Peruvian Amazon by Pinedo-Vasquez and Pinedo-Panduro (2001). One may ask: how can we possibly intervene successfully, when the whole system is changing so rapidly and so unpredictably? There is a diversity of conditions of the natural environment, often over very short distances. The quality of soils may vary from excellent in small pockets where a barrier has retained good depths of sediment, to very poor, thin, stony soils on eroded slopes. Similarly, other aspects of the biophysical environment may change rapidly over time and space. This diversity is compounded by a complexity of ethnic groups, minority tribes, languages, and cultural practices existing on steep slopes. It means that blueprint solutions, blanket forms of aid assistance, and simple extension messages cannot possibly be appropriate to more than a very small percentage of the people and places in hillside environments. So, for example, spatial diversity of soil types is reflected in complex niches, part of the mosaic of micro-variability of field plots. It is impossible to recommend a fertiliser or cropping strategy for such complexity. Indeed, the farmers own response to this complexity is to plant and manage a wide diversity of species, varieties, and genotypes in order to utilise the micro-variability.

These two related attributes of complexity and diversity in small-holder farmers' livelihoods have been well described in a number of recent books on natural resource management topics: in the context of agricultural experimentation (Prain et al. 1999), plant genetic resources (Almekinders and De Boef 2000), and soil fertility (Scoones 2001). In the Peruvian example cited above, the biodiversity found in the landholdings of Muyuy residents is largely a response to complex production and management technologies gained in periods of political instability and fluctuating markets. Yet, as the authors of the study note, most development projects in rural areas are still promoting single crops or single products. This ignores the important role of diversity in matching the very different specific needs of different farmers. Diversity acts as insurance and provides farmers with options to respond to change. Taking plant genetic diversity, for example, it supports access and exchange, and this in turn contributes to the dynamic and adapted nature of farmers' management. Almekinders and De Boef (2000) talk of "reversing the treadmill" (p. 325) and embracing diversity and complexity as positive attributes of resilient agricultural systems. So-called 'modern' agricultural systems are vulnerable to environmental disturbances, such as pests and diseases, or even small variations in climate. El Niño climatic events, for example, are a major problem for farmers in the Bolivian Andes, affecting choice of crops, soil management, and indeed whether to seek work outside the rural areas because of wholesale crop failure (source: NRSP/DFID Project R7584 – www.nrsp.org.uk). So, diversity and multiple routes of change are the only answer to these challenges.

Capital Assets

In order to appreciate how and why people can live in challenging environments, such as hillsides, it is necessary to understand the resources they have at their disposal, usually termed their 'resource endowments' or 'entitlements' (Sen 1992). A good recent example of the importance of endowments in their relation to poverty is amongst the hill and tribal people of the Chhotanagpur Plateau of eastern India (Banik et al. 2004). Endowments are not just material assets; they include everything that people can access and transform into a livelihood outcome. Sen, for example, explains how people can starve in the midst of food plenty because of a collapse of their means of command over food (Sen 1981), a situation that pertains in many hillside areas. Because the biophysical environment is either deficient (for example, thin, poor, stony soils) or hazardous (landslides, hailstorms) or simply naturally poor (for example, growing season), it has often been concluded that livelihoods are inevitably insecure and sustainable management of natural resources is effectively impossible. Is this necessarily so?

To concentrate solely on the biophysical is to ignore a wealth of other resources. It is said that the blind or deaf compensate (if only partially) for the loss of one faculty by enhancement in another, such as touch, taste, or smell. Similarly, it seems from anecdotal evidence that there is compensation for the lack of biophysical resources in a greater abundance of attributes related to society, local economy and human resources. Such compensation is implicit in the many case studies recounted in the UNEP volume on 'Cultural and Spiritual Values of Biodiversity' prepared for the Global Biodiversity Assessment. They recount a wealth of value in the non-biophysical aspects of difficult environments, such as those that occur on hillsides (Bernbaum 1999). There is a spiritual, cultural and social distinctiveness, which cannot simply be explained by isolation or inaccessibility. The natural forest islands around orthodox churches in highland Ethiopia are one example. How can these compensatory mechanisms be addressed within one framework that can bring together all the resource endowments at a society's disposal that constitute the building blocks of a sustainable environment? The answer has been the development of the SRL Framework. It balances what are called the five 'Capital Assets' and provides a framework for analysing how livelihoods may be constructed by any combination of different assets and how dynamic societies trade off one asset for another according to immediate and longer term needs.

The different capital assets and their manifestation on hillsides are described in Table 3.2. Essentially the livelihoods approach is concerned with people, and understanding their strengths (assets or resource endowments) and how they endeavour to convert these into positive livelihood outcomes (DFID 1999). The approach is founded on a balance of assets required in order to achieve a positive livelihood outcome. This can be constructed as a pentagon (Figure 3.5a) in order to present information about the diversity of assets that may be combined in order to construct a livelihood. The shape of the pentagon (Figure 3.5b) may then be used schematically to show the variation in

Table 3.2: **Capital assets in the Sustainable Rural Livelihoods Framework, with a particular emphasis on areas prone to land degradation***

Natural capital	"The natural resource stocks from which resource flows and services (e.g. nutrient cycling, erosion protection) useful for livelihoods are derived." Included here are aspects of the natural environment such as soils, topography, water, and the livestock, crops, and other plants that together support livelihoods. In hilly areas, these stocks of natural resources may be quite vulnerable – e.g. deforestation and loss in biodiversity; land clearance and erosion.
Human capital	"The skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve livelihood objectives." Innate and learned skills in hilly areas include physical fitness and ability to carry heavy loads on steep slopes.
Physical capital	"The basic infrastructure and producer goods needed to support livelihoods." Infrastructure includes accessible transport, secure shelter and buildings, adequate water supply and sanitation, affordable energy, and access to communications. Producer goods include tools and equipment to enable people to exploit the natural capital. Hilly areas are usually always deficient in physical capital, except water.
Social capital	"The social resources upon which people draw in pursuit of their livelihoods." These social resources are developed through networks, membership of more formal groups, allegiances and relations of trust, reciprocity, and exchanges. Social capital is probably the key transforming and 'safety-net' capital for poor, mountain societies.
Financial capital	"The financial resources that people use to achieve their livelihood objectives". It comprises access to cash (including remittances from migrants) or to credit, which enable the land user to make choices about investments in natural or human assets (e.g. building a terrace, or hiring labour).

* adapted from DFID (1999) by Stocking and Murnaghan (2000)

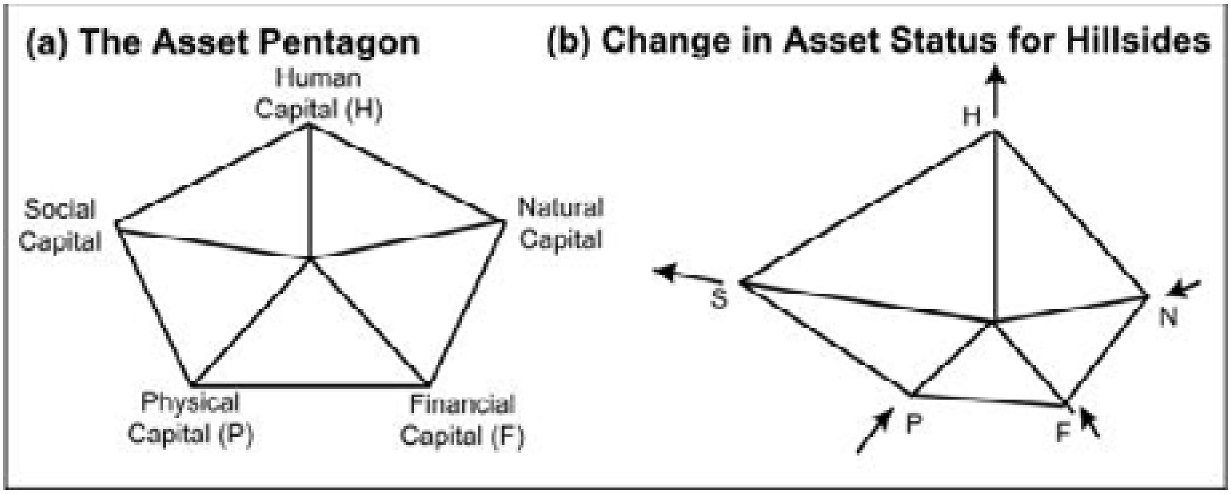

Figure 3.5: **Capital assets pentagon (a) and a possible representation of dynamic change in hillside environments (b)**

the combination of assets for any particular situation. The centre of the pentagon represents the situation of zero assets, while the outermost points are maximum access. In hillside environments (Figure 3.5b), social and human capital may be high (good social networks and available labour, for example), while physical and financial capital may be somewhat deficient (poor climate and growing season, and poverty). Pentagons such as these can be a useful focus for “debate about suitable entry points, how these will serve the needs of different social groups and likely trade-offs between different assets” (DFID 1999, Section 2.3). In other words, they encourage holistic thinking about the real-life building of a sustainable livelihood by using the resources at local people’s disposal. The SRL Framework and the pentagon are tools for assembling the relevant information and assigning it to useful categories. It is not a panacea for either full quantification of all factors or for solving intractable problems.

As the guidance notes at DFID (1999) describe, there are important relationships between assets categories that should be investigated before interventions are proposed. Assets combine in many complex ways. There is **substitution** between assets. For example, a lack of financial capital in mountains may well be compensated for by enhanced social capital. Understanding this may then encourage further development of these strengths in recognition that there may be little that could be immediately accomplished in the way of financial assistance. In the course of time, a reverse substitution may occur, as the communities become more financially secure through the exploitation of other assets (e.g. tourism). There is also **sequencing** between assets. An escape from poverty may need a recognisable sequence of use of other assets. So, the natural capital of hillsides could be identified as an entry point to overcoming the lack of financial capital. Then human capital in providing guides and social capital in knowledge could be brought into play to secure the ultimate goal of increase in financial capital or wealth status of the community.

Social capital has been described as a ‘resource of the last resort’, and is therefore of especial interest in understanding the transforming processes on hillsides and how coping structures are built to deal with the hazardous environment (Grootaert 1998; Pretty and Ward 2001). It makes a particularly important contribution to people's sense of well-being through giving identity, honour, and a sense of belonging to a group. Social capital is at the heart of strong groups in civil society, and the formation of new organisations and institutions. It is a resource especially used by the poor and vulnerable, providing a buffer to cope with external shocks, an informal safety net for survival during periods of insecurity, and to compensate for a lack in other types of capital (DFID 1999). Social capital is important because social networks, mutual trust, and reciprocity lower the costs of working together. By working together, social groups improve efficiency in their economic relations (economic capital), enable more effective exploitation and management of natural resources (natural capital), and allow the sharing of infrastructure and services (physical capital). Social networks facilitate innovation, the development of knowledge, and the sharing of this knowledge. Of all the 'capitals', it holds the key to the distinctiveness of mountain societies, their colourful nature, and their ability to endure hardships. When it is under threat or breaks down, perhaps because of political instability, social capital may decline rapidly or be driven underground, thereby excluding the more vulnerable groups.

Sustainable Rural Livelihoods Framework

The Capital Assets pentagon (Figure 3.5) is a useful means of organising the many types and pieces of information that relate to building livelihoods; the land user, the production system, local society, and changes to the biophysical environment. However, the important dynamic and transforming processes in rural environments cannot be displayed. That is why the Sustainable Rural Livelihoods Advisory Group at DFID developed the SRL Framework (Figure 3.6).

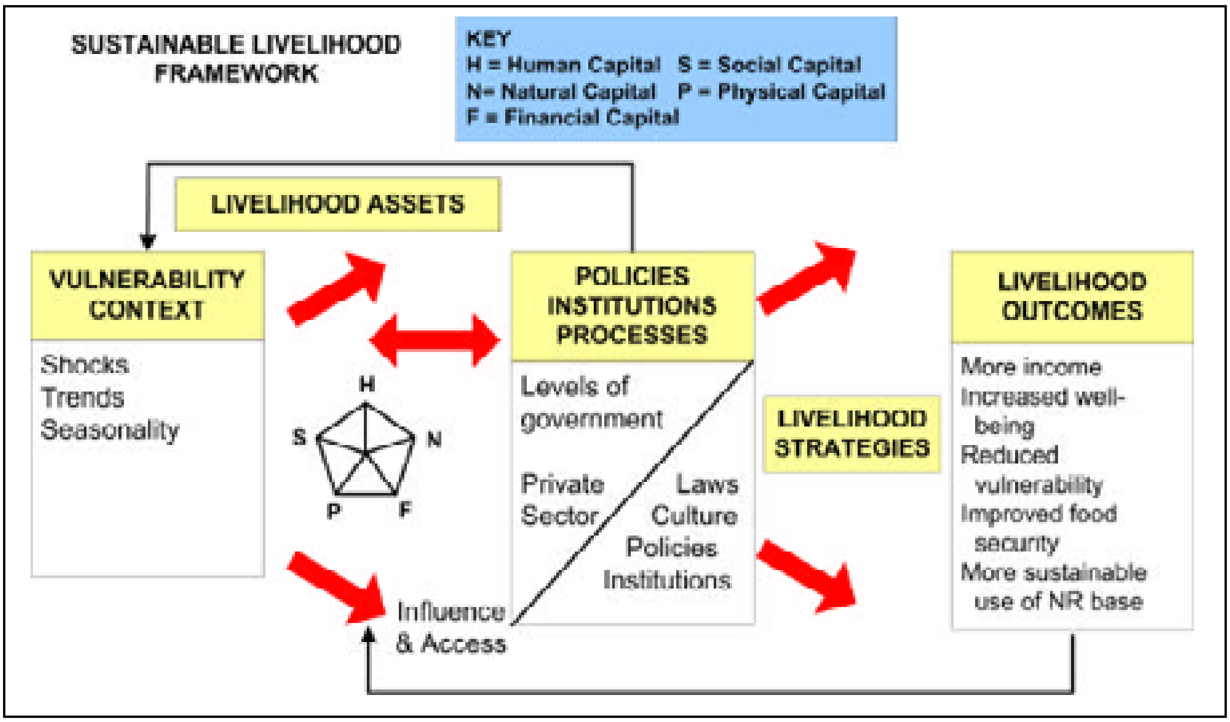

Figure 3.6: **The sustainable rural livelihoods framework** (source: DFID 1999)

The framework is a versatile tool to improve our understanding of the livelihoods of the poor, and to see how transforming processes and structures lead to livelihood strategies and eventually to outcomes. These outcomes then feed back to the assets. Stocking and Murnaghan (2001) give worked examples of the application of the capital assets pentagon in the context of land degradation, a common phenomenon of hilly areas, and how changes in assets affect this issue of global concern. The SRL Framework itself is now common in many publications from the leading development agencies, and examples can be found of its application for poor and vulnerable people (Bebbington 1999), food insecurity (Sutherland et al. 1999), and for developing countries generally (Ellis 2000).

As a tool for use in planning and management of ways in which assistance may be offered to poor people, the primary considerations taken into account by the framework are all part of the process of understanding the dynamics of rural society:

vulnerability, or the danger of asset destruction through external shocks;
transforming structures and processes, or the way people create assets and determine their access to them;
livelihood strategies, or the way people may switch between assets and the options they have;
livelihood outcomes, or the minimum needs for securing an acceptable livelihood.

The framework is not a new 'miracle solution' to age-old problems. Its proponents see it as a way of thinking about livelihoods that helps us order complexity, making clear the many factors that affect how people build a sustainable living. It enables the development analyst to see how changes in one part of the livelihood system, induced by policies or aid interventions, may affect the livelihood outcomes from the use of all resource endowments. As such, it is a platform for rural development and a major initiative in the fight to eliminate poverty in difficult areas such as mountains.

Highlights from NRSP-HSPS Research on Building Sustainable Livelihoods

As the main output of NRSP-HSPS is "Improved hillside farming strategies relevant to the needs of marginal farmers developed and promoted" (Table 3.1), research has identified a number of key findings that are summarised here (Table 3.3). Other chapters in this book elaborate on these and other findings.

Project R6621 (project details are given in Table 3.3) comes from the early phase of NRSP in which technologies and their development were more prominent. It developed from a project in Honduras in the early 1990s that discovered that traditional soil conservation methods such as terracing are well known and are successfully used, but their construction costs can be prohibitive. Therefore, in the challenging semi-arid hillsides of the inter-Andean valleys of Bolivia rising in altitude to 4000 metres near to Cochabamba and Santa Cruz, the researchers of R6621 worked on live barriers as a

Table 3.3: A selection of NRSP-HSPS findings

Project No.	Title	Key Finding
R6621	Soil and water technologies, Bolivia (1998-99)	Live barriers of more than 20 species of grasses and shrubs evaluated for their technical performance and livelihood potential
R7412	Incorporation of local knowledge into soil and water management interventions which minimise nutrient losses in the middle hills, Nepal (2001-2)	Farmers can see for themselves that they can be researchers, developing innovative solutions for soil and water management. Farmers are more impressed when they hear directly of experiences from other farmers and see them in practice. Involving the farming community at all stages of research projects is necessary and provides essential feedback to researchers.
R7584	Community-led tools for enhancing production and conservation, Bolivia (2000-01)	Local professionals are the best way of reaching the poorest households and dealing with multiple problems of hillside communities
R7856	Strengthening social capital for improving policies and decision-making in natural resources management, Uganda (2002-3)	Identification of the presence of 'social capital' is an important way forward to elicit positive change. Social capital can be built through mutually beneficial collective action for managing natural resources. Village Policy Task Forces were especially successful in Uganda in leading development of bye-laws to encourage better NR management.
R7865	Scaling up strategies for research in natural resources management (Gündel et al., 2001)	NR research has had very few cases of validated scaling up: i.e. impact wider than the immediate target. Scaling up is the creation of sustained poverty alleviation and increasing local capacity for innovation at a larger scale. Research must be integrated within a wider pro-poor development process

Sources: Natural Resources Systems Programme, *Research Highlights* 1998-2003 [published annually] – available from NRSP office and website; Gündel et al. 2001

technical innovation. Farmers in this area complained that their hillside plots, often less than 0.1 ha in size, were becoming unprofitable because of falling yields. The researchers reported that farmers were eager to try new techniques and to become involved in participatory research, a novel idea at that time. Over a dozen leguminous species were evaluated, with the best technical options being vetches, lupins, and broad beans. While the results were made available to more than 250 hillside farmers and they show possible avenues for further investigation, such as modelling, this technology-led approach to research has limited impact. NRSP changed its approach to a more central focus on livelihoods and scaling up the results of research.

R7412 started with the premise that farmers have always engaged in research. They test new ideas, crops, and techniques. It is unnecessary and possibly counterproductive for researchers to bring in outside technologies and expect farmers passively to validate the technical effectiveness in a new environment. Closer and more participatory engagement is an essential component of natural resources research that has any hope of yielding a sustained up-take. Working in the mid-hills of Nepal, where more than 12 million people subsist on hillsides with small terraced holdings, R7412 investigated the extent and performance of farmer knowledge in soil and water management. A major finding was that exploiting farmers' knowledge is a necessary but not a sufficient way to promote beneficial change. Research farmers were enthusiastic, but they acquired new knowledge from researchers in setting up experiments and analysing the results.

R7584 is an example of the change in focus of NRSP towards greater awareness of the role of human and social capital. The research site was Tarija in southern Bolivia, an extremely degraded area, at altitudes of between 2,000 and 4,000 metres, where farmers keep livestock and grow a range of rainfed crops under difficult conditions. Developing community interaction between local professionals and community groups proved successful in a number of key natural resource topics. For example, the local agriculturalist helped farming families to map their soil types and plan cropping strategies. Livestock diseases were controlled through enabling farmers to administer intra-muscular and sub-cutaneous injections. The grazing land and livestock were improved through farmer-led experimentation of new management techniques. The researchers monitored the interactions and drew lessons as to the best way to enable communities to identify problems and adapt to changing circumstances. They claim that the poorest are enabled to help themselves. This project led to follow-up activities in Bolivia, using local professionals working within municipalities and isolated communities.

R7856 focused on Uganda's hillsides where soil erosion and loss of soil fertility are perceived by farmers to be among the greatest problems (see Chapter 18). Researchers investigating ways to address the problems found that the presence of 'social capital' is a necessary pre-condition for resource-poor farmers to participate in policy formulation. Social capital improved willingness not only to be involved in research but also to adopt innovations in natural resource management. The researchers hypothesised that by helping to build social capital, even the poorest could be helped. The '2002-2003 NRSP Research Highlights' (p.5) describes the case of one village, Habugarama, rich in complex social capital, where at least 12 local groups and organisations are active; these range from labour parties, savings groups, pig rearing, and swamp association, to 'Determined Women,' and drumming and singing groups. The researchers engaged with this social capital to build a capacity to develop, implement, and enforce local policies. Bye-laws in particular were targeted as one of the best means of supporting local natural resources management. Policy Task Forces at the village level have proved to be effective as a means for community groups to implement and develop new bye-laws. A useful finding is that in this process, officials at sub-county level become more embedded in local social relations and can be put under pressure to perform for the community and be responsible to it.

R7865 investigated the conditions necessary for scaling up of the application of new knowledge to natural resources management. Scaling up means to spread the benefits of a project more widely to more people and communities, and to expand findings institutionally to other sectors, stakeholders, donors, and the many agencies involved in development interventions. Natural resources research to date has taken a far too narrow view of scaling up in seeing the challenge simply as improving the ways to get technologies out to target groups. Scaling up, the R7856 researchers argued, is about creating sustained poverty alleviation and increasing capacity for innovation. There are no simple rules to achieve this. However, the potential pathways would include understanding institutional processes and a more integrated focus on geographical and quantitative dimensions of project design and implementation. Eight elements of good practice for maximising scaling-up were identified as having a direct bearing on success in scaling up (Gündel et al. 2001). They range from identifying the target groups carefully to building networks and partnerships. Scaling up can and should be built into project design. These findings are not limited to hillside environments. However, they have significant application in projects where researchers can only work with a small target group and within restricted geographical areas.

Conclusions

People build livelihoods on hillsides, despite the fact that they live 'at the margin', spatially, socially, economically, and environmentally. It might be expected that the worst land degradation and mismanagement of the landscape would occur in such areas; that terrace systems and other human endeavours would be transient and poor; that societies would be impoverished in every sense. The evidence, however, is quite the reverse. There is a wealth of innovation, creation, and knowledge in hillsides areas, indicating that substitutions happen between aspects that are truly limiting, such as growing season and soil depth, to aspects that have good potential, such as social networks and human expertise. The Sustainable Rural Livelihoods Framework provides a good analytical tool to understand the various resource endowments or capital assets that people use to survive and endure. Social capital is especially important.

There are essential lessons arising from an understanding of how hillsides societies cope with a difficult biophysical environment. DFID's Natural Resources Systems Programme and its Hillsides Production System portfolio has made a major contribution to understanding livelihoods and the better management of renewable natural resources of poor rural households on hillsides. Capital substitution and building livelihoods out of meagre natural resources by concentrating on social aspects are ways in which sustainable livelihoods are fashioned. These understandings should lead the international community to draw positive lessons and outcomes from such an analysis, and use it to design targeted interventions, not only for hillsides but also for other poor rural situations.

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Case Studies of Renewable Natural Resources Management

Photo:

Erosion plots

Hilde Helleman, 2003

4 USING LOCAL KNOWLEDGE TO DEVELOP SOIL AND WATER MANAGEMENT INTERVENTIONS FOR MINIMISING SOIL AND NUTRIENT LOSSES IN THE MIDDLE HILLS OF NEPAL[1]

Pratap Shrestha[2], Morag McDonald[3], Anna Lawrence[4], and Fergus Sinclair[3]

Abstract

The middle hills range in altitude from 1,000 to 2,000m above sea level and occupy about 30% of the land area of Nepal. Upper-slope, rain-fed land (locally called bari) constitutes a major proportion of cultivated land in the middle hills and is particularly vulnerable to nutrient losses through surface soil losses and leaching. These nutrient losses have been regarded as one of the major causes for declining soil fertility and crop productivity in the middle hills. Despite years of efforts, there are very few technological options available to farmers that are effective in reducing such losses. Although some technologies have been found effective in controlling soil erosion, farmers' adoption of these technologies has been low. As a result, increased emphasis is now being given to a process that combines farmers' local knowledge and practices with their needs and resources in the development of appropriate soil and water management technologies.

This chapter presents experiences of a research project on soil and water management in the middle hills of Nepal. It applies a participatory technology development (PTD) approach to generate appropriate soil and water management interventions that reduce nutrient losses from bari land. The core of the approach lies in combining farmers' local knowledge and practices with scientists' knowledge and findings and supporting farmers' experimentation in developing soil and water management interventions. The process includes four stages: problem identification; knowledge analysis and sharing; farmers' experimentation; and participatory monitoring and evaluation. The results obtained so far suggest that incorporation of farmers' knowledge and perspectives in the technology development process, and giving farmers and the farming community a leading role in experimentation and decision-making, not only ensures development of appropriate technologies, but also increases farmers' empowerment and participation in the whole development process.

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Introduction

The hills of Nepal account for about 51% of the total agricultural land of the country and are home to about 52% of the total population. The average agricultural land holding is less than 1 ha with nearly half of the population owning less than 0.5 ha (CBS 1996; 1999). The middle hills, which range in altitude between 1,000 and 2,000 m above sea level, occupy about 30% of the land area of the country (Carson 1992). The agricultural landholdings in the hills are highly fragmented, with about 4 parcels per holding (CBS 1996). Crops are cultivated mainly on rain-fed upland, locally called bari. Bari constitutes 64% of the cultivated land in Nepal, a little over 1.7 million ha, of which 61% lies in the middle hills (Carson 1992).

Bari soils are particularly vulnerable to soil losses through a combination of natural factors, such as sloping topography and heavy seasonal rainfall, as well as human factors, such as intensive cultivation of land and erosion–prone farming practices (Sherchan and Gurung 1992; Tripathi 1997). Various studies conducted in Nepal show that soil loss through surface erosion from agricultural land in the hills varies from less than 2 t/ha per year to as high as 105 t/ha $year^{-1}$ (Gardner et al. 2000). A recent study has revealed that nutrients, especially nitrogen (N) and phosphorous (P), are also lost through leaching at rates exceeding those from runoff and soil erosion by up to an order of magnitude (Gardner et.al. 2000). The soil and nutrient losses occurring in these ways have been regarded as the major reason for declining soil fertility and crop productivity (Carson 1992; Vaidya et al. 1995; Turton et al. 1996).

At present, there are few technological options available that are effective in reducing soil losses and that farmers' have access to and that suit their needs and environments. The interventions that have been directed at controlling soil erosion, including sloping agricultural land technology (SALT) (Partap and Watson 1994), have not been widely adopted by farmers, although they are effective in reducing surface runoff and controlling soil erosion (Carson 1992; Tang Ya 1999). One of the main reasons for this has been the inadequate consideration of farmers' knowledge and practices and their needs for soil and water management.

A number of studies have now revealed that farmers in the middle hills of Nepal possess detailed knowledge about ecological processes related to soil and water conservation and that they often make rational use of this knowledge in the practices that they use to combat soil erosion and declining soil fertility (Gill 1991; Tamang 1991, 1992; Carson 1992; Joshi et al. 1995; Nakarmi 1995; Shah 1995; Subedi and Lohar 1995; Turton et al. 1995; Turton and Sherchan 1996; Joshy 1997). This has drawn the attention of research scientists and development workers towards the value of farmers' knowledge and its potential use in technology development. These studies, however, are mainly limited to documenting farmers' knowledge and practices at a general level. There have been few attempts to explicitly incorporate farmers' knowledge into the research process. Drawing from the experiences of a DFID-funded project, this chapter presents the experiences of a participatory technology development (PTD) approach that combined farmers' knowledge and practices with scientific research in developing soil and water management interventions to minimise the soil and nutrient losses from bari in the middle hills of Nepal.

Research Process: PTD Approach

The participation of farmers at various stages during technology development is the key element of a PTD process. PTD occurs in a number of different forms worldwide and the degree of farmers' participation in the process ranges from a simple consultation to empowering farmers to design and experiment with new technologies themselves. The PTD process discussed here aims to enable and empower farmers to innovate and experiment with new soil and water management interventions by combining their local knowledge and practices with scientific knowledge and understanding of the problem in question. The process was not designed in advance but evolved through the interaction with the farmers and their community structures during the implementation of the project. The whole process was divided into four interlinked stages with a number of steps as shown in Figure 4.1.

Stage 1: Problem identification

Conceptualising the problem and research approach and sharing this with institutional stakeholders

The PTD process started with the identification and conceptualisation of the problems and issues relevant to soil and water management prevalent in the middle hills of Nepal. In this case, the loss of soil and nutrients from bari and the low adoption rate of technical interventions by farmers had already been widely identified as major research and development issues by front-line research and extension agencies. However, re-visiting these problems from the perspectives of stakeholders and building a common consensus was important before undertaking any research and development activities. A workshop of all potential stakeholders was organised for that purpose. About 15 participants from 10 different research and development organisations, both government and non-government, participated in the workshop. The project team and the participating stakeholders shared their views and experiences about the problem and then the concept and methods of the PTD process to be adopted were developed. The mechanisms and means to communicate amongst stakeholders were also discussed and agreed. All the stakeholders showed a keen interest in the proposed research and agreed to participate throughout the research process.

Selection of research sites

The last step of the first stage was to identify suitable and representative research sites. To take advantage of the previous research on soil erosion by Gardner et al. (2000), the same three villages used in that research were selected. These were Landruk, in Ward 9 of Lumle Village Development Committee in Kaski district; Bandipur in Wards 3, 4, and 6 of Bandipur Village Development Committee in Tanahun district; and Nayatola in Wards 4 and 5 in Kushumkhola Village Development Committee in Palpa district, all in the western hills of Nepal. There were three main reasons for the selection of these villages. First, a good amount of baseline data and information about soil and nutrient losses had already been collected at those sites, which enabled the assessment of the

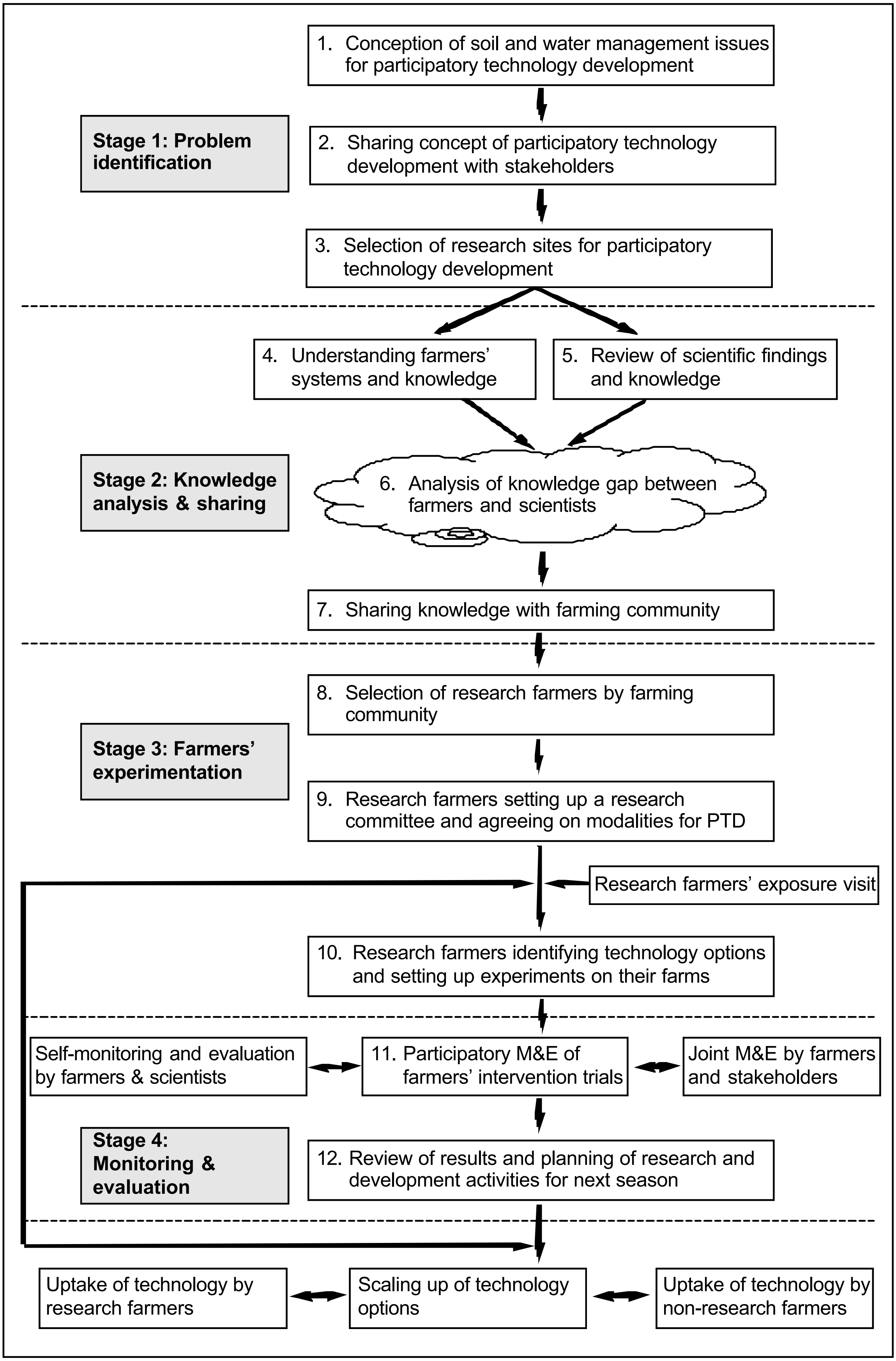

Figure 4.1: The participatory technology development (PTD) process adopted in Nepal

effectiveness of the new research programme. Second, a good relationship had already been established with the local farmers, so the programme could begin immediately. Third, the three locations were representative of the existing ecological and cultural diversity in the middle hills of Nepal.

Stage 2: Knowledge analysis and sharing

Documentation of farmers' and scientists' knowledge

The second stage of the PTD process began with the documentation and understanding of farmers' local knowledge and practices related to soil and water conservation. The collection, storage, and analysis of farmers' knowledge was done using the agroecological knowledge toolkit (AKT5) developed by the University of Wales, Bangor, UK (see Dixon et al. 1999 for details). The AKT methodology uses an ethnographic approach to knowledge acquisition and applies artificial intelligence and computer technology to storing, retrieving, and assessing knowledge (Thapa et al. 1995; Walker et al. 1995; Walker et al. 1997; Sinclair and Walker 1998; Walker and Sinclair 1998). Farmers' local knowledge is elicited using various participatory rural appraisal (PRA) tools and semi-structured interviews with individual farmers, tailored to suit available resources and local circumstances.

The elicitation of farmers' local knowledge on soil and water management was done at the three research villages. More than 20 farmers, both men and women, were selected at each site. These farmers were interviewed informally by both male and female project staff who were living with the farmers in their village. It took about 3-4 weeks for 3 people to complete the knowledge elicitation in each research village. Similarly, the knowledge generated by scientists through earlier research at these sites and elsewhere was also documented. The knowledge documented was then represented in an electronic knowledge base, using the AKT5 computer software. The analysis of knowledge gaps between farmers' and scientists' understanding was done using the automated reasoning capacity built into the AKT5 software (Kendon et al. 1995). The creation of electronic knowledge bases and their subsequent analysis for consistency took about 1 month for the principal investigator. Characteristic of the ethnographic studies, the process was relatively resource intensive but generated valuable insights about the wealth of farmers' knowledge that, because it is durably recorded, will be available for future as well as the present purposes.

Analysis of knowledge gaps

The analysis revealed that farmers possessed a wide range of knowledge about soil and water management on their farms as well as at larger scales in the community. Farmers' knowledge was largely explanatory and experiential and was commonly held. There was also a large amount of knowledge that was commonly held by both farmers and scientists that we refer to as shared knowledge. On the other hand, there were some key aspects known only to farmers or only to scientists and these represented the knowledge gaps between farmers and scientists. The nature of the shared and unique knowledge showed that farmers knew more about above-ground than below-ground ecological processes. Some of the farmers' and scientists' knowledge gaps that had implications for the current research are listed below (Shrestha et al. 2001).

Farmers did not know or had very little knowledge about the following aspects:

- rainwater infiltration is greater than surface runoff;
- nutrient loss through leaching is greater than loss through surface soil erosion;
- soil texture influences the nutrient-holding capacity of soil and so influences leaching losses;
- organic matter increases the nutrient-holding capacity of soil and so minimises leaching losses;
- the role of deep-rooted plants in nutrient recycling;
- the role of legume root nodules and the mechanism of N fixation.

Scientists had very little knowledge about the following:

- multiple ploughing leads to an increase in maize yield – it mixes manure well into the soil and the resulting fine soil particles provide a good growth environment for seeds and roots;
- farmers' classification of a large number of fodder trees as 'malilo' (contributing to soil fertility and not too competitive with crops) or 'rukho' (detrimental to soil fertility and competitive with crops) – the classification is based on the decomposition of litter and competition for light and nutrients.

This analysis of knowledge gaps between farmers and scientists provided a basis for sharing knowledge with the farmers.

The knowledge analysis also looked into causal relationships and used the resulting information to evaluate farmers' soil and water management practices. The causal analysis clearly established disparities between farmers' knowledge and their practices. There was knowledge that was not translated into practice, as well as a number of practices that were followed without much understanding of why they were effective. The analysis of knowledge and practices provided a basis for the identification of potential intervention options, which were then used as ideas for designing new soil and water management interventions together with farmers in the later stage of the PTD process.

Sharing knowledge with farming communities

The last step of the second stage of the PTD process was sharing new knowledge with the farmers and the farming community. Village workshops were organised at all three research sites for this purpose. Farmers (both men and women) were informed of and invited to the workshops through their village leaders. Knowledge on soil and water management was shared with the participating farmers with the help of charts, posters, and demonstration equipment prepared by the project team of scientists. A large number of farmers participated in the workshops that lasted for 2-3hours (Figure 4.2). Additional emphasis was given to the areas of knowledge that were not well known to the farmers. For example, the concept of leaching loss of nutrients was demonstrated to the farmers by using coloured water poured into locally made glass boxes holding a soil profile similar to that used by Hagmann et al. (1997) (Figure 4.3).

Figure 4.2: **Village workshop for sharing knowledge**

Figure 4.3: **Demonstrating loss of nutrients by leaching at the village workshop**

Stage 3: Farmers' experimentation

Farmers are known to do their own research when they have access to new seeds, planting materials, animal breeds, and information (Richards 1985; Chambers et al. 1989; Haverkort et al. 1991; de Boef et al., 1993; Rhoades and Bebbington 1995). Farmers' research or innovations are largely explorative and adaptive in nature, and are influenced by their needs and resource endowment. Building on these experiences, empowering and supporting farmers to design and experiment with new soil and water management interventions by themselves form the key elements of the PTD approach discussed in this chapter.

Selection of research farmers and formation of research committees

The sharing of knowledge led to a realisation that nutrient losses occur through soil erosion and leaching and motivated farmers to participate in the technology development process. Farmers and village leaders participating in the village workshop were requested to identify farmers who would undertake research on soil and water interventions suitable for themselves and the community more generally. They selected 12 farmers at each site for this purpose. To facilitate communication and support amongst each other, as well as with the wider farming community and with research scientists, these farmers were called 'research farmers' and their group was constituted as a research farmers' committee.

Research farmers' exposure visit

The 36 research farmers from the 3 sites were taken on a week-long study tour to research and demonstration sites in different parts of the country. The places included in the study tour were:

- Paireni research and demonstration site, managed by the National Agricultural Research Council, Nepal (NARC) and the International Centre for Integrated Mountain Development (ICIMOD);
- Majhitar farming community in Dhading district, supported by the Nepal Agro-forestry Foundation (NAF);
- Godavari Demonstration and Training Centre site, managed by ICIMOD; and
- Sankhu project site of the Bagmati Integrated Watershed Management Programme (BIWMP) under the Department of Soil Conservation and Watershed Management.

Farmers acquired new knowledge and were able to see a range of new soil and water management practices. They returned to their villages highly motivated to try a number of new soil and water management practices on their own farms. During the visit, the farmers also had an opportunity to discuss and conceptualise ideas about new experiments that they would like to test on their farms.

Identifying and designing new interventions for farmers' experimentation

Meetings of research farmers were called and facilitated by the research scientists to discuss the design of new soil and water management interventions. The meetings started with a review of the knowledge shared in the first village workshop and any insights gained during the study tour to the research and demonstration sites. This helped farmers to conceptualise and identify potential soil and management interventions for their experimentation. The concept of systematic research, including the role of control and replication, was also shared with the research farmers. This helped them to:

- realise that whatever new intervention they would like to experiment with required testing for several seasons to draw a meaningful conclusion;
- visualise that the interventions they would experiment with needed to be compared with their current practice to see their effectiveness (the concept of comparison with a control);
- think about the selection of land on which interventions were to be tested to enable suitable comparisons to be made;
- think about methods of observation and indicators for judging the effectiveness of new interventions; and
- realise the need to test the interventions in different environments to judge their robustness or reliability (the concept of replication).

After a thorough discussion, farmers came up with four intervention designs at each of the research sites and, based on their interest in these, they were divided into four groups of three farmers to experiment with the identified interventions. These interventions included the use of legume and non-legume forage species; fruit trees and water-harvesting structures; and crop layout patterns that conserve nutrients and water in bari land. The next day of the meeting, the research scientists visited individual research farmers, made joint observations at the plot selected for establishing the experiments, and measured the experimental plots to estimate the planting materials required. Scientists supplied the new planting materials to the research farmers. With technical support from the scientists, the research farmers and their family members planted research materials in the experimental plots as they had agreed to in the meeting. At Landruk and Bandipur, sites with bench terraces, each research farmer allocated two to three terraces to establish experimental plots. Half of each terrace was used to plant research materials, as specified in the particular intervention design, while the other half was retained as control. At Nayatola, a site with sloping terraces, such an arrangement was not possible, therefore control plots were not established. The research farmers and their families provided all the care and management required for the experimental plots.

Stage 4: Participatory monitoring and evaluation

Farmers generally make careful observations of the performance of their experiments and use the information to evaluate the effectiveness of new interventions. If the results meet farmers' expectations, there is a likelihood that the new intervention will be adopted. If not, then farmers either abandon the experiment or make necessary changes in the process of adapting the new interventions to suit their farming conditions. Based on these general observations about farmers' experimentation, the present PTD process involved a participatory monitoring and evaluation approach for both new interventions and the research process as a whole. A number of methods were employed that provided a forum for research farmers, scientists, and stakeholders to make both independent and joint assessments of the new interventions.

Self-monitoring and evaluation by research farmers

As part of the PTD process, the research farmers were given a leading role in making independent observations and assessments of the effectiveness of the new interventions using their own methods and indicators. The interaction with farmers during knowledge acquisition and at other times revealed that they used a number of criteria to assess soil erosion and its effect on soil and crop production. Farmers mentioned 18 indicators of which 8 associated with positive effects and a further 5 that indicated negative effects were used by the research farmers to monitor the effectiveness of the new interventions that they were experimenting with (Table 4.1). The research farmers were requested to make close observations of the effectiveness of the new interventions during the season to obtain systematic feedback. At the end of the rainy reason, each of the research farmers was requested to assess the effectiveness of their interventions by scoring both treatment and control plots for the indicators specified earlier. Maize seeds were used for scoring and farmers were given a maximum of 10 seeds for each indicator, the number of these that they allocated indicating the score.

Table 4.1: **Farmers' indicators used for measuring effects of new interventions at the three research sites**

	Indicators of change	Landruk	Bandipur	Nayatola
1.	Plant vigour and health	*	*	*
2.	Crop yield	*	*	*
3.	Growth and vigour (orange trees)	-	*	-
4.	Orange production per tree	-	*	-
5.	Forage production on the terrace risers	*	*	-
6.	Stability of terrace risers	*	*	-
7.	Soil softness and ease of tillage	*	*	*
8.	Soil moisture	-	-	*
9.	Formation of rills on soil surface	*	*	*
10.	Exposure of stones on soil surface	*	*	*
11.	Exposure of crop roots	*	*	*
12.	Surface soil erosion	*	*	*
13.	Field rat infestation	*	-	-

The scores given to each intervention for different indicators were combined at two levels – one at the level of the intervention and another for all interventions at the site level. The combined scores at site level obtained at the end of the second year of experimentation are presented in Figure 4.4. The combined scores, both at intervention and at site level, given for indicators of positive effects were consistently higher for intervention than control plots. On the other hand, the scores obtained against indicators of negative effects were consistently higher for the control than the intervention plots. The research farmers, therefore, perceived that the new interventions were effective in reducing soil and nutrient losses, improving soil quality, increasing crop and fruit yield, and increasing forage production. In addition to this, farmers' qualitative feedbacks on the performance and adoption and/or adaptation of the new interventions

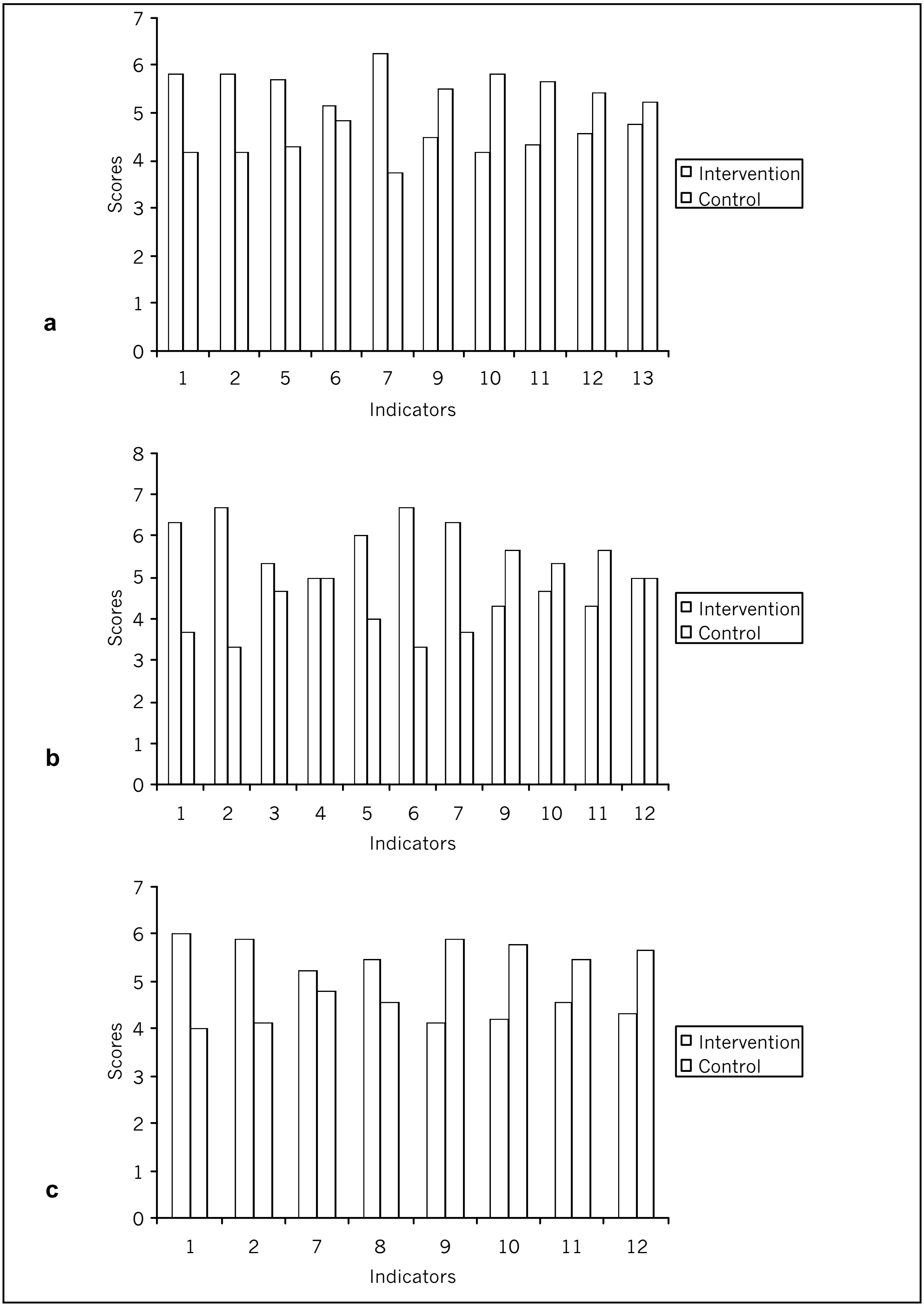

Figure 4.4: **Farmers' scores for indicators used to measure effectiveness of interventions at the three research sites, 2002: (a) Landruk; (b) Bandipur; (c) Nayatola**

1=plant vigour and health; 2=crop yield; 3=growth and vigour of orange trees; 4=orange production per tree; 5= forage production on terrace risers; 6=stabilisation of terrace risers; 7=soil softness and ease of tillage; 8=soil moisture; 9=formation of rills on soil surface; 10=exposure of stones on soil surface; 11=exposure of crop roots; 12=surface soil erosion; 13=field-rat infestation. The higher scores represent higher values for a particular indicator.

was also collected using an open-ended checklist. The analysis of this feedback further confirmed that farmers were positive about the effectiveness of the new interventions, while some of them also indicated modifications to be made in the subsequent season.

Monitoring and evaluation by scientists

The purpose of monitoring and evaluation of farmers' experiments by scientists was two-fold, firstly to provide technical feedback to the research farmers about the performance of their experiments and make necessary technical suggestions if required. For this, regular field visits by scientists were made to monitor mortality, growth, and health of the plants in the new interventions. During these visits, scientists also held discussions with the farmers about the performance of the interventions. Secondly it was to supplement research farmers' assessment of new interventions with quantitative measurements of changes brought about by the new interventions.

At the Landruk and Bandipur research sites, with bench terraces, two measurements were made: one on runoff sediments, to measure changes in soil erosion, and another on forage production from the terrace risers, to measure changes in forage supply and nutrient uses from the terrace. For this, simple techniques involving easily made observations that were manageable under farmers' conditions, were used. To measure changes in runoff sediments, small metal troughs measuring 75 cm in length, 15 cm in width, and 10 cm in depth were placed at the base of the terrace risers and sediments collected from the intervention and control plots were regularly monitored and recorded. At the end of the rainy season, the amount of sediment in each trough was calculated to get a quantitative assessment of the effectiveness of forage species planted on the terrace risers in minimising soil loss from the cultivated terrace. Similarly, to measure changes in forage production, samples of forage produced on the terrace risers of intervention and control plots were collected at regular intervals and weighed and recorded. At Nayatola, with sloping terraces, three measurements were made: soil build-up against the hedge, dhik (terrace riser) formation, and slope angle of the terrace.

The findings of the runoff sediment measurement are presented in Figure 4.5. The soil erosion as indicated by the amount of runoff sediment was more than three times higher at Landruk than at Bandipur, which is consistent with the findings of a more rigorous study done at these sites by Gardner et al*.* (2000). The difference is attributable to higher total rainfall and with it the higher cumulative kinetic energy (erosivity) at Landruk. The findings, therefore, suggest that the method can be used to derive an estimate of the extent and pattern of soil erosion and so measure the effectiveness of new interventions. At Landruk, contrary to expectations, the amount of runoff sediment from intervention plots was more than from non-intervention (control) plots (Figure 4.5a). A possible reason for this is the method of planting of new forage species. The research farmers at Landruk scraped and cleaned local grasses from the terrace risers to increase the survival rate of the new forage species. This obviously exposed more soil to runoff erosion. This finding was contrary to farmers' scoring for soil erosion and suggests that farmers perceptions may sometimes be value driven rather than based on factual information, especially in a case like this, where results are not clear at an early stage of experimentation. At Bandipur, however, the planting of new forage species on the terrace risers appeared to trap more sediment than the local practice of just maintaining natural growth of the local species (Figure 4.5b).

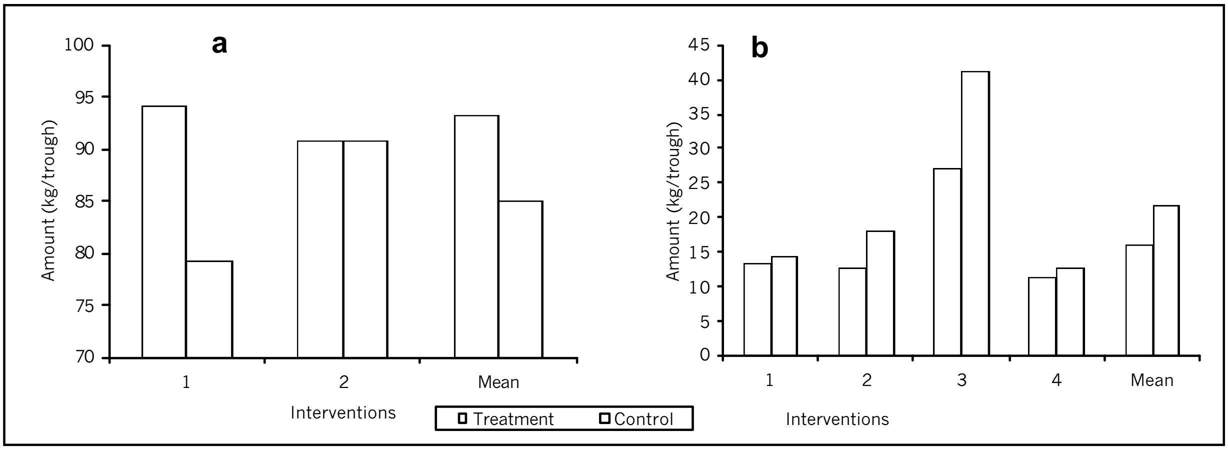

Figure 4.5: **Runoff sediment losses from experimental plots at (a) Landruk and (b) Bandipur, 2002**
The interventions at Landruk are 1=new forage species planted on the terrace risers; 2=new forage species planted on the terrace risers and fruit trees on the edge of terrace. The interventions at Bandipur are 1=new forage species on terrace risers and tree fodders on the top of terrace risers in young orange orchard intercropped with food crops; 2=new forage species on terrace risers, tree fodders on the top of terrace risers, and coffee in old orange orchard; 3=new forage species on terrace risers, and tree fodders on the top of terrace risers in the crop field; 4=new forage species on terrace risers, tree fodders on the top of terrace risers, and water harvesting pond in the crop field.

There appeared to be a trend towards higher forage production in the intervention plots but differences were small (Figure 4.6). Nutrient analysis of forage biomass from intervention and control plots was also done. The results showed that the amount of N, P, and K per unit area of forage biomass from the intervention plots was also higher than that from the control plots (Tables 4.2 and 4.3). The new forage species appeared to trap more soil nutrients and therefore were efficient in minimising leaching loss of nutrients.

At Nayatola, all three types of hedgerow intervention showed some positive effects on minimising soil losses from the sloping bari land (Table 4.4). The difference between the treatments was, however, small. The hedgerow had started to become an effective barrier to soil movement causing soil build-up against the hedge. As a result, the slope angle of the terrace was also decreasing. Similarly, soil build-up against hedge and tillage down the hedge (tillage erosion) initiated formation of dhiks (terrace risers) which gradually increased over the two years. Hedgerows of forage species alone showed larger effects on the parameters considered than other hedgerow interventions.

Joint monitoring and evaluation
At the end of the rainy season, a joint monitoring programme was organised separately at each research village involving research farmers, scientists, stakeholders from district and central level research and development organisations, and other farmers in the village. The main objective of the joint monitoring was to provide stakeholders and other farmers of the

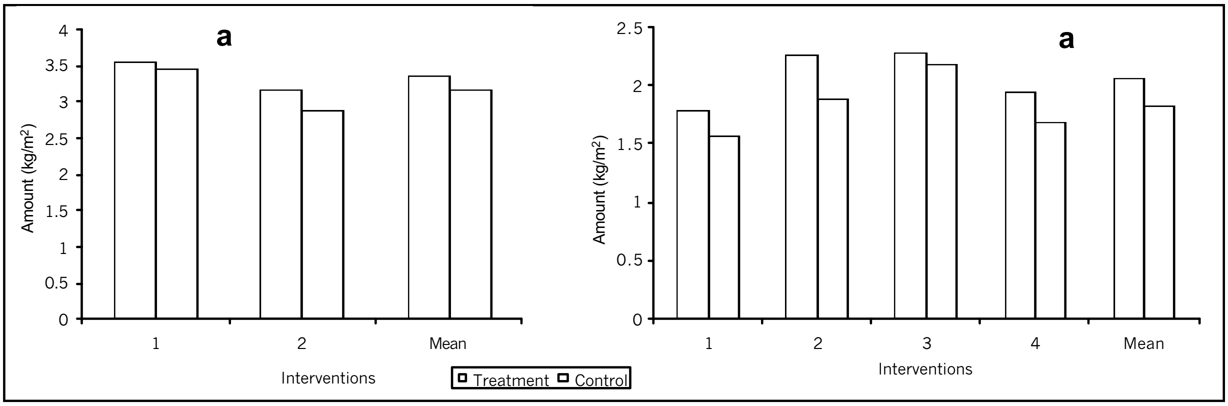

Figure 4.6: **Forage production from the terrace risers of experimental plots at (a) Landruk and (b) Bandipur 2002**

The interventions at Landruk are 1=new forage species planted on the terrace risers; 2=new forage species planted on the terrace risers and fruit trees on the edge of terrace. The interventions at Bandipur are 1=new forage species on terrace risers and tree fodders on the top of terrace risers in young orange orchard intercropped with food crops; 2=new forage species on terrace risers, tree fodders on the top of terrace risers, and coffee in old orange orchard; 3=new forage species on terrace risers, and tree fodders on the top of terrace risers in the crop field; 4=new forage species on terrace risers, tree fodders on the top of terrace risers, and water harvesting pond in the crop field.

Table 4.2: **Nutrient content of forage produced on the terrace risers of the trial plots at Landruk in 2002**

Inter-ventions	N content (g/m^2 forage)			P content (g/m^2 forage)			K content (g/m^2 forage)		
	Treatment	Control	Difference	Treatment	Control	Difference	Treatment	Control	Difference
1	18.57	15.38	3.19	0.23	0.19	0.04	15.48	12.47	3.01
2	11.91	10.77	1.14	0.18	0.16	0.02	11.09	10.10	0.99
Mean	15.24	13.08	2.17	0.21	0.17	0.03	13.28	11.29	2.00

1=new forage species planted on the terrace risers; 2=new forage species planted on the terrace risers and fruit trees on the edge of terrace.

Table 4.3: **Nutrient content of forage produced on the terrace risers of the trial plots at Bandipur in 2002**

Inter-ventions	N content (g/m^2 forage)			P content (g/m^2 forage)			K content (g/m^2 forage)		
	Treatment	Control	Difference	Treatment	Control	Difference	Treatment	Control	Difference
1	5.06	4.89	0.17	0.08	0.06	0.01	6.15	4.89	1.26
2	8.48	6.39	2.09	0.16	0.10	0.07	9.89	4.33	5.56
3	8.55	10.58	-2.03	0.12	0.15	-0.03	10.43	8.72	1.71
4	5.56	5.46	0.10	0.06	0.08	-0.01	8.89	5.19	3.70
Mean	6.91	6.83	0.08	0.11	0.10	0.01	8.84	5.78	3.06

1=new forage species on terrace risers and tree fodders on the top of terrace risers in young orange orchard intercropped with food crops; 2=new forage species on terrace risers, tree fodders on the top of terrace risers, and coffee in old orange orchard; 3=new forage species on terrace risers and tree fodders on the top of terrace risers in the crop field; 4=new forage species on terrace risers, tree fodders on the top of terrace risers, and water harvesting pond in the crop field.

Table 4.4: **Effects of new interventions on soil build-up against the hedge, formation of dhik (terrace riser), and change in terrace slope (Nayatola, 2002)**

Intervention	Soil build-up against hedge (cm)	Dhik height (cm)	Change in terrace slope angle[1] (°)
Hedge of forage species	11.14	49.72	-2.17
Hedge of forage species and orange trees	11.56	45.06	-0.94
Hedge of forage species, orange trees, and coffee	8.84	44.33	-1.13

[1] Changes from base year (2001) measured in 2003. Negative sign shows a decrease in slope angle

community with an opportunity and forum to monitor and evaluate the performance of farmers' experiments; interact with research farmers, scientists, and amongst each other; collect their feedback; and assess actual and potential adoption and adaptation of the new interventions.

All the participants were first briefed about the research activities implemented in the village and about the purpose of the monitoring programme. After the introduction with the research farmers and other farmers in the village, the joint monitoring team started a village walk and made observations of all the experimental plots one after another. At each experimental plot, the owner research farmer explained the details of the new intervention to the participants. The participants then questioned the research farmer and acquired feedback on the effectiveness of the new interventions obtained so far. After about four to five hours of village walk and field monitoring a round-up meeting was held to discuss what had been observed and how the new interventions were performing. The participants also clarified experimental details and discussed possible modifications in the design of farmers' experiments that could be made in the next season.

Annual review and planning village workshop

At the end of the summer season crop, during which the effect of new interventions was more prominently observable, a village workshop was organised at each research site. Research farmers and scientists shared their experiences of experimenting with new soil and water management interventions with each other and with the farming community at large. Modifications suggested by the research farmers or farming community were discussed and the joint research planning for next season was done. The workshop also provided a forum to disseminate the findings of the farmers' experiments to fellow farmers in the community and motivated others to try the new interventions on their own farms. The workshop was also used as a means to explore and monitor adoption and/or adaptation of the farmers' interventions by the research farmers as well as inside and outside the farming community at each research site.

Adoption and/or Adaptation of New Interventions

Soil and water management interventions usually have a long gestation period and take a long time to show their effects. At the end of the second year of farmers' experimentation, it would be too early to achieve a full-scale assessment of the adoption and/or adaptation of the new interventions. Attempts, however, were made from the very beginning to monitor farmers' responses and actions that were indicative of their interest in the interventions and to measure any current or potential adoption and adaptation of the interventions. The methods employed and results obtained are discussed here.

Observation of farmers' responses and actions to new interventions

This simply involved observing and recording farmers' responses and actions to the new interventions experimented with at each research site. The observations made were of requests by farmers for planting and other research materials and distribution of such materials and types of interventions adopted by farmers. Farmers at all three research sites showed keen interest in the new interventions. Based on this interest, planting materials were supplied to each of the research sites and new farmers joined the farmers' research group in the second year of experimentation (Table 4.5). This showed that there had been a steady increase in the adoption and adaptation of the new intervention, largely within the research villages.

Table 4.5: **Number of new farmers adopting/adapting new interventions and trial materials distributed at the three research sites**

Description	Landruk	Bandipur	Nayatola
New farmers started adopting/adapting new interventions in the second year (number)	15	12	14
Trial materials distributed to farmers (number)			
Setaria grass slips	6000	7000	6000
Napier grass slips	1000	1000	-
Moth Napier grass slips	-	1000	-
NB-21 grass slips	1000	-	-
Guinea grass slips	500	-	-
Mulberry saplings	-	-	1200
Orange saplings	-	-	688
Lemon saplings	-	-	26
Coffee saplings	-	-	121

At Landruk, community action also emerged from farmers' own initiative, to construct diversion channels at strategic locations in the village to divert excess runoff water that would otherwise enter bari land or the village itself, with an objective of reducing soil erosion and landslides. This indicated that some activities were required to be implemented at landscape scales, beyond the control and management capacity of individual farmers.

Tracer study for tracking flow of information and materials

The flow of information about interventions amongst farmers is an indication of their interest in these interventions, and can be used as an indicator of potential for adoption. On the other hand, flow of materials indicates current adoption of the new interventions. Therefore, an attempt was made to trace the flow of any information and research materials from research farmers to non-research farmers and from there on to other farmers. Starting from the farmers directly involved in the research (research farmers), each farmer in the chain of information or material flow was traced and any flow of information or materials was recorded and then mapped to derive a flow network diagram. One example of a flow network diagram from the Landruk research site is shown in Figure 4.7.

The flow network analysis showed that the flow of information between farmers was higher than the flow of materials (Figure 4.7). This was obvious because the experiment was only in its second year and adequate planting materials were yet to be produced on farm for farmer-to-farmer distribution. With the increase in planting materials within the

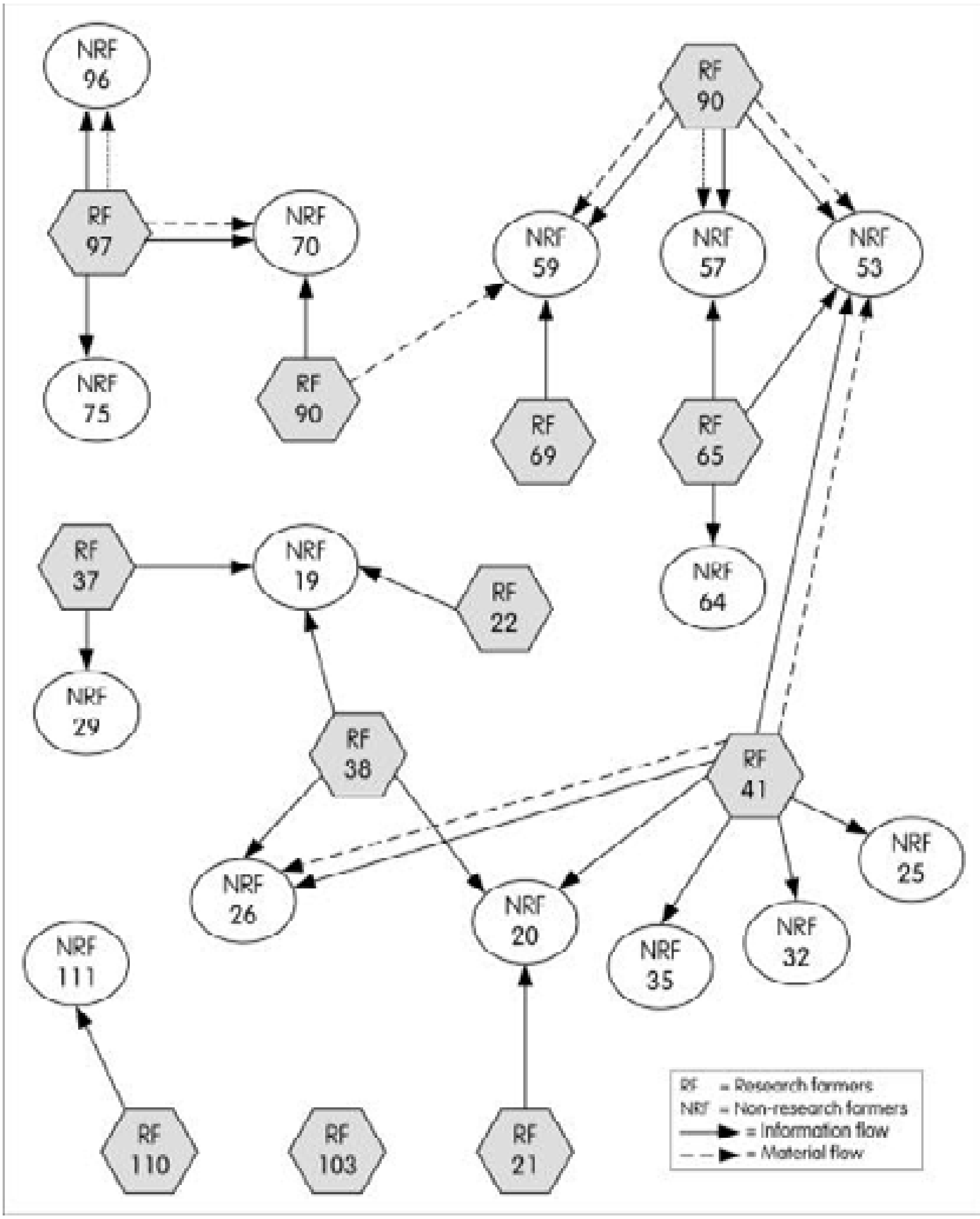

Figure 4.7: **Flow of information and materials from farmer-managed experiments at Landruk, 2002. Nodes are individual farmers; the numbers in them are simply for identification purposes.**

village in subsequent years, the potential for adoption/adaptation of the new interventions appeared to be high. Another finding from the analysis was that the flow of information and materials from research farmers to non-research farmers was higher from farmer-managed experiments (shown by a large number of inter-connected nodes) compared to scientist-managed experiments (diagram not shown as there was no flow of information and materials from research farmers). This indicated that the PTD approach to technology development was more effective in promoting flow of information and materials. It was also an indication that non-research farmers in the community were interested in what their fellow research farmers were experimenting with.

Household sample survey

At the end of the second year of the experimentation with new interventions, that is at the end of the 2002 summer crop, a household survey was conducted to monitor and evaluate the dissemination of information and interventions among the farmers in the community. A systematic sampling procedure was adopted to discern any pattern of such dissemination and to apply statistical tests to measure any significant differences. All the farmers in the community were categorised into the following three groups of farmers:

a. house neighbours of farmers involved in farmer-managed and scientist-managed interventions;
b. field (with experiment) neighbours of farmers involved in farmer-managed and scientist-managed interventions;
c. other farmers of the community selected through random sampling.

Two sets of questionnaires were developed: one to get feedback about farmer-managed interventions and another to get feedback about scientist-managed interventions (implemented concurrently to complement each other). The heads of the sample households were individually interviewed using a structured questionnaire and data analysis was done using Statistical Package for the Social sciences (SPSS) computer software. C^2 statistics were used to test for significant differences in farmers' responses. The data obtained from interviews with farmers sampled with respect to scientist-managed interventions were used as a baseline to evaluate the effectiveness of the farmer-managed PTD approach. At the Bandipur research site, however, there were no scientist-managed experiments and therefore no such comparison was possible.

A large proportion of farmers (>70%) were aware of the farmer-managed and scientist-managed experiments on soil and water management in their village (Figure 4.8). At Landruk, farmers' awareness about scientist-managed experiments was even higher. This was mainly because of the visibility of effects of erosion plots and drums of the scientist-managed experimental plots and this was evident when farmers were asked about the details of these experiments. A higher proportion (57%) of farmers reported knowing about the details of the farmer-managed experiments than the proportion (34%) of farmers who reported knowing about the details of scientist-managed experiments (Figure 4.9). This showed that the PTD approach enhanced the flow of information.

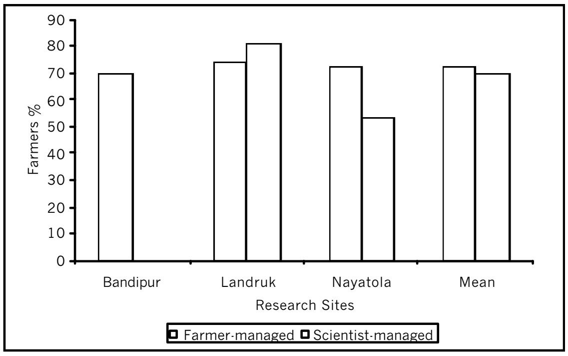

Figure 4.8: **Farmers' awareness about the existence of experiments on new interventions, 2002**

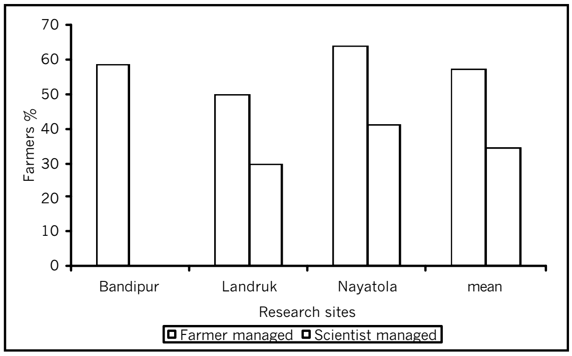

Figure 4.9: **Farmers' knowledge about the details of experiments on new interventions, 2002**

Regarding differences in awareness, no significant difference was found among farmers attributable to differences in farmer types (field neighbour, house neighbour, and other farmers) or ethnicity and wealth categories. However, a higher proportion of farmers from Brahmin, Chhetri, and Gharti groups at Landruk and from poor and medium-wealth categories at Nayatola were reported as more knowledgeable about the details of farmer-managed experiments; and a higher proportion of house and field neighbour farmers and farmers from Brahmin, Chhetri, and Gharti groups reported more about the details of scientist-managed experiments.

The adoption of new interventions by non-research farmers was also higher for farmer-managed interventions, as reported by about 25% of farmers against about 7% for scientist-managed interventions (Figure 4.10). This indicated that farmer-managed interventions were more readily adopted and adapted by farmers. The difference in adoption was found significant for ethnicity at Landruk, where a significantly higher proportion of farmers from Brahmin, Chhetri, and Gharti groups were reported to adopt or adapt new interventions than farmers from other groups. None of the farmers from Kami, Damai, and Sarki, representing a low-caste and resource-poor ethnic group, reported adoption or adaptation of any new interventions. Regarding potential adoption, more than 30% of the farmers were willing to adopt or adapt new interventions in the future (Figure 4.11).

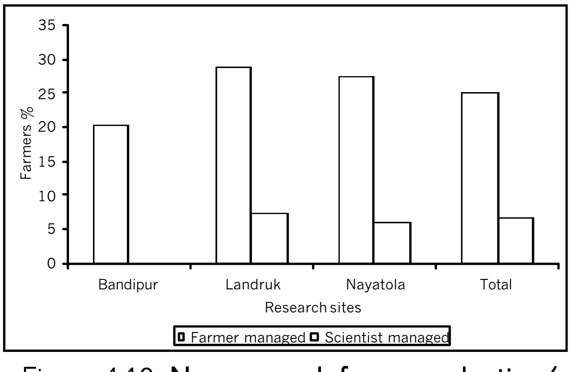

Figure 4.10: **Non-research farmers adopting/ adapting new interventions, 2002**

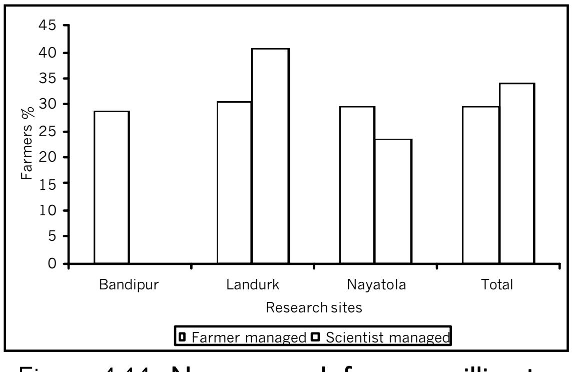

Figure 4.11: **Non-research farmers willing to adopt/adapt new interventions, 2002**

Peer assessment by visiting farmers

A farmers' visit programme to Nayatola, one of the three research sites, was organised by ARS/Lumle in September 2002, in coordination with the District Agricultural Development Offices (DADOs) of Syangja, Palpa, Gulmi, and Arghakhanchi districts. Eighteen farmers from these districts visited the site to see the on-going research activities and to interact with the research farmers. These visiting farmers were asked to evaluate the performance and effectiveness of the new interventions independently. This provided an indication of the potential for wider dissemination of the new interventions.

About 95% of the farmers visiting the Nayatola research site liked and saw benefit from the new interventions under experimentation. While about 78% liked both the hedgerow and ginger strip cropping interventions, about 11% liked only hedgerow interventions and about 6% only strip cropping. Farmers mentioned a number of reasons for liking these interventions, of which control of soil erosion was the highest, reported by about 88% of farmers. The other important reasons mentioned by more than 35% of farmers were increase in soil fertility, increase in crop yield, and increase in on-farm forage production.

Similarly, about 82% of the farmers reported that both hedgerow and strip cropping interventions would be suitable for their village while about 12% reported only strip cropping and about 6% only hedgerow interventions. A high proportion, about 94% of farmers, expressed their willingness to try out these interventions on their own farms. Of these, about 56% were interested in both hedgerows and strip cropping, about 33% only in hedgerows, and about 11% only in strip cropping.

The peer assessment by farmers from other communities provided an indication of the effectiveness and suitability of the new interventions in a wider environmental context. These farmers, however, suggested that access to seed and planting materials, multi-location demonstration of the new interventions, dissemination of information about the new interventions through audio and visual media and taking farmers to the research and demonstration sites would be useful to enhance wider scaling up of the process and therefore the use of the new interventions.

Scaling up of New Interventions

To facilitate scaling up of new interventions from research village to wider farming communities, the extension and development agencies working on soil and water conservation in the region were involved in various stages of the PTD process. The participation of these agencies in the joint monitoring and evaluation of research activities at the three research sites was very useful in terms of scaling up of the new interventions. It provided them with an opportunity to get information about the new interventions and to make a judgement on whether those interventions could be scaled up to other similar areas. A very good working relationship has now been established between the local project institutions – LI-BIRD and ARS/Lumle – and the DADO, District Soil Conservation Office (DSCO), and non-government organisations working in the region, which is the first important step in the wider scaling up of the new interventions.

One of the last meetings held with the institutional stakeholders, DADO and DSCO, in the hill districts of the Western Development Region, showed a keen interest in the new interventions and the PTD process; they were already planning some activities in their regular annual programmes. However, they pointed out strongly the need for close collaboration and technical support from the local project team in scaling up the new interventions and institutionalising the PTD process in these institutions. To start with, the following suggestions were made:

- use the existing research sites as resource villages for the supply of planting materials and as demonstration sites for farmers of other villages;
- organise farmers' visits to the three research sites;
- provide training and orientation to the staff of the extension and development agencies in the region;
- establish multi-location demonstration sites at a number of strategic locations in the region;
- disseminate information about new interventions and the PTD process;
- create conducive environments for the wider uptake of new interventions such as value addition, opening up of markets, and introducing other associated enterprises, for example, livestock production or silk rearing.

Following these suggestions, a farmer exchange visit was organised to the Nayatola research site for farmers from Syangja, Palpa, Gulmi, and Arghakhanchi districts (Nayatola is a representative site for these districts) and a 'training cum orientation' was given to the field extension workers of the DADO and DSCO of these districts. These initiatives represent a good start, but require further commitments from the project team in terms of technical and material support to widen the prospects for scaling up, especially for soil and water management interventions that require long timeframes to achieve the desired results.

Another important consideration is that the scaling up of the products of the research, that is the new interventions, should be done along with the research process used in generating those products. Often, the products, being tangible and visible, are taken for dissemination leaving behind the process that was used to generate them. This has been one of the main reasons for low adoption of new interventions. Unlike crop varieties or new seeds, which are either adopted or rejected, soil and water management interventions are management-oriented technologies and, in almost all cases, require adaptation to the new environments. The scaling up of new soil and water management interventions should, therefore, be process led, applying the PTD process that includes at least a short cycle of knowledge analysis and sharing, farmers' experimentation, and participatory monitoring and evaluation. While this process requires staff resources to implement, it is essential in order that interventions remain relevant to farmer circumstances, and is generally affordable in Nepal where constraints for extension staff lie primarily in lack of operating costs, rather than lack of staff time. Demands for additional operating costs can be minimised by re-orienting and rationalising existing development programmes to start from a small number of strategic locations, and gradually expanding from these locations to neighbouring areas by establishing a network for the flow of locally generated materials and information. The farmers involved in the programme can be used as resource people to support other farmers in neighbouring areas.

Considerations for Farmer-oriented NRM Strategies

It is a well-established observation that the management of natural resources is best done by its users and that such farmer-oriented strategies of natural resource management (NRM) are viable, productive, and sustainable. The current work on the PTD process discussed in this chapter is an example of farmer-oriented NRM strategies which further reiterates this position. It has, however, also identified a number of issues that need to be considered in designing effective and sustainable farmer-oriented NRM strategies. Some of the important considerations are listed here.

- Farmer-oriented NRM should consider farmers' local knowledge and practices and incorporate them explicitly into a PTD process that gives farmers a leading role in all stages of decision-making. This, in turn, ensures a process of learning and empowerment.
- Building on farmers' knowledge and practices, sharing technical knowledge, and supporting farmers in their experimentation empowers farmers and the farming community and strengthens their social capital. This is particularly important in achieving sustainable NRM.
- Research and development endeavours in NRM should be process-oriented allowing changes to be made as they progress, to enable adaptation of management options to local environments and situations.
- This experience of PTD on soil and water management strongly suggests that farmers are interested in NRM practices and interventions that start generating economic benefit very quickly. Therefore, ecosystem services should be tied with productivity enhancement. Farmers' priorities, or highly productive areas with income maximisation potential, should be used as entry points for promoting NRM interventions. In the current case, farmers were interested in grasses and forage species not only because these were effective against soil and nutrient losses, but largely because they increased access to and provided quality fodder for their animals.
- Consideration of equity issues in NRM is important but should not be imposed from outside. It should be internalised through the involvement of the community. It has been seen that resource–poor farmers do not generally participate in the beginning of a new initiative to minimise their risk, but they will often join later when they see the benefits.
- Interventions for NRM should be system compatible and harness niche opportunities. In the current work on soil and water management, hedgerows on the outer boundary of the bench terrace were not preferred by some farmers as they replaced soybean and beans. Similarly, farmers at Nayatola research site preferred to integrate orange and coffee along the hedgerow as the site had a good niche for production as well as marketing for these crops.

- Consideration of the scales of operation is equally important. Management of natural resources, initiated at farm or farmer level, often requires consideration at watershed and/or community level. In the current work on soil and water management, farmers were found to be aware of the benefit of diverting runoff from the cultivated land but most of them were not practising it. This required constructing a network of diversion channels at watershed level, and community action to initiate and complete the construction.
- The management of natural resources often requires long-term decision-making and investments by farmers and by the farming community and therefore, a long-term commitment from research and development institutions involved in the process.

Conclusions

Understanding farmers' knowledge and farming practices lays a firm foundation for the initiation of PTD in soil and water management. The experiences of incorporating farmers' local knowledge into the PTD process for developing soil and water management interventions in the middle hills of Nepal suggest that the process is powerful in understanding farmers' knowledge and the rationale behind their practices; in identifying locally suitable soil and water management interventions; and in motivating and empowering farmers to experiment with new interventions by themselves.

Sharing of scientific knowledge and understanding of the ecological processes with farmers and the farming community and exposing farmers to research and demonstration sites helps them to visualise the positive and negative aspects of their practices and conceptualise the new interventions and motivates them to undertake their own research. Such motivation is even higher when they are provided with technical and material support from outside. The partnership and collaboration between farmers and scientists appears to better target research and produce more useful outputs than research done by farmers or by scientists in isolation.
Involving farming communities, including village leaders, at various stages of the technology development process ensures their continued support in the smooth running of the research activities. The farming community and village leaders also feel an obligation to keep an eye on the process and provide feedback for further improvement. Similarly, their involvement in the selection of research farmers imparts the notion that these farmers represent the community and so should be committed to their experiment and share information and findings with other farmers in the community.

The PTD approach used here appears to have been more effective in disseminating information and new interventions from research farmers to non-research farmers in the community than the conventional research method. Extending adoption and/or adaptation and scaling up of the new interventions within and outside the research communities, however, needs long-term support and collaboration between research farmers, scientists, and development agencies.

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5 THE HILL AGRICULTURE RESEARCH PROJECT – Status and Achievements

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Abstract

This paper illustrates the status and activities of the Hill Agriculture Research Project (HARP) funded by the Department for International Development (UK) (DFID). It describes the major strengths and achievements of HARP and the Hill Research Programme (HRP) component. HARP aimed through HRP to demonstrate the benefits of the competitive grant system (CGS) in agricultural research in Nepal. With 131 sub-projects funded and implemented through HARP across the hills of Nepal, it clearly demonstrated the potential of delivering projects' outputs through better practice of the CGS. As a result, the government has created the National Agriculture Research and Development Fund (NARDF) to provide continuity of CGS in the country and HARP is fully supportive in strengthening NARDF. Future work with the NARDF component of HARP will be to make NARDF an effective, sustainable, and independent body.

Introduction

The Hill Agriculture Research Project (HARP) was a five-year project (1996-2001) funded by the Department for International Development (UK) (DFID) in Nepal, and later extended for three years (2001-2004). HARP is a follow-up of two long-term projects previously supported by the UK Government at the Pakhribas and Lumle Agricultural Centres, in the mid-hill districts of the eastern and western regions of Nepal. Some block grant funding to the two centres was continued for the duration of HARP Phase I at a much reduced level and it decreased annually. When the decision to reduce the block grant funding was made, it was agreed that a competitive grant fund called the Hill Research Programme (HRP) should be established in its place, to support both public and private sector agricultural research in the hill regions of Nepal. It was initially opened only to a restricted number of the hill research stations of the National Agriculture Research Council, Nepal (NARC).

The goal of HARP is "enhanced livelihoods of hill families on a sustainable basis". The project's purpose is to "establish a sustainable and effective hill agriculture research system". HRP, as one of the major components of HARP, was designed with the objective of supporting the development of high-quality research outputs, which address the problems and production constraints of hill farming families in Nepal. The programme supports research projects that address the agricultural perspective plan (APP), which is the official strategy document for agricultural development in Nepal for a 20-year period beginning in 1995. HRP aimed to demonstrate the benefits of

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The HRP Project Cycle

A call for project concept notes (PCNs) is made annually in the local press during the month of July. A PCN template is provided either on paper or computer diskette by the HARP office.

Assessments of PCNs and full project proposals (PPs) are carried out through a process of peer review by independent assessors who remain anonymous to the applicants; the process is the same across all programme areas. All assessors are given training in how the assessment process should be undertaken.

Each proposal is sent to a minimum of three reviewers. While assessment will always contain an element of subjectivity, the procedure adopted by HRP tries to be as objective as possible. Assessment is made against a series of questions and a score is then assigned. At the end of the concept note assessment process, each assessor has to rank the PCNs and the PPs (HARP 2000).

All PCNs and PPs assessed by the peer reviewers are compiled at the HARP Secretariat for discussion at the TSC. The TSC discusses thoroughly each PCN and PP submitted by the research providers. Finally, based on the general consensus of the TSC, it is decided whether the projects are to be funded or not or in a few cases recommended for re-submission. Then, with the permission of the Chairman of the Steering Committee, the Steering Committee is called upon for final decisions in selecting projects for funding. Those decisions made in the TSC are presented at the Steering Committee meeting. The Steering Committee makes the final decisions and recommendations for funding of approved projects through HARP.

Status of HRP-Funded Projects

The priorities for allocating funding to different research topics were developed by the TSC based upon the stated objectives of the APP for hill agriculture development. Every year, prior to the call for concept notes, the TSC re-examines the amount of research funding currently allocated to the APP priority topics and adjusts the amount of new funds to each accordingly. There have been five calls for PCNs since 1997.

Prior to the call for PCNs, training in concept note and full proposal writing was given by HARP to the staff that would be submitting the proposals. Assessors were also given training in the methodologies of assessment required by the HARP Secretariat. Based upon the feedback and the experience gained, both by scientists submitting proposals and the assessors evaluating them, the procedures for making awards and for the training courses have been refined and updated.

HRP was a major feature of the first phase of HARP and had two functions. Firstly, it aimed to support the generation of new and appropriate technologies for hill farmers, particularly women and marginalised groups and secondly, it aimed to demonstrate project. HARP I demonstrated that a competitive research fund could operate successfully and encourage collaborative and productive research; it was largely responsible for the establishment of NARDF by HMGN.

NARDF is controlled by a Fund Management Committee and supports, on a competitive basis, both research and development activities. HARP II is guiding and assisting the development and establishment of NARDF based on experiences gained in the HRP project and through the provision of appropriate financial, physical, and logistical support.

Impact of HARP

In late 1999, it was recognised that an immediate impact on the livelihoods of farming households by most of the HRP-funded projects, although highly desirable, was unlikely to be achieved, due to their original research and technology generation based design. The need to be more specific in addressing issues of technology uptake by a broader base of end-users led to the inclusion of a description of potential uptake pathways in the assessment criteria for HRP-funded projects.

At the last HARP review (March 2001), the concept of uptake pathways (UPs) for each of the HRP-funded projects was introduced. The development of UPs was conceived as a means of enabling a more effective delivery of research outputs to farmers. It was left for HARP to foster appropriate mechanisms that would work within the Nepalese context. Based on this, and as a pilot test, project leaders of HRP-funded projects were invited to submit UP proposals to HARP.

UP proposals were evaluated internally by HARP; a total of 18 were approved and of these 6 have been successfully completed. The UP projects are dominated by crop and crop-based interventions; only three projects (17%) focus on livestock. Areas of focus have been niche crops/markets and post-harvest handling and marketing, key areas where a significant impact can be made.

Support to NARC

One of HARP's objectives was to support the institutional change process envisaged in NARC's 'Vision 2021'.'Vision 2021' proposes the creation of two organisations from the current NARC. One is an overarching body responsible for coordinating and guiding national agricultural research (NARC). The other is a public-sector implementing agency or board (the Nepal Agricultural Research Executive Board (NAREB)). HARP's support consisted of organising workshops to explain the 'Vision 2021' document, and assisting in consensus building and the development of an implementation plan.

At the moment there are three active groups concerned with core functions, human resources, and funding. The fourth group, which will deal with legislative issues, has not yet been created. These groups are (1) the Funding Working Group; (2) the Human Resource Working Group; and (3) the Core Function Working Group (HARP 2003).

The Future of HARP

Some of the major reasons for continuing HARP activities in the future are described below.

i. Out of 30 current projects, 18 HRP-funded projects will be completed by mid-July 2003 and the remaining 12 will continue until September 2004. In order to manage, monitor, and evaluate these, the HRP component of HARP will need to continue until December 2004 when the existing, 3-year, HRP-funded projects will have been completed and properly documented. In order to maintain the momentum of the ongoing HRP-funded projects (in terms of releasing funds, monitoring and supervision, output delivery, and project cycle results [PCRs]), it is essential that the HARP Secretariat continues to provide support. At present, the newly formed and developing NARDF is not in position to absorb and implement ongoing HRP-funded projects; further support and training in fund management and additional personnel are required.

ii. HARP would like to use its resources in the remaining period of the project to capitalise on the successes of the UP approach by further developing the methodologies and by implementing large-scale UP projects directly involving non-government organisations and community-based organisations with technical backstopping from research workers.

iii. Outcome evaluations, assessing the potential impact of agricultural research of some completed HRP-funded projects, were done with satisfactory results. This is a new initiative to find out the results, or outcome, of research investment on the livelihoods of hill farmers. The process and methodology needs to be strengthened and promoted on a wider scale so that the stakeholders, NARC, NARDF, and other institutions that are directly working on agriculture technology generation, can learn from the experience and adapt it for their own systems. HARP is working on this development with the stakeholders and supporting its institutionalisation.

iv. M&E is needed to support the implementation of newly-funded UP projects. Assessing the impact of research projects is one of the major components of HARP's M&E system. The impact assessment of HRP-funded projects has not yet been done. It is now necessary, not only to show the benefits of past investment, but also to establish and develop the methodology in order to assess the impact of other agricultural research projects and to serve as a model for other institutions.

v. Future work of HARP with NARC will focus on the further development and implementation of current activities, the key element of which is the full implementation of 'Vision 2021', with all this implies.

vi. Focusing research activities and addressing national priorities as envisaged in the APP and the tenth national development plan has resulted in the start of a process for developing a National Commercial Agriculture Research Programme (NCARP). This will include livestock and crops and will be based at the Agricultural Research Station, Pakhribas. The project is providing technical and financial support to this process. At a micro level, it will involve the same assessment of core function,

6 TAKING SUSTAINABLE SOIL MANAGEMENT TO SCALE – Experiences with Practices, Methods, Approaches, and Policies for Nepalese Hillsides

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Abstract

The promotion of sustainable soil management (SSM) implies the exploration of technical interventions and social processes. The former includes combinations of indigenous and new knowledge and practices, the latter refers to methods of promotion, approaches in working with farming communities, and policy-level support. Both have implications for gender, social, and economic equity. This chapter describes experiences in SSM promotion by government and non-government organisations in Nepal over the past four years. Emphasis is given to the following: (1) a national competitive grant system for innovation; (2) a system of decentralised demand-led farmer-to-farmer diffusion for scaling up at the local level; (3) joint efforts between farmers, researchers, and extension staff for technology innovation from an open 'basket of knowledge'; (4) farmer leadership in the overall innovation and diffusion process that is cost efficient and effective; and (5) open linkages and feedback with the policy level to ensure a supportive environment. Gender, social, and economic equity are cross-cutting themes at all levels.

Experiences with the promotion of SSM in Nepal indicate that neither technologies nor processes for SSM extension are based on a straightforward scaling up of research results. It is rather the diversity of inputs from research, extension, policy level, and farmers, that induce changes in SSM at the farm and higher levels. In the case of SSM in Nepal, almost no researched practice has been scaled up as originally designed. However, intended and unintended information from research have provided vital input into a 'basket of knowledge' and many bits and pieces of these research inputs have gone to scale.

Introduction

Soil is the primary resource base for agricultural production. Farmers in the hills of Nepal are well aware of this and have developed elaborate indigenous methods of soil conservation and soil fertility management (Tamang et al. 1993). Integrated crop-livestock systems are common across the hills with substantial nutrient transfers

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between grazing, forest, and agricultural land. Ecological, economic, and social conditions are highly diverse in the hills resulting in highly heterogeneous production conditions.

Traditional knowledge may not provide farmers with solutions to tackle new challenges that originate from recent intensification in agricultural land use and reduced access to biomass from common property land. New practices such as the application of inorganic fertilisers and the planting of nutrient-demanding crops, such as vegetables, are gradually spreading without thorough experiences of farmers on integrating these into their farming system. The degree and pace of change differ widely across the hills and different pathways of intensification emerge. These pathways largely depend on two main determinants: access to markets with use of external resources and access to local private or common property natural resources.

Background and Sources of Information

The SSMP started in 1999 with the objective of promoting the uptake of sustainable soil management (SSM) practices by women and men farmers in the hills of Nepal. The programme supports government and non-government actors in working with local communities in this effort.

The experiences of SSMP and its collaborators with practices, methods, and approaches for the promotion of SSM were analysed in 2002. The methods used for the assessment include

- external evaluation of projects by farmers from non-project areas;
- self-assessment of projects by farmers and organisations;
- topic-specific studies by external experts;
- analysis of experience through stakeholder workshops.

More than 600 farmers, staff from more than 40 organisations, independent experts, staff from the STSS under the Department of Agriculture, and staff from the PMU of SSMP contributed to this effort. This summary was prepared by the PMU and STSS based on the above-mentioned sources. References are cited where possible. However, as usual in extension projects, learning and subsequent adjustments have priority over documentation and the diversity and richness of the underlying processes remain largely undocumented.

Experiences with the Promotion of SSM

A word of caution first. Experiences are gained under specific circumstances and may differ accordingly. Additionally, a period of four years (1999-2002) is short, thus, we prefer to talk about a process of continuous learning rather than experiences. Experiences today may be overcome by new learning tomorrow. Nevertheless, we use the term ‘experiences’ in its wider meaning.

The promotion of SSM comprises a technical intervention and a social process, these are difficult to separate from each other. In spite of this, the following sections try to outline experiences related to technical, methodological, and approach matters separately.

Developing the approach

In 1999 SSMP encountered the challenge of a largely compartmentalised institutional environment. Linkages between actors in research and extension were weak and a large number of mostly district-level non-government organisations (NGOs) had emerged. Most of these local organisations came into existence after the establishment of multi-party democracy in 1990. They have largely focused on activities related to social mobilisation. The bigger NGOs tend to be managed by local elites and depend on external funding for their operations.

Competitive Grants

SSMP was designed as a competitive grant system so as to capitalise on the existing institutional diversity and related comparative advantages. This implied the involvement of government and non-government organisations (NGOs) in the process. Competitive grant systems have been used globally in many countries for funding research. The Hill Agricultural Research Project introduced such a system for financing agricultural research in Nepal in 1998 (Mathema 2003). SSMP could build on these experiences in research funding. However, the establishment of a competitive grant system for agricultural extension was new for Nepal and had to be built on limited international experiences (see AKIS 2000).

The overall management of the SSMP competitive grant system is similar to the one described for research by Mathema (2003). A total of 67 organisations (called collaborating institutions (CIs)) were supported in 2002. Among these, 15 were government organisations, 5 farmer associations, 29 local NGOs, 10 national NGOs, and 8 district-level farmer-to-farmer diffusion fund committees. The organisations implemented projects in 213 village areas of 10 mid-hill districts. A total of about 1,925 leader farmers (LFs) and 18,700 group farmers (GFs) were involved (Figure 6.1).

So far, the experience with providing project support under a competitive grant system indicates the following.

- Collaboration based on confidence building and performance
  The government extension service can multiply its impact through technical advice and support to local NGOs. However, the development of a trusted collaboration between government organisations and NGOs in a district happened as a gradual process over three to four years. SSMP supported it through quarterly district-level reviews and planning workshops and special support to collaborative efforts. However, collaboration was not an enforced precondition for project support. Organisations had to gain and maintain their reputation.
- Comparative advantage of organisations
  National NGOs are best positioned to fulfil the administrative requirements of a competitive grant system. They are most experienced in writing proposals and most of them have professional staff for project management and implementation. Most

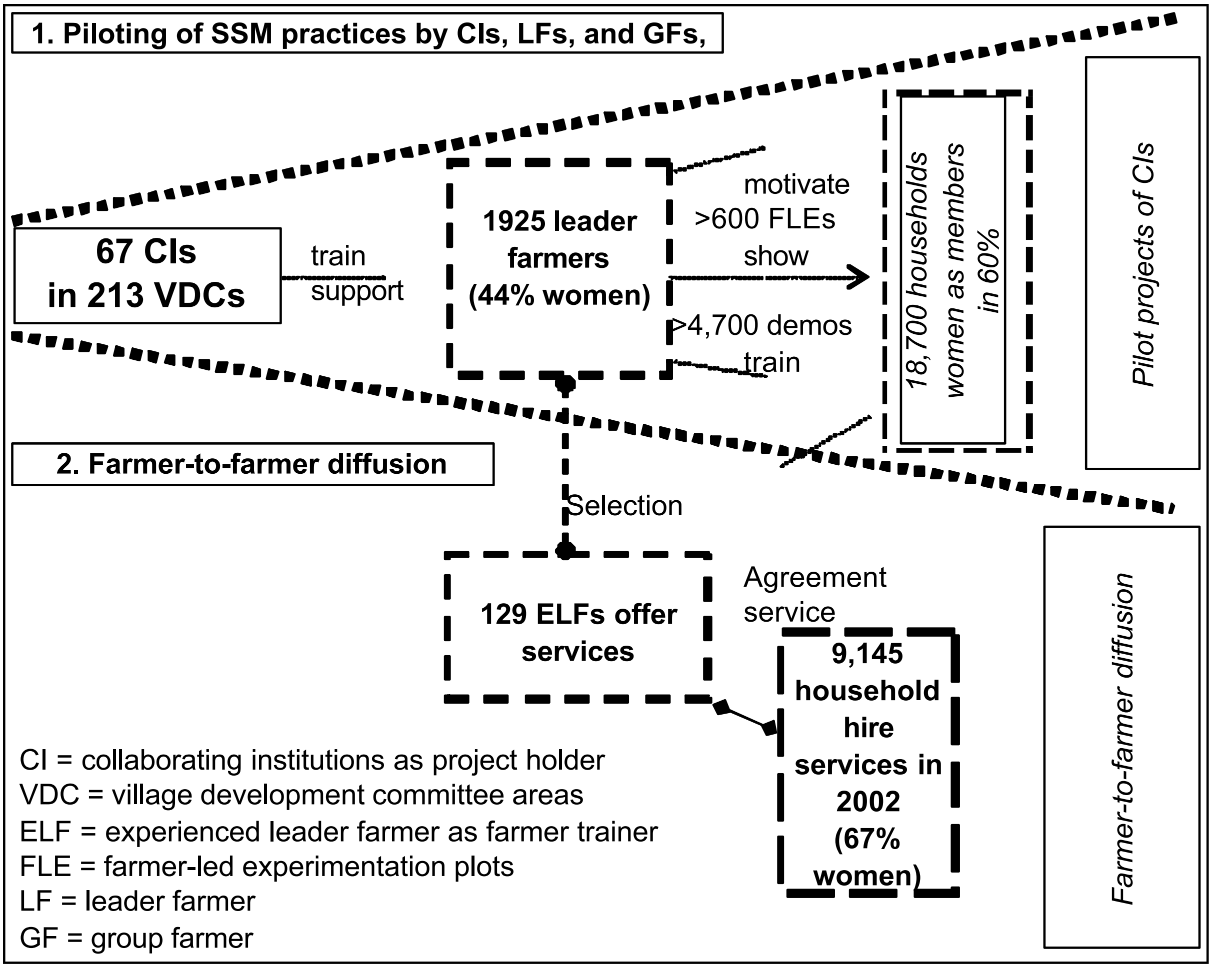

Figure 6.1: **The approach of SSM-testing and diffusion: CIs test and demonstrate new SSM practices with LFs and GFs in pilot areas.**

Once a technology has proven successful, the most 'experienced leader farmers' (ELFs) offer their services to GFs outside of the pilot area for wider farmer-to-farmer diffusion. The numbers indicate the support provided by SSMP in 2002.

of their staff are not locally recruited and senior staff take responsibility for proposal writing and reporting. Field observations indicate that farming communities often perceive projects implemented by national NGOs as external projects in spite of the commitment to participatory methods. Project implementation costs in terms of investment per attended farm family tend to be higher for national NGOs than for local NGOs and government organisations. SSMP's experiences indicate that national NGOs can best contribute to the promotion of SSM by providing technical and institution-building support to local-level organisations. The intensity of this support depends on the experience and maturity of the local-level organisations.

- Capacity building in local NGOs
  Local NGOs can be the most effective and cost-efficient implementers. This applies in particular to the local NGO that is well-rooted in the community and whose members have a farming background. However, a large number of local NGOs were created for the benefit of their members rather than for the benefit of the

community. Therefore, a critical assessment of detailed institutional profiles of all organisations forms an important step before the project concept notes can be accepted by SSMP. Whereas local NGOs normally do not have trained staff, SSMP has developed training modules on technical and methodological aspects. The first year of project implementation by local NGOs is mostly a year of learning, experience building, and performance testing on a very limited scale. Government organisations can greatly contribute to this process through technical advice.

- Competition and collaboration
  Support to regular district-level workshops for all project implementers, including district-level authorities, has been an essential element for gradually developing concerted efforts in a district. At the same time, each organisation is free to prepare its own proposal and is accountable for its performance. Thus, SSMP supports organisations individually under a competitive grant system, while collaboration and concerted efforts increase the chances of the organisation to ensure continued support.

Institution-led pilot projects
The main purpose of these institution-led 'pilot' projects is to test and identify with farmers relevant innovations for SSM that contribute to better income and/or food production. The pilot projects are implemented in a well-defined and limited target area. Once such innovations have been identified (for example, vegetables with SSM, groundnut as a food and cash crop, urine as liquid fertiliser), the main challenge becomes the wider diffusion of these practices. In this case, the extension service needs to shift its attention from active promotion of the practice towards supporting suitable conditions for wider diffusion. This may imply support to marketing opportunities that attract farmers to adoption and the creation of an effective and low-cost diffusion service.

Farmer-to-farmer diffusion
SSMP is presently assessing if an approach of demand-driven farmer-to-farmer (FTF) diffusion can serve the purpose of a low-cost and effective diffusion system for SSM. Under FTF, the most experienced farmers from pilot project sites are identified and receive additional training to upgrade their communication and service skills. Subsequently, farmer groups in neighbouring areas can hire the service of these experienced leader farmers (ELFs) to learn about and implement the new SSM practice. An ELF is free to explain and show the SSM practice in the way they have adopted it on their own farm. Simple service agreements are signed between the group and the ELF. These can be presented to a district-level committee for funding support. The Department of Agriculture, district-level authorities, local NGOs, and farmers are members of the FTF committee. Funds are allocated on a competitive basis. Priority is given to the most needy communities. The involvement of SSMP is limited to the additional training of ELFs and to contributing to the district-level FTF fund.

More than 9,000 households have hired the service of ELFs in 2002, the second year of operation of FTF diffusion. First experiences indicate a high rate of adoption of the main practice (for example, vegetable production), while the SSM component behind the main practice (for example, better manure management under vegetables) may be less adopted (Table 6.1). This needs further observation and discussion with ELFs and demand farmer groups in 2003.

Table 6.1: Comparison of adoption rates under different extension methods for vegetable and farmyard manure management

Diffusion process	Adoption rates (% farmers) (preliminary data)	
	Better FYM	**Vegetables**
LF to GF approach *(GF adoption in pilot projects by CIs, after 3 years)*	42	46
FTF diffusion *(Adoption by demand farmer groups, after 2 years)*	36	>90

SSMP (unpublished) preliminary data based on field surveys in 2001 and 2002 in more than 5 districts involving more than 500 farmers FTF diffusion is used in areas adjacent to CI pilot projects

Investments

An analysis of the investments for diffusion indicates that the cost per GF household under the pilot projects implemented by CIs is approximately US$ 20-30/year. This is significantly lower than the average investment of about US$ 45-50/household in 20 development projects implemented by government organisations and NGOs in Nepal hill areas over the past decade (SAPROS 2001). The investment per supported farmer household under the FTF-diffusion is about US$ 3.5. Thus, FTF diffusion indicates an opportunity for effective low-cost extension. However, the demand for FTF diffusion will depend on the continuous availability of attractive innovations from the pilot projects and on marketing opportunities for the new practices.

Developing SSM practices

Farmers in the hills base their soil fertility management on organic matter management. An average of 3-10 t/ha of farmyard manure (FYM) is added every year to rain-fed crop land (Subedi et al. 1989). The amount varies depending on the number of livestock in the farm unit and the amount of fodder and bedding material accessible to the farm. The applied manure maintains soil organic matter levels at about 2-5%. Higher organic matter levels may prevail in the higher hill areas while organic matter levels tend to be around 1-2% in the low hills. Lower levels in the low hills are due to higher decomposition rates under more intensive land use and because of limited access to forest biomass for fodder or bedding material.

The use of inorganic fertilisers has increased over the last two decades, particularly in areas with good market access and with planting of cash crops like vegetables. No, or very limited, amounts of fertiliser are used in remote areas. However, since the gradual removal of subsidies for fertilisers over the past five years, farmers have tried to limit their investments in fertilisers by using urea instead of the more expensive diammonium phosphate (DAP). In addition, farmers have observed a decline in soil fertility under the continuous use of fertilisers. A common observation is, for example, that land fertilised with inorganic fertilisers becomes hard and difficult to plough (unpublished reports, CI of

SSMP). Therefore, there has been a high interest by farmers in organic soil amendments. Basically all projects supported by SSMP promote practices of organic matter management.

CIs experienced a much higher interest in SSM practices when these were combined with crops and agricultural enterprise activities which have market and income-generating potential. This has resulted in substantial changes in the projects presented to SSMP over the last four years. The proportion of projects integrating SSM with income-generating activities has increased from about 25% in 1999 to more than 75% in 2002. Vegetable production, fruit trees, coffee, ginger, fodder for dairy, and other income-generating commodities have become integral components of most projects. SSMP supported these changes by actively encouraging CIs to analyse experiences with farmers and by offering the opportunity to change project activities on an annual basis. Flexibility by SSMP to adjust projects on an annual basis has been an essential element for supporting these changes.

Sources and pathways of identifying SSM practices

Farmers' interest in new SSM practices varies by gender, social belonging, economic status, and access to resources. For example, men tend to be more interested in cash crops than women, who often lack control over the income from such commodities. Methodologies to address these issues and their implications for the selection of SSM practices are discussed in the section below on developing methods.

The sources and pathways for technical innovations varied widely and included the following.

- Enrichment of local innovation: learning and experimentation with farmers on local resource management
- Stakeholder design of external innovations: design of a new technology through a working group from research, extension, and policy level and subsequent testing with farmers
- Demand-based transfer of innovations: training, demonstration, and farmer-led experimentation in response to market demand

Examples of identified innovations are described in Table 6.2.

The combination of new and local knowledge is common to all three although the first originates in farmers' knowledge while the second originates in research. Farmer-led experimentation for local adaptations is an essential step in all three (see next section).

Innovation in FYM management

The introduction of improved FYM management is an example for learning and experimentation with farmers on more efficient local resource management (Figure 6.2). Previous research had developed recommendations for improved manure management which included the following main elements: digging a pit; covering with a roof against rain and sun; and turning 2-3 times for better decomposition. Promotion of this practice

Table 6.2: **Experiences with SSM practices of SSMP collaborating institutions**

SSM Practice Adopted by Farmers	Contribution from Research / Research needs	Experiences at Farm Level of Farmers and CIs	Driving Force for the Diffusion of Practice	Experiences with Equity Implications
FYM management Simple piling, plastic sheet cover, urine collection About 42% adoption	Data on nutrient content and flows (fodder, manure ...) Trials on combined use of organic and inorganic fertiliser *Research needs* *Urine as liquid fertiliser* *Urine plus plant extracts for pest control*	Less use of inorganic fertiliser (urine replaces urea) Combination of organic and inorganic with use of inorganic for top-dressing Higher crop production from quality manure	Removal of subsidy on fertilisers Soil fertility decline and more work to plough land after fertiliser use Adoption of crops responsive to increased nutrient supply Stall feeding with urine availability	Local inputs available to farmers without access to markets and fertilisers More workload, mostly for women Less cash for external inputs (implications depend on family) Not for poor farmers without livestock
IPNS Cropping system based over 1 year Nutrient balance estimate for organic matter and main nutrients Includes overall crop and field assessment	IPNS trials by research Data on soil dynamics, nutrient flows, and losses Trials on use of organic and inorganic fertilisers *Research needs* *More data on soil dynamics (for example tillage effects, organic phosphorous, micronutrients)* *Nutrient flows in farming systems (forest crops ...)*	Basal nitrogen often not necessary as sufficient free nitrate in soil Top-dressing time and use of urine as top-dressing as key learning on nutrient management in first year Reduced rates of fertiliser with appropriate timing in external input systems	Increased factor productivity (mostly output per unit of local or external input, output per land area) Interest in combining efficiently local inputs (for example, FYM) with external input (fertiliser) Learning and experimentation on nutrient management	Access to resources (local and external), not their effective and efficient use, is the main constraint for landless or very poor households High interest and participation by women farmers, however, women IPNS groups may need to be formed in traditional societies
Vegetables and SSM Vegetables for food and as cash crop About 45% area increase per farm	Agronomic practice for vegetable production Trials on use of urine as liquid fertiliser Varieties of vegetable Pest and disease identification *Research needs* *Organic pest management using local resources* *Local varieties*	Farmers' interest in easily marketable vegetables (for example, cauliflower, four season beans) Vegetable production stimulates farmers to invest in soil fertility management	Cash income from vegetables Reduced external input cost for vegetable production Improved soil fertility under vegetables plus SSM Better nutrition for family from vegetables	Better workload sharing among men and women in gender aware groups More workload but limited benefits in areas of dominance by men Poor household participation through land leasing

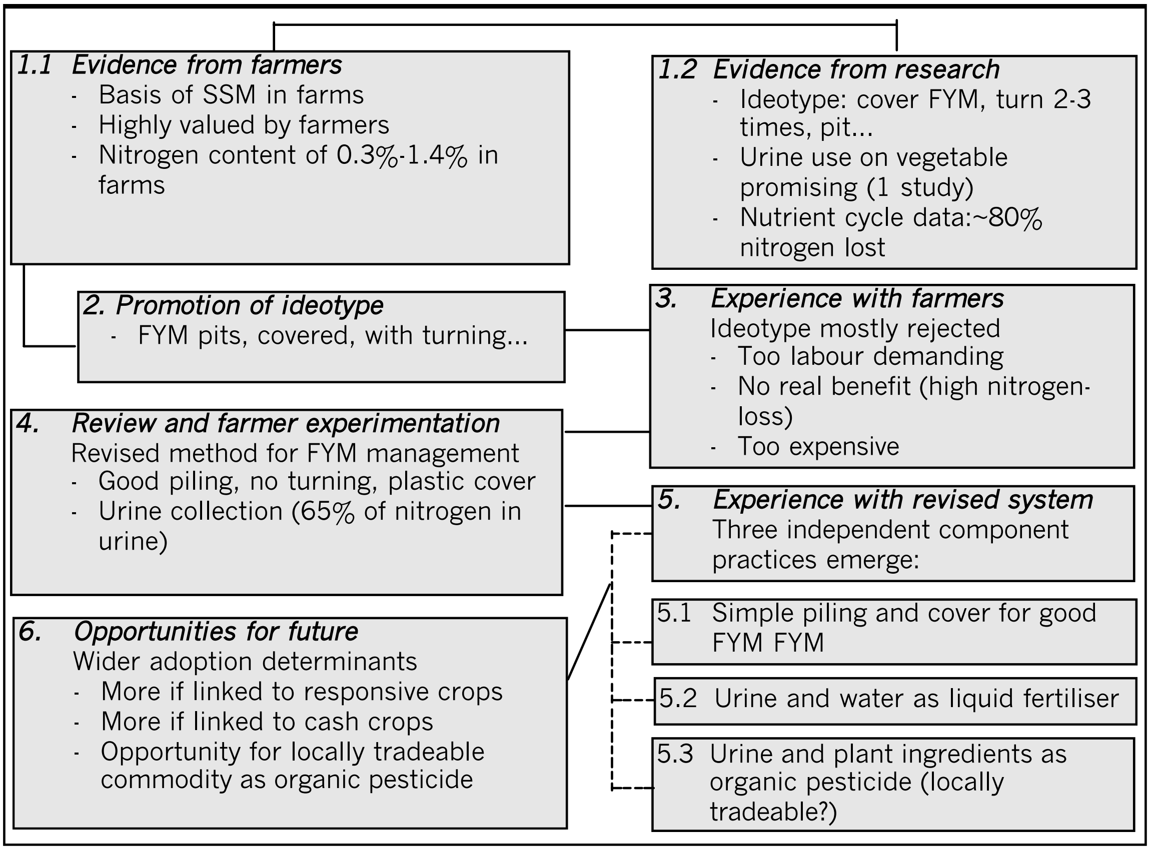

Figure 6.2: **The process of change of a local technology (example, manure management) through learning and adjustments with farmers (based on experiences of SSMP collaborating institutions, 1999-2002)**

in 1999 failed as farmers rejected it as being too labour demanding and not resulting in improved crop production. Further literature reviews, field observations, and discussions with farmers resulted in a revised system: simple piling of manure, urine collection for nitrogen-preservation, covering with plastic sheets, no turning, and protection from run-off water. This was taken back to farmers with special emphasis on the fact that about 65% of the excreted nitrogen is in urine not in the dung. Farmers tested this in 2000-2001 and experimented with the manure management and with the use of urine as a liquid fertiliser. Three component technologies are emerging: (1) a simple method of manure preparation (piling, plastic cover, no turning), (2) urine collection and use as liquid fertiliser, and (3) use of urine combined with various plant ingredients for the preparation of organic pesticides as well as fertiliser. The latter may have the chance to become a locally tradeable commodity (Ojha et al. 2002a).

Integrated plant nutrient management

The introduction of an Integrated Plant Nutrient Management System (IPNS) developed along another pathway. Various researchers under the National Agricultural Research Council, Nepal (NARC), together with international collaborators, implemented trials on IPNS or related topics over the past years (Pilbeam et al. 1998; Gardner et al. 2000; Maskey 2000; Tripathi et al. 2001). The Ministry of Agriculture and Co-operatives and the Department of Agriculture committed themselves to the introduction of IPNS in extension. Therefore, a working group on IPNS was formed among all actors to summarise the available information and to develop a common concept for IPNS. The wide range of different experiences and the pulling together of information and expertise from different sources were the basics for developing a practical concept of IPNS for extension. Trials, for example on the combined use of organic and inorganic fertilisers (Bhattarai et al. 2000; Tripathi et al. 2001), provided essential data for IPNS but were not the basis for taking IPNS from research to extension. A major technical challenge for the design of IPNS for Nepal hill farming systems was the predominant role of organic matter management in hill farming. Most IPNS work in other countries had focused on the appropriate use of inorganic fertilisers while giving less importance to organic matter dynamics in soils (Dobermann and Fairhurst 2000). Research and extension experiences with organic matter management in African farming systems provided relevant input for the design of IPNS for Nepal (for example, Swift and Palmer 1995; Scoones 2001).

Vegetables and SSM

Vegetables are highly valued by farmers because of their utility as food and as cash crops. Over the past decade, vegetable production has rapidly spread in areas with good market access. Farmers from other areas observed this and demanded training and demonstration of vegetable production under SSMP-supported projects. However, field observations indicate that fertiliser and pesticide use are widespread under intensive vegetable production without proper knowledge about their judicious use. This raised the concern that the planting of highly nutrient-demanding crops, such as vegetables, may actually cause a decline in soil fertility and may not be sustainable. The combination of vegetable production with SSM practices was therefore considered an essential element of SSMP-supported projects. A study in three field sites, where vegetable production had been combined with SSM practices for the last three years, indicated that the planting of vegetables had indeed stimulated farmers to increase their investment in soil fertility maintenance. Vegetable-producing farmers had increased the application of manure in the vegetable fields, increased fodder planting for more manure production, and invested more in inorganic fertilisers, including DAP (Table 6.3).

Lessons learned about SSM practices

The lessons that emerged from these experiences are described below.

- New knowledge to enrich local resource management
  Practices perceived by research and extension as a single technology may be broken down by farmers into several component practices. New knowledge about practices (for example, the relatively higher proportion of nitrogen in urine against dung), not skill development, may be essential for farmers to initiate their own experimentation. This applies in particular to innovations in local resource management.
- Reporting research results
  Research trials may provide information that is not expected or is not part of the intended outcome. Such information may still be highly relevant for extension purposes. For example, a large number of research trials on erosion control were planned and financed on the assumption that erosion is a major problem. Many of

Table 6.3: **Effects of the integration of vegetables and SSM on soil and farm systems**		
Characteristic	**Vegetable Grower Plots**	**Non-vegetable Grower Plots**
Fertilisation *per year*		
- Manure (t/ha)	31	14
- Urea (kg/ha)	74	38
- DAP (kg/ha)	66	20
***Soil* analysis**		
- Soil organic matter %	2.2	2.1
- Soil phosphorous kg/ha	41	28
- Soil pH	6.6	6.4
***Fodder* production**		
% change, private land	+ 50	+ 20
Crop yield (% change/ha)		
- Maize yield	+36	-
- Millet yield (maize shade)	-2	-
- Cauliflower (more disease)	-16	-
Data for 20 farms in Parbat. Fields close to farmhouse with 2-5 years vegetable production (Ojha et al. 2002b)		

these trials indicated that erosion is rarely a major problem in farmers' mostly terraced fields. However, such information does not get widely distributed and many researchers as well as extension staff remain reluctant for a paradigm shift from erosion control to soil fertility management.

- Technologies and knowledge for complex farming systems
  The expectation that research needs to develop new technologies may not apply if the challenge is to improve complex crop-livestock-forest farming systems. Research on such systems tends to be highly site specific. Thus, trial results cannot be extrapolated. Therefore, quantitative information on resource flows in these systems, not technologies, is important for extension. This, however, is only valid if close research-extension linkages ensure that the information derived from research is translated into practically relevant extension knowledge. This is the main challenge for further development and local adaptation of integrated resource management practices, such as IPNS.
- Markets and sustainable farming
  Market access provides a strong incentive to farmers to adopt new practices. It is essential early on to combine the promotion of these practices with sustainable resource management. However, most research on market-oriented crops is based on high external input management.

Developing methods for SSM extension

Methods for testing new ideas together with farmers, for increased farmer involvement in extension, and for interactive learning have been documented widely (for example, Bunch 1996; Holt-Gimenez 1996). Methods have shifted from message delivery from research-to-extension towards methods of interactive learning. Research is no longer perceived as the only authorised source of extension content and processes of multi-source enrichment are recognised. These conceptual changes went along with innovations in participatory methods such as farmer-led experimentation and farmer-field schools. Some of these innovations have been implemented in Nepal over the last decade, although often at a limited pilot scale. NGOs have often taken the lead but, in several cases, government organisations were also major actors in innovation (for example, Scheuermeier 1988; Chand and Gibbon 1990; Pandit 1996).

The challenge for SSMP was to test relevant methods accessible to its partner organisations and to promote their adaptation and use. This was initially done in collaboration with more experienced national organisations that subsequently shared their knowledge with other partner organisations of SSMP. However, some local NGOs and some district-level government offices turned out to be more dynamic and innovative in testing new methods with farmers than some of the national organisations. Therefore, SSMP promotes increasingly a working group approach for exploring new methods. The working groups may include members from national and local organisations and government and non-government actors.

Sources and pathways for identifying methods

The source and pathways for innovations in methods are more difficult to trace than those for technical innovations. Examples of identifying innovations are described in Table 6.4. They respond to the following requirements.

- Methods for local innovation at field level
  Need for local testing and adaptation of SSM practices by farmers in highly complex farming systems and heterogeneous environments (for example, farmer-led experimentation)
- Methods for knowledge enrichment
  Need for knowledge sharing with farmers in order to enhance the decision capacity of farmers combining indigenous and new knowledge (for example, farmer-field schools)
- Methods for participatory planning and evaluation
  Well-targeted and learning-oriented projects through a stronger involvement of farmers in the planning and assessment of projects (for example participatory project evaluation)
- Methods to assess equity implications of technical change
  Need to critically analyse the implications of project activities on gender and social equity and to design appropriate actions

The first two method needs mentioned above respond to interests expressed by farmers and the implementing partner organisations. The latter two are requirements that are all too easily overlooked by leaders in organisations and in communities. Thus, SSMP is gradually enforcing these as prerequisites for project support.

Training and demonstrations

Different methods of training are widely used for knowledge and skill transfer. They are efficient in informing farmers and in developing specific skills (for example, nursery establishment, citrus die-back control). Practical demonstrations of new SSM practices are used by most organisations although the main actors for demonstrations are not staff but LFs in coordination with their groups. LFs implemented more than 4700

Table 6.4: **Experiences by collaborating institutions (CIs) of SSMP with methods of SSM promotion**

Method and Use	Source of Information	Experience at Field Level of Farmers and CIs	Driving Force for Utilisation of Method	Experiences with Equity Implications
Farmer-led experimentation Testing of new SSM practices About 30 CIs use farmer-led experimentation with more than 600 farmer-led experimentation plots in 2002	On-farm research and participatory variety selection (for example LI-BIRD) Working group on farmer-led experimentation *Future needs* *Link with research stations to enrich experimentation*	Highly stimulating for farmers Integration of new SSM practices into local systems Data recording and documentation weak	Lack of research on local system improvements Farmers' interest in testing innovations	Farmers with more land and resources tend to be leaders in experimentation Risk of not sufficiently including indigenous knowledge or women
Participatory planning, monitoring, and evaluation Increase GF involvement in project planning Project evaluations by farmers 20% CIs apply in 2002	Development organisations (PDDP, community forestry projects, ...) *Future needs* *Simple economic evaluation criteria and methods* *Stronger role of poor households in participatory planning, monitoring, and evaluation*	Limited commitment of organisations to prepare proposals based on participatory planning, monitoring, and evaluation Group processes often not sufficiently sensitive for intra-group equity	Interest of genuine local NGOs and farmer organisations to involve farmers in participatory planning, monitoring, and evaluation Increased chances for project approval if based on farmers' demand Support to local cooperative formation	Local elite tend to dominate the process Separate planning sessions with women farmers essential in traditional societies Very poor households have different livelihood base
Gender implications of SSM practices Assessment of implications of adoption on women and men Identification of actions for better sharing About 13 practices characterised	Research by University of East Anglia and others Working group of CI *Future needs* *Characterise technologies for gender implications* *Extend to social equity*	Relevant for farmers if concrete actions defined (seed thresher to reduce women's workload, ...) Local restrictive or supportive actors need to be involved Local promoters needed for advocacy in district	Search for action-oriented gender work Local promoters essential to move process forward and to maintain stimulus Increased chances for project approval if equity concern addressed	Local adaptations needed depending on local gender relations
Farmer-field school Strong GF involvement Visual learning tools very useful (pH, nitrogen, ...) 30 farmer-field schools in 2002	IPM experiences in Nepal and elsewhere *Future needs* *Simple tools for nutrient balance estimates* *Development of integrated crop management*	Nutrient balance calculations difficult One learning plot and individual plots for testing in each farm Combination with farmer-led experimentation very effective for learning	Regular and integrated learning approach on SSM easy to implement High interest by farmers in regular social gathering with learning and experimentation	Very poor households prefer to work for earning income instead of attending farmer-field schools

demonstration plots in 2002. Practical demonstration remains a simple method for creating awareness and teaching about a practice or method.

Farmer-led experimentation

Farmer-led experimentation was new to most organisations in 1999. However, based on experiences in Nepal (Staphit et al. 1996; Gautam et al. 2002) and elsewhere (Holt-Gimenez 1996; Ashby et al. 2000; Reij and Waters-Bayer 2001), a working group of five national and local NGOs developed a method of farmer-led experimentation for Nepal. This included the initial design of a step-wise implementation process, its field testing over two seasons, and the documentation of experiences in a field guide (Sharma and Bajracharya 2002). More than 30 organisations have adopted farmer-led experimentation in 2002 and more than 600 experimental plots were implemented by farmers.

Farmer-led experimentation has greatly enriched the process of innovation for SSM. It has enabled the organisations to shift project activities from demonstration and training of recommended practices towards a design of innovations with farmers. As planning of experiments is done with farmer groups, it has also diversified the range of SSM practices tested and promoted under SSMP-supported projects.

The recording of information from farmers' experiments remains weak. We presently consider the sharing of information among local farmers and groups more important than the formal recording of experiences. The involvement of researchers in the design and evaluation of farmers' experiments has been limited. However, farmers and the supporting organisations recognise increasingly that involvement of researchers can enrich the ideas for experimentation. Recent changes in the research system, like actively seeking partnership with NGOs and giving more independence to regional research stations, are supportive to local partnerships for innovation.

Participatory planning, monitoring and evaluation

Although GFs are involved in training, demonstrations, and farmer-led experimentation, their role often remains limited. Therefore, participatory planning, monitoring, and evaluation methods, have been promoted over the past three years to ensure that projects are more clearly based on GFs' priorities. Experiences in Nepal (Hamilton et al. 2000; Participatory District Development Programme (PPDP) personal communications and field observations) and elsewhere (Gohl and Germann 1996; Obando et al. 2001) were again instrumental inputs for designing methods for SSM promotion in Nepal. An important innovation has been the evaluation of all three-year projects by farmers. This implies that a team of evaluating farmers external to the project area, visits a project site and assesses with the resident farmers the activities and impacts of the ongoing project in the area (Dhital and Dhakal 2002). About 40 projects have been evaluated using this method in 2001 and 2002. Experiences indicate that the outcomes from farmers' evaluations are more critical than evaluations done by the organisations. Farmers' evaluations (or, in more general terms, evaluations by beneficiaries or clients) can be powerful tools to assess project performance in competitive grant systems. A challenge remains in the documentation of evaluations by farmers, as they do not conceptualise their findings in the way trained research, extension, and development staff do.

Gender implication assessments

Women farmers contribute greatly to farming and soil management in the hills of Nepal and have substantial indigenous knowledge. A wide range of projects and institutions in Nepal have promoted awareness of gender disparities and have contributed to women's empowerment although a lot remains to be done in changing attitudes, policies, and social relations. The main challenge for SSMP is how to support partner institutions to integrate issues of gender equity into technical projects. Discussions with staff of CIs and with women farmers indicated a desire for concrete change rather than further efforts through gender awareness campaigns. Literature on methods and tools for gender equity did not offer what staff and farmers requested, although it enriched their ideas on how to tackle the issue.

Most enriching were the discussions of a working group of dedicated field staff from various partner organisations, experiences from other countries, and direct interactions with experts working in other social environments (Zweifel 1998; Locke and Okali 1999). The implications of technical change in SSM on gender equity were identified as a major objective to address. When women and men farmers have knowledge about these implications, they can discuss the sharing of workload and benefits, before adopting or not adopting new practices. The development of a method to address this issue was done through action research at the field level. The main outcome is a method to analyse gender implications of SSM practices together with farmers. These discussions contributed to the identification of concrete actions to improve equity in workload and benefits (Shakya et al. 2002). An example of one of the outputs from an analysis of the implications of vegetable integration into the farming system is outlined in Table 6.5. The introduction of organic pest management practices, men's commitment to contribute more time to vegetable cropping, and the initiation of a marketing cooperative are the main concrete actions that came from the analysis.

Table 6.5: **Results of an analysis of gender implications of vegetable production with women and men farmers**

Women farmers	Men farmers
Positive effects	
1. Income for household expenditure 2. Soil quality improved 3. Better schooling of children 4. Better nutrition and health	1. Land productivity increased 2. Income increased 3. More employment 4. Social status improved
Negative effects	
1. Workload increased 2. No leisure time left 3. Insect pest problems increased 4. Lack of market facilities	1. Lack of improved/quality seed 2. Insect pest problems increased 3. Could not get expected price of the product in the market

The information resulted from discussions on gender implications of SSM with farmers in Kavre district, based on various tools such as effect tree and priority setting (Bajracharya 2002)

Farmer-field schools

Since 2001, farmer-field schools on IPNS have been set up, based on the experiences with integrated pest management (IPM) under the Department of Agriculture and collaborators in Nepal and elsewhere. However, adjustments had to be made from experiences in IPM to meet the needs of IPNS. For example, SSM needs to be planned over an entire cropping cycle, at least one year, while IPM is crop specific for one season. Pest incidence and severity may change over a few days requiring weekly group meetings, while changes in soil nutrient status may only be observed over a period of 2-4 weeks. A prerequisite for the implementation of IPNS farmer field schools was the availability of simple tools that visualise soil dynamics. Nitrate strips, pH paper, hydrogen peroxide, and other tools (Subedi et al. 2000) were found very useful. Most of these tools were not derived from research but from extension organisations in other countries. Research has in the meantime started to calibrate these tools and to develop new tools. Another innovation used in IPNS farmer-field schools is the combination of farmer-field schools with farmer-led experimentation, also reported elsewhere (Braun et al. 2000).

Partner organisations of SSMP are free to use their own methods for working with farming communities, as long as these methods meet the principles of farmer participation, gender equity, and the combined use of indigenous and new knowledge. Additionally, SSMP supported the development of training modules and manuals on these methods, while respecting the independence of each organisation in its process of implementation. This has resulted in a diversity of methods used by government and non-government, and national and local organisations. It is an ongoing process that further enriches experiences.

Lessons learned on methods for SSM extension

Below are the lessons that emerge from these experiences.

- Diversity of organisations
  A range of methods can be used depending on the objective and circumstances. The diversity of local and national and government and non-government organisations working with SSMP has enriched the overall learning. Action research on methods through working groups composed of different organisations has been particularly productive.
- Participation and effective delivery
  Farmers' patience, in particular women farmers' patience, with lengthy participatory processes is limited when farmers have clearly identified their need. In such cases, concrete action is more important, such as training on skills (for example how to make a coffee nursery), demonstration plots (for example, management of cauliflower), or simple farmer-led experiments (for example, women workload reduction with a seed thresher).
- Technical research on methods
  Technical research mostly intends to develop the content of extension messages, while social research looks at methods of extension. However, technical researchers (for example, soil scientists) can greatly contribute to enrich extension methods. For example, the development and calibration of simple tools to visualise soil processes

and to measure soil processes at the field level are essential for interactive learning in farmer field schools (for example, nitrate strips to measure soil nitrate and to define the need for nitrogen application; see also Stocking 2003). The demonstration of soil analysis in a laboratory is of little use to farmers if they have no access to simple tools to measure their own soils.

- Decision support
  Methods of interactive learning and tools to assess problems (for example, pH paper to measure soil acidity) are of little use if they are not combined with methods of decision support for concrete action. Farmer-led experimentation has been identified as an excellent method for testing or adapting new practices. However, simple decision support tools to identify relevant options for experimentation are lacking. Institutional responsibilities need to be clarified. Who is responsible for compiling knowledge across disciplines into a simple decision support tool (for example, vegetable management including soil, pests, and varieties)? Who updates such knowledge (for example, translates new results from a manure experiment into the decision support tool)? How can we avoid decision support tools being misused for external planning and decision-making?
- Scaling up is not a linear process
  Pressure on research institutions and projects for scaling up results is intended to increase impact. However, this greatly ignores the way innovations happen at field level and how research results are used. In the case of SSM, a wide range of sources contributed to the identification of innovations in technologies and methods for SSM. Bits and pieces of information and experiences have been scaled up, but not a single SSM technology has been scaled up as originally designed.
- Equity implications of technical change
  Technical researchers can contribute as much as social researchers to social change. An example is the characterisation of implications of technical change on gender equity and the identification of opportunities for change.
- Poverty orientation in agricultural projects
  SSM primarily benefits those who have land. Landless households and wage labour with very small landholdings may barely benefit directly from such programmes. The analysis of SSM projects over the past four years confirms this. Therefore, a new initiative was started in 2002 to develop a specific line of project activities that explicitly target the very poor households. This implies a much broader look at livelihoods in these households, including their direct or indirect relationships to SSM. A working group has started action research on how best to address this challenge.

Developments in the policy environment

Research in Nepal over the past years has indicated that soil fertility can best be maintained if inorganic fertilisers are combined with organic fertilisers (Bhattaria et al. 2000; Tripathi et al. 2001). At the same time farmers indicated that the use of inorganic fertilisers had resulted in a decline of inherent soil fertility and an increased workload to plough the harder soil (Maskey et al. 2000). The successful promotion of improved manure management as part of SSM indicated opportunities for better soil fertility management through changes in local resource management. Positive experiences with farmer-field schools in IPM and the development of farmer-field schools on IPNS outlined a technical and method concept for better fertility management of agricultural soils in Nepal.

The review of these research and extension experiences and the joint efforts by a working group for developing IPNS provided baseline information for a revised 'Fertiliser' Policy. It recognises organic amendments as fertilisers, defines IPNS and farmer-field schools as essential elements for fertility management in the country, and includes NGOs as actors in the promotion of better fertility management.

Experiences with competitive grant systems for research (Mathema 2003) and extension (SSMP) have stimulated the government to establish a National Agricultural Research and Development Fund (NARDF). The fund is open to government organisations and NGOs and recognises the diversity of actors in agricultural development. SSMP intends to gradually hand over the management of competitive grants for SSM to NARDF while concentrating increasingly on capacity building for district-level government organisations and NGOs to compete for funds from NARDF.

His Majesty's Government of Nepal intends to gradually decentralise planning, decision-making, and management of its agricultural extension system. To be effective, a concerted effort needs to be made among government organisations and NGOs at the district level. Therefore, the national competitive grant system for innovative pilot projects needs to be combined with decentralised, district-level planning. SSMP supports a process whereby organisations compete under a national grant system for innovative pilot projects, while a competitive district-level fund supports the broad extension of proven practices through FTF diffusion. The elements are in place, but further testing and learning is essential to create an effective system.

Conclusions and Challenges

SSMP was established with an explicit mandate for the extension of SSM. This was based on the assumption that technology on improved soil management is available and that this technology needs to be promoted. The assumption proved to be wrong in the sense that few SSM practices could be taken from the 'shelves of research'. The assumption proved to be right in the sense that research and extension had accumulated considerable experience on soil fertility management and methods of technology diffusion. Thus, the major challenge for SSMP was to capitalise on available information, build on institutional expertise, and involve farmers in the design and testing of SSM practices appropriate for local farming systems.

Based on the experiences over the last four years, we can conclude the following.

- Scaling up into a basket of knowledge.
  Scaling up of research results on SSM is not a straightforward process in hill farming systems. It is often not the technology developed by research that enters

the diffusion process, rather the following are scaled up: bits and pieces of information that contribute to improve local farming systems; simple tools for local measurement; rules of thumb that support decision-making; and ideas for new components in the system. For example, farmers started to experiment with improved manure management when they knew that about 65% of the nitrogen is in urine, that the organic matter quality of soil and manure can roughly be measured with hydrogen peroxide, that a cup of urine is about equal to the application of about 2-3 kg urea, and that urine can be enriched by fermenting it with certain plants. In the case of new crops and varieties, farmers prefer to have a range of options to be tested under local conditions. Research results and experiences from extension organisations contribute to enriching a 'basket of knowledge' for SSM. Current investments by research on testing location-specific adaptation and on targeting of specific technologies may better be allocated to an enrichment of local innovation by farmers in close collaboration with extension services and development organisations. This can best be achieved, when decision-making and accountability in research and extension organisations are sufficiently decentralised to promote local joint action.

- Competitive grant for innovation in extension.
  The establishment of a competitive grant open to government extension and non-government development organisations can contribute to local innovation in extension. As mentioned above, this is particularly important in heterogeneous hill farming systems. The involvement of local development organisations and district-level government agencies has been particularly important for SSMP. Although these organisations needed most support for developing their capacity on SSM, proposal writing, and project management, they are emerging as effective and cost-efficient implementers. Collaboration among organisations at the district level can best be developed through gradual trust building and performance-based recognition.
- Local fund for demand-driven diffusion
  Innovation in pilot projects results in locally proven new SSM practices. The wider diffusion of these practices can be managed under a locally-managed fund that supports farmer-to-farmer diffusion. The latter should be demand driven with complementary efforts to create and improve reliable access to markets.
- Equity in technical change
  The implications of technical change on gender, social, and economic equity often become visible only years after their introduction. Families and communities may therefore be confronted with 'unexpected' change in equity. The analysis of gender implications of technical change in SSM has proven a useful tool to stimulate men and women to consider carefully the implications of adopting a new technology. Such discussions need to become an integral part of introducing new practices into farming communities. Additionally, we call on technical researchers to participate in such an analysis with farming communities and to contribute ideas to overcome equity constraints.

In summary, we confirm that research on natural resources management has an important role in contributing to innovations in technologies, methods, and approaches.

The integration of research results into the continuous development of farming systems remains a challenge. It needs to be done through an open interface between research, extension, and farmers.

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7 BUILDING UP AND SHARING KNOWLEDGE FOR BETTER DECISION-MAKING ON SOIL AND WATER CONSERVATION IN A CHANGING MOUNTAIN ENVIRONMENT – The WOCAT Experience

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Abstract

For successful implementation of any soil and water conservation (SWC) or sustainable land management practice, it is essential to have a proper understanding of the natural and human environment in which these practices are applied. This understanding should be based on comprehensive information concerning the application of the technologies and not solely on the technological details. The World Overview of Conservation Approaches and Technologies (WOCAT) is documenting and evaluating SWC practices worldwide, following a standardised methodology that facilitates exchange and comparison of experiences. Notwithstanding this standardisation, WOCAT allows flexible use of its outputs, adapted to different users and different environments. WOCAT offers a valuable tool for evaluating the strengths and weaknesses of SWC practices and their potential for application in other areas. Besides collecting a wealth of information, gaps in available information are also exposed, showing the need for more research in those fields. Several key issues for development-oriented research have been identified and are being addressed in collaboration with a research programme for mitigating syndromes of global change.

Introduction

Fragile mountain environments with their steeper slopes and erodible soils require well-adapted land use systems that maintain the role of mountains as water towers, minimise the risk of degradation, and optimise production (Oldeman et al. 1991, UNEP 1997, WBGU 1997, Liniger et al. 1998, Hurni and Meyer 2002, The Bishkek Mountain Platform 2002; Viviroli et al. 2003). Mountain areas have a high risk of land degradation with negative impacts on natural resources (water, soil, and vegetation), which in turn affect rural livelihoods. Mountains have been identified as areas with fast changes, either in the human environment through high out-migration or changes in the market and economy, or in the natural conditions due, for example, to climate change. (Denniston 1995; Messerli and Ives 1997; Ojany 1998). Because of socioeconomic impacts of

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degradation such as out-migration and because the biophysical environment is so precarious, sustainable land management (SLM) strategies need to be addressed.

In the search for land management solutions and improvements, consideration needs to be given to the fact that the conditions are not static; therefore this search is a continuous process that needs continuous adaptations to the changing environment. Hence it is crucial to show how different land management technologies function and what impact they have on the natural resources, on production, and on the socioeconomic situation. Reasons need to be addressed as to why a certain technology at a given time and in a certain environment works or fails, or what advantages and disadvantages it has.

Success or failure of soil and water conservation (SWC)3 measures or land management practices in a wider context does not only depend on technical appropriateness and applicability. Measures that have proven their technical effectiveness in field experiments may be a success in one place but can be a failure in another despite similar biophysical conditions. Factors such as cost/benefits (both for the implementation phase and for maintenance), incentives, participation issues, land users' skills and priorities, training and extension, market and infrastructure, and various other aspects influence the uptake of a specific technology.

For every intervention the assessment of the current situation and the trends is a prerequisite for success. In addition, the assumptions made in identifying different scenarios and how they lead to various improvements should be stated.

The Need to Document and Use the Available Knowledge

Experience shows that a wealth of knowledge exists (with land users, extension workers, experts, and researchers) but that it is not available in an easily accessible format. Knowledge is scattered and unrecorded. Comparison of different types of experience is difficult. This SWC knowledge therefore remains a local resource, often known only by individuals and unavailable to others working in the same areas and seeking to accomplish similar tasks. This is one of the reasons why soil and water degradation persists, despite many years of considerable investments in SWC throughout the world.

During the International Soil Conservation Organisation (ISCO) conference in Sydney in 1992, a global network of SWC specialists was initiated, called the 'World Overview of Conservation Approaches and Technologies' (WOCAT). The CDE, Institute of Geography, University of Bern provides the secretariat and a management group4, consisting of members from international and national institutions, and coordinates the network and

[3] In the context of WOCAT, SWC is seen as part of SLM and is defined as: activities at the local level which maintain or enhance the productive capacity of the land in areas affected by, or prone to, degradation. SWC includes prevention or reduction of soil erosion, compaction, and salinity; conservation or drainage of soil water; maintenance or improvement of soil fertility.

[4] Currently the management group is represented by CDE (Switzerland), ISRIC (The Netherlands), the Food and Agriculture Organization of the United Nations (FAO, Italy), the Regional Land Management Unit (RELMA, Kenya), the Institut du Sahel (INSAH, Burkina Faso), the Bureau of Soil and Water Management (BSWM, Philippines), and the Soil and Water Conservation Monitoring Center (SWCMC, P.R. China)

its activities. Since 1992 over 30 international workshops have been held to discuss the development and improvement of the methodology and the operation of the network. Whereas in the first five years the emphasis was on methodology development and expanding the international network, the second five years concentrated on training, data collection, and production of outputs (Figure 7.1). This is a steady process, but WOCAT is gradually gaining momentum and getting increasing attention at local, national, and international levels. Progress in methodology and outputs has been fully reported in Giger et al. 1999, Liniger and Schwilch 2002, Liniger et al. 2002a, b, and Van Lynden et al. 2002.

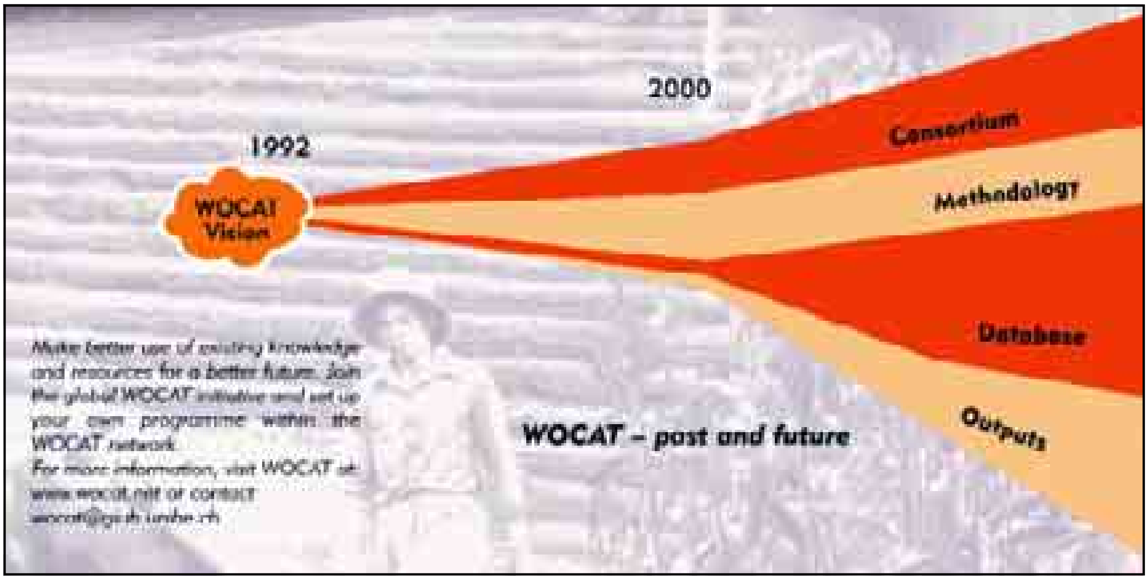

Figure 7.1: WOCAT past and future

Scaling up SWC Knowledge

WOCAT documents and evaluates experiences in SWC and SLM from all over the world. This requires a common platform and therefore a standardised methodology (a framework) had to be developed to handle the information (Figure 7.2). So far this framework has been translated into nine languages. WOCAT takes care that local and regionally important peculiarities are not being lost. Based on the feedback from over 25 national and international WOCAT workshops, improvements have been made as illustrated in the evaluation of the participants concerning the usefulness of the WOCAT framework.

Information is collected by local and regional experts in consultation with land users, through the use of a set of three questionnaires. In case studies, information on technical and non-technical aspects is collected through two comprehensive questionnaires on SWC technologies and SWC approaches. These case studies may be applied from small areas (field level) to larger regions, although the rather specific questions in the questionnaires encourage necessary detail. The information is stored in a database that facilitates data entry, editing, and querying. The questionnaire on SWC technologies (‘QT’) covers details of a technology as applied in a specific case (WOCAT 2003a), and the second questionnaire describes the approach (‘QA’), for example the ways and means and conditions to implement successfully a technology on

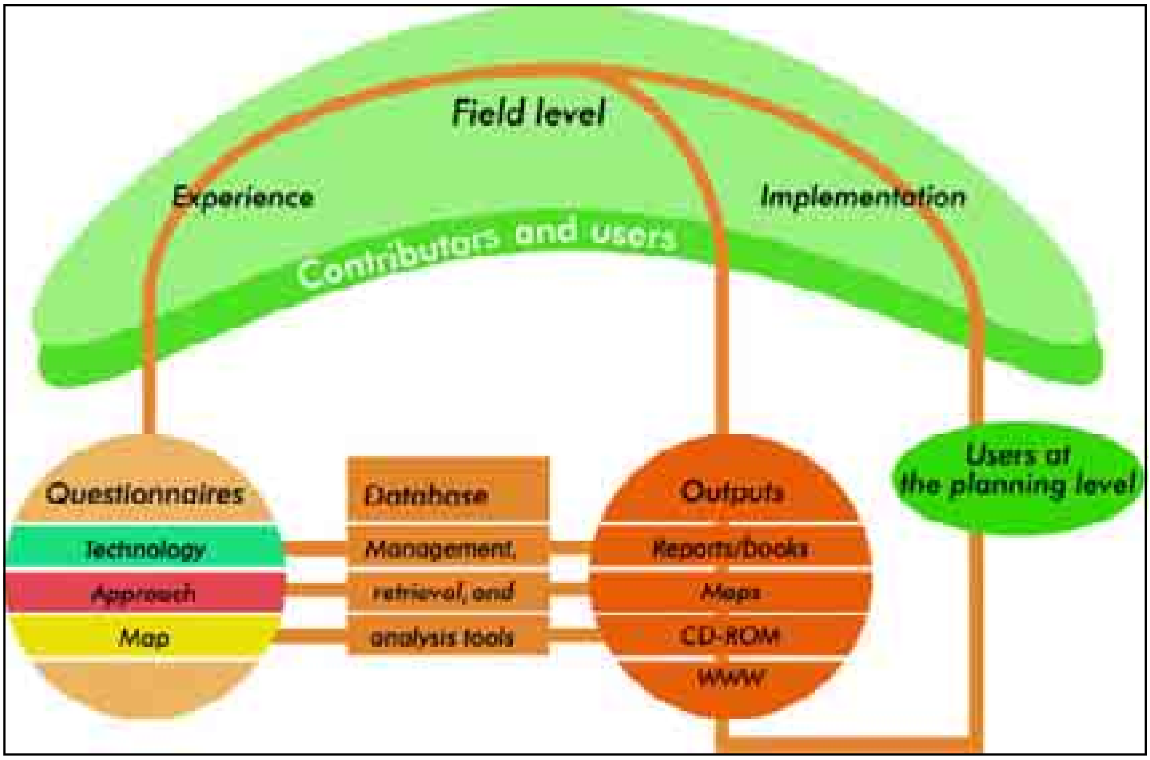

Figure 7.2: **The WOCAT process and tools**

the ground (WOCAT 2003b). These two questionnaires are strongly interrelated. The case studies may constitute project-implemented changes, traditional practices, or farmers' innovations (see Mutunga and Critchley 2002).

The third questionnaire concerns the spatial distribution of SWC/SLM for the purpose of mapping ('QM') in order to show where degradation is occurring and where SWC is being applied and with what impact (WOCAT 2003c).

WOCAT has been tested and applied in a wide range of environments (Figure 7.3). Because soil degradation in sloping areas is a much bigger problem and threat than in lowlands, lots of SWC activities actually take place in mountains and highlands. The declaration of the UN International Year of Mountains 2002 and International Year of Freshwater 2003 (Box 7.1) provided a good platform for WOCAT to emphasise the importance of land management in mountain regions and to stress that water and land cannot be separated and need to be seen as an entity (Liniger and Schwilch 2002).

Experience so far has shown that appropriate land use and management are key to local and global issues such as combating desertification, mitigating water conflicts, providing food security, alleviating poverty, and even maintaining or improving biodiversity.

The compilation, evaluation, and dissemination of SWC knowledge should be considered as an ongoing activity at local, national, regional and global levels (Figure 7.4). WOCAT is not a centrally run data collection exercise and should not be seen as a separate activity or project that runs parallel to existing efforts in SWC.

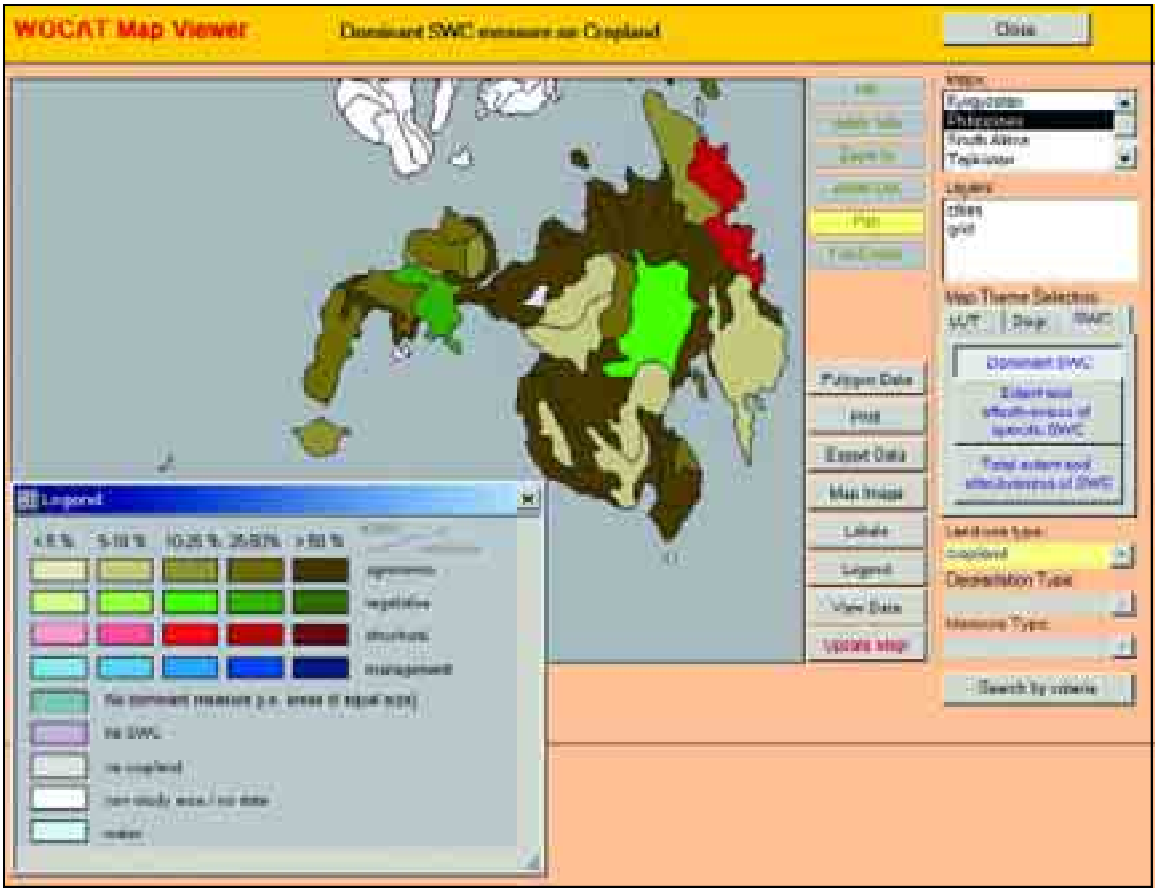

Figure 7.3: **Example of a WOCAT map for Mindanao Island, the Philippines**

Hanspeter Liniger

Figure 7.4: **Compiling knowledge from different resources: the land users, SWC specialist and researchers**. Source: Research Workshop on Renewable Natural Resource Management in Landruk, Nepal, March 2003

Box 7.1: **WOCAT and the International Year of Mountains 2002 and the International Year of Freshwater 2003**

The basic purpose of the International Year of Mountains 2002, as declared by the UN General Assembly, was "to promote the conservation and sustainable development of mountain regions, thereby ensuring the well-being of mountain and lowland communities." In order to achieve this purpose, natural resources in mountain regions need to be used in a sustainable way that avoids overuse and degradation. Mountains are particularly susceptible to soil erosion caused by surface runoff due to high rainfall, steep slopes with erodible soils, growing pressure to use marginal lands for agriculture in some areas, abandonment of agropastoral land in other areas, and the construction of infrastructure for economic activities.

More than 50% of the global soil degradation is caused by water erosion, due to improper water management with excess water causing damage. On the other hand there is a globally growing freshwater crisis with growing conflicts over decreasing quality and the diminishing availability of water. Both water quality and quantity depend heavily on land use and management. So far WOCAT's focus has been firstly on the soil and its degradation or improvement. In future additional emphasis will be given to the impact of land management on water. The year 2003 has been declared by the UN General Assembly as the International Year of Freshwater. WOCAT provides tools that show achievements made towards improving freshwater availability and quality.

Because mountains also provide water for the surrounding lowlands, land degradation in mountains has serious impacts on the global supply of freshwater and may contribute to water-related conflicts. The documentation and exchange of knowledge on sustainable use of the fragile mountain systems through WOCAT should be seen as a contribution to the overall purpose of the International Years of both Mountains and Freshwater.

Through the WOCAT network, national and regional initiatives have been developed and the activities are being integrated into ongoing government (mostly the Ministries of Agriculture, Water, or Natural Resources), non-government, and other development projects (for example, in the Philippines, Ethiopia, Tanzania, South Africa, and P.R. China) as part of their efforts to use their existing knowledge for improved decision-making and comparison with other experiences within their own countries, in the region, or even on other continents. Additionally, WOCAT tools and results have been increasingly used in training and education for universities and in extension programmes.

At the international level WOCAT has been mentioned amongst others as a useful tool for the Land Degradation Assessment in Dryland Areas (LADA) project (FAO 2002) and within the framework of the UN Convention to Combat Desertification (UNCCD).

WOCAT experience so far in over 35 countries shows that no other systematic and standard tools for documentation and evaluation exist, despite the expressed need. However, even if these tools are now made available, considerable efforts and dedication would be needed to put them into practice.

Knowledge Gaps and the Need for Research

Data quality is a major concern of WOCAT. Completion of the questionnaires is demanding and complicated and cannot just be approached as a quick and simple desk study, because it requires dialogue with colleagues and land users.

The questionnaires themselves already force the contributor to consider many relevant issues related to SWC/SLM. As this knowledge is scattered in different reports and in the minds of various SWC specialists and researchers, the compilation of the information constitutes a first form of self-evaluation. Sometimes information on important aspects related to SWC turns out to be unknown. Although this creates data gaps or inconsistencies in the database, it shows at the same time that the SWC experts are lacking information crucial for the success or failure of a technology or approach. The lack of information hence constitutes valuable information in itself, but the data contributors should clearly indicate whether data are not available or not known, rather than leaving a question blank, as this may also mean that it has just been overlooked.

An analysis of how well questionnaires were filled in and especially which questions were inconsistently, incompletely, or not answered (Table 7.1) shows that the contributing specialists had particularly problems in identifying the area coverage of the technologies and approaches and often had difficulties in providing information about the economics. In almost half of the selected case studies in Table 7.1, figures on the costs and/or returns were not or only partially known and it was just assumed that the measures taken were beneficial. The absence of this information, however, poses a serious limitation to the successful implementation and maintenance of such measures.

Experience during training workshops also showed that there is much guesswork and uncertainty on the impacts of SWC – ecological, social, or economic. Although questions about the impact of land use and SWC measures are often answered in the questionnaires, the analysis shows that there are contradictions or vague and unconsolidated statements. This reveals important gaps in essential information required for application of SWC.

Although WOCAT was not designed originally as a research programme, the experience gathered so far has shown that WOCAT is also a research tool. Through the compilation and exchange of knowledge, gaps and contradictions are being exposed, which need to be addressed by research. Based on the analysis of the data received so far and the experiences during the training workshop, the following contributions of research towards better understanding of degradation and improved implementation of good land management practices have been identified:

- compilation and analysis of existing SWC knowledge – traditional/indigenous and new SWC technologies and approaches;
- assessment and monitoring of the state of degradation and good land use using the WOCAT mapping tool combined with remote sensing, surveys, and so on;
- assessment of impacts of land use (ecological, social, economic);

Table 7.1: **Questions that were not or were incompletely answered out of 42 selected datasets**	
Question	**%**
Questionnaire on SWC technology	
Define the area in which the SWC technology has been applied: total area	36
Indicate in the map below the area where the SWC technology is applied	38
Provide a sketch ('artist's impression') and a photograph/slide showing an overview of the technology	33
Provide a technical drawing	33
Establishment and recurrent costs	45
How many land users have implemented the technology with incentive support/ wholly voluntarily	71
List the major strengths/advantages of the technology and how they can be sustained / enhanced, in the land users' view	24
List the major weaknesses/disadvantages of the technology and how they can be overcome, in the land users' view	43
Questionnaire on SWC approach	
Define the area where the SWC approach has been (or is still being) implemented	33
Provide a photograph / slide showing an impression of the approach	74
Provide, if possible, an organogram that points out important actors within the approach	82
Indicate the total budget for the SWC component of the approach (over entire period)	54
List the major strengths/advantages of the approach and how they could be overcome, in the land users' view	24
List the major weaknesses/disadvantages of the approach and how they could be overcome, in the land users' view	42
Source: WOCAT database	

- identification of impact indicators and threshold values;
- assistance in the search for solutions based on land users' experiences and adapted to specific natural and human environments.

In order to address several of the above identified key questions and assist in further analysis of the existing knowledge as well as in filling in the gaps concerning sustainable use of land resources, WOCAT actively searches for the collaboration or synergies with research programmes. As examples, two recently initiated research activities are described briefly.

The first research activity is related to WOCAT's involvement in a proposed European Union project 'Soil and Surface Water Protection using Conservation Tillage (SOWAP)'. This project aims to assess the viability of a more 'conservation-oriented' agriculture in north and central Europe, where reduced tillage practices replace the numerous cultivations carried out under more 'conventional' arable farming systems. The use of appropriate herbicides is tested and their potential for off-site contamination assessed, to ensure that suggested approaches are environmentally sound.

SOWAP involves various institutions (universities, non-government organisations, a commercial company, and government agencies), and will be implemented in the UK, Belgium, and Hungary. Field sites (farm scale) will be identified for each country, and the proposed conservation tillage system will be applied at each site. Local variations and farmer/land owner preference are crucial in the project and will be taken into account, so although inter-country comparisons may not be possible, the reasons for local variations in the adopted practices will be documented.

One criterion for the success of such a project is the potential for independent assessment of the environmental and economic benefits of the suggested approaches and a suitable manner for transmitting this information. This is in essence the role of WOCAT.

The second collaboration of WOCAT in research is a programme entitled 'Research Partnerships for Mitigating Syndromes of Global Change' (NCCR North-South 2000; Hurni et al. in press). In central Asia, the Horn of Africa, and eastern Africa, the main research issues are related to land resources, mainly water, soil, and vegetation. Two frequently occurring syndromes of global change are addressed, which are land degradation, particularly in rural areas and restricted access to and availability of freshwater. The research and the building up of research capacity focuses on the assessment and impacts of human-induced land degradation and conservation (good land use practices) and on the support of development activities in finding SLM options.

Through compilation of existing knowledge using the WOCAT tools combined with research addressing the knowledge gaps, training, and capacity building, a better understanding on SWC and SLM is envisaged in the search for improved solutions to land degradation (Figure 7.5).

Search for Solutions: Better Use of Knowledge and Better Decision-Making

Different stakeholders need to appreciate and recognise what options are available. The different users of the SWC knowledge database need to be able to compile the information that they are looking for in a number of ways, so that they can adapt it to their needs. Therefore WOCAT has created different ways to access information either digitally (CD-ROM, Internet) or as hard copy: in summary format (for example in overview books), through a multiple criteria query system, as selected chapters from the database, or using assessment criteria that help to evaluate the strengths and weaknesses (potential and limitations) of a given technology and approach. The latter could be either an evaluation of the users' own experience or an assessment of the applicability of a technology and approach from elsewhere.


Hanspeter Liniger

Figure 7.5: **Training on the assessment of soil degradation and conservation in Kyrgyzstan (using the WOCAT mapping tool) with students from central Asia**

Conclusions

During the last 10 years the WOCAT programme has developed a framework for the documentation, evaluation, and dissemination of knowledge in SWC, consisting of tools and methods such as questionnaires and a database, as well as a network of SWC specialists from all over the world. The main aim has been to share the knowledge of SWC specialists and land users and assist them in the search for options to mitigate land degradation and improve land management. Through national and regional initiatives, these methods and tools have been used and improved during over 40 workshops and meetings and subsequent data collection activities in over 35 countries all over the world.

The experiences so far show that WOCAT assists SWC specialists, in collaboration with land users, in compiling valuable but scattered information and in evaluating and disseminating the knowledge. This is essential to make better decisions and provide better advice to land users on how to improve SWC activities. The experience has revealed that SWC, as part of SLM, is a complex issue that involves a variety of different stakeholders and thus needs to be approached in a comprehensive way. Documentation, monitoring, and dissemination of SWC technologies and approaches therefore needs time and commitment, but it is perceived as useful in improving the effectiveness of SWC and thus should have a high priority on the agenda for development. However, the compilation of available knowledge has revealed a number of knowledge gaps and contradictions, which need to be presented and addressed by research. A key issue identified so far is the need to clarify the impacts of land degradation or good land management practices on the natural resources and on human welfare.

Land use has been identified as playing a key role in the degradation or conservation of natural resources. In many societies of the less-developed world and in mountain regions in particular, over 80% of the population depend on agriculture. Great efforts are needed to identify well-adapted land use systems that do not degrade the natural resources and that provide a basis for the livelihood of people. Due to the continuous changes in the human environment (for example, high migration, changes in market situations) and natural conditions (climate change, degradation processes), solutions and improvements in land management that can be adapted to these changing environments have to be found. This is a process that needs continuous commitment of development institutions and research. Thus durable solutions need to be flexible and adaptable.

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8 WATER-RELATED KEY ISSUES IN MESO-SCALE CATCHMENTS OF THE HINDU KUSH-HIMALAYAS

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Abstract

In many meso-scale catchments of the Hindu Kush-Himalayas (HKH) water is in short supply and water quality is increasingly becoming a concern. A study in five catchments across the HKH in Pakistan, India, Nepal, and China has shown that irrigation water availability followed by inadequate drinking water supply are the main concerns of the local residents. According to the perception of local residents, irrigation water availability has decreased over the last 5-25 years. The main reason for this is the intensification of cropping systems with now up to four crops annually. Drinking water supply has improved in many cases, but is still insufficient. Water demand, due to improved living standards, is expected to increase further. The increase in population, large numbers of livestock, and, in some cases, intensive farming practices have led to water quality concerns. It was found that in general the nature and the mismanagement of water resources are the main reasons for water scarcity.

This paper discusses the preliminary findings from the catchment-based synthesis of water-related activities in the People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas project (PARDYP). It focuses on the key issues as identified by the local residents of the five research catchments. The current status of these issues, the processes leading to these issues, possible future developments, and tested and proposed options are discussed on the basis of results from participatory surveys and intensive hydrometeorological monitoring. The paper concludes with an outlook of the planned programme for phase 3 of the project.

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Introduction

Water is life – a perception that is shared by more than 60% of the residents in the two catchments studied in the Nepal Himalayas. Simultaneously, water is destructive when there is too much and is the reason for great despair in many regions of the world when there is too little. Too much and too little, both issues are experienced in the Hindu Kush-Himalayas (HKH) on an annual basis during the monsoon and the dry seasons, respectively (Chalise and Sial 2000). On the basis of an opinion poll conducted in July 2002 through the Internet, four key water-related issues were identified to be of utmost importance at the regional scale in the HKH. The answers of 49 respondents from 13 countries including India, Nepal, China, the UK, and others were divided into the causes and the effects. There were 63 causes mentioned, including water management, water institutions and policies, deforestation, and climatic constraints. On the basis of these causes the following main effects were identified:

- water availability for human purposes (agricultural, domestic, and industrial use);
- flooding in the foothills and adjacent plains;
- water quality and pollution;
- water-induced land degradation and sedimentation.

The availability of adequate water resources for future generations is not only a regional issue, but is also a subject of concern at global scale. Water demand has increased globally 6-fold in the past 100 years and about half of all available freshwater is being used directly for human purposes (Cosgrove and Rijsberman 2000). Globally 38% of people are living in countries under severe water stress (Alcamo et al. 2000). Within the HKH region, in Pakistan and Afghanistan in particular there are concerns that already most of the available water resources have been exploited. According to Shiklamonov (2000) water availability in south Asia was already very low in 1995 and is expected to decrease further.

After water availability, floods are rated the second biggest issue. The HKH has a long history of floods and annually tens of thousands of people are affected by medium to large flood events in the region. It is the plains adjacent to the mountain ranges where the floods are most destructive in terms of loss of lives and financial losses. This is not only due to the force and magnitude of the floods but also to the number of people and the value of the assets at risk. Flooding also occurs in the inner valleys of the HKH (for example, the Kathmandu Valley in Nepal, valleys in the Garhwal-Kumaon Himalayas and the Eastern Himalayas in India) and is often related to erosive processes such as landslides and debris flow. To what extent effects of land use change and management of natural resources are responsible for large flood events in the plains has been the subject of heated discussions over the last two decades (see, for example, Ives and Messerli 1989; Hofer and Messerli 1998).

Increasingly water pollution is creating a problem not only in urban areas, but also in areas with intensive agriculture. Excessive use of chemical fertilisers leads in many cases to increased eutrophication, which according to Kraemer et al. (2001) has shown the biggest worldwide growth in Asian rivers.

The reasons for the issues mentioned above, such as water scarcity, floods and water pollution, and the impacts of these processes at the local scale in rural areas of the HKH are not yet fully understood, partially due to inappropriate or missing data. Recognising the need for an integrated and interdisciplinary approach to the above problems with a long-term perspective, the People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas (PARDYP) project was launched. For an introduction to the PARDYP project and the location of the sites refer to White and Merz (this volume, Chapter 2). The following provides an introduction to the activities and issues related to water.

Water-related Key Issues in Selected Catchments of the HKH

Water availability was identified to be the main issue for residents of the selected middle mountain catchments (Table 8.1). Insufficient water for irrigation was cited as the main problem, closely followed by drinking water shortages. Increasing water pollution is becoming a concern in some catchments. Other studies in the HKH show similar results. In Changar, Himachal Pradesh, India (part of the Indian Western Himalayas), acute water scarcity prevails for both drinking as well as irrigation (IGCEDP 2001).

Table 8.1: **Water-related key issues at the catchment scale (PARDYP catchments*)**

Priority	Hilkot (Pakistan)	Bhetagad (India)	Jhikhu (Nepal)	Yarsha (Nepal)	Xizhuang (China)
1	Water shortage for irrigation	Depletion of water resources	Irrigation water shortage	Irrigation water shortage	Water shortage during dry season
2	Water management	Inappropriate management of water resources	Drinking water shortage	Drinking water shortage	Too much water during wet season
3	Poor water quality and quantity for drinking	Soil and nutrient losses	Deteriorating water quality		Drinking water shortage
4		Water pollution	Top soil loss and nutrient build-up		

* These issues were identified by the PARDYP country teams through household surveys, focus group meetings, hydrometeorological monitoring and several years work experience in their respective catchments; for location of the catchments refer to White and Merz (this volume, Chapter 2).

Negi and Joshi (2002) identified drinking water as a major problem in the Central Himalayan region. In the Sikkim Himalayas Sharma et al. (1998) likewise postulated that drying up of springs and drinking water scarcity are putting considerable stress on the local population. Singh and Pandey (1989) also report water scarcity due to drying up and decreasing yields of springs in the Kumaon Himalayas. They mainly held the degradation of the natural oak forests responsible for this process. Hill towns in Darjeeling and Shillong, the wettest corner of the Indian sub-continent, face water scarcity all year round according to Subba (2001).

While people of the HKH have learned to cope with seasonality of water availability in the past, new pressure on water resources with decreasing water availability may threaten livelihoods, particularly of marginal people. The root causes of this crisis can be attributed both to human and natural factors. Possible factors leading to reduced water availability are discussed below.

Status of the Main Issue: Water Availability

The main issues reported in the two catchments studied in Nepal are access to irrigation water, followed by adequate drinking water. In the Jhikhu Khola catchment, 33% of the total 356 respondents indicated problems in terms of irrigation water quantity. In the Yarsha Khola catchment, 41% of 436 respondents reported that their irrigation water demand is not met. Similarly, 27% of the respondents in the Jhikhu Khola catchment and 37% in the Yarsha Khola catchment indicated an inadequate supply of drinking water (see Table 8.2).

Table 8.2: **Water-related problems in the Yarsha Khola and Jhikhu Khola catchments (%)**

Problem indicated			Percentage of respondents	
			Jhikhu Khola	**Yarsha Khola**
No problems			12	4
Irrigation water	-	quality	41	33
	-	quality	0	7
Drinking water	-	quality	37	27
	-	quality	9	17
Flooding			0	1
Surface erosion			0	3
Slumping			1	8

Jhikhu Khola n= 356, Yarsha Khola n = 436 (multiple answers possible)

In the Hilkot catchment of Pakistan the last five years have been exceptionally dry and during this time 52 springs out of a total 152 have dried up. Another 45 springs have very low discharge and only 55 springs now yield an adequate supply. In the Chinese catchment, a karst area, many river courses in the upper areas, where most of the residents live, only show discharge immediately after rainfall.

Water availability is not just an issue of quantity, but also of quality. Water quality has a major impact on drinking water availability. None of the 33 water sources tested in the Jhikhu Khola catchment, including natural springs, water supply schemes, and wells, complied with the World Health Organization (WHO) guidelines for faecal coliform. Similarly in the Indian catchment none of the 12 investigated springs was free from faecal coliform. In terms of chemical pollution, none of the parameters were above guideline levels, although phosphate and nitrate were both elevated in many water sources in the catchments of India and Nepal. This can be attributed to intensive agriculture with high fertiliser application rates. According to a national survey by the National Planning Commission (NPC 2000) the microbiological contamination seems to have a major impact on health. In Nepal 16.2% of surveyed children had had diarrhoea during the 2 weeks prior to the survey, which was conducted during the peak season for diarrhoea in April to May. During a survey of the health posts located in the Jhikhu Khola catchment, 25% of the patients visiting these health facilities in the catchment suffered from water-related diseases. The most frequently occurring diseases are diarrhoea, worms, and dysentery.

Water availability is also limited by restricted access to water resources for social or economic reasons. A case of non-equal water distribution was documented by Nakarmi (1995) where low-caste farmers at the tail end of an irrigation system were not given adequate access to irrigation water during the dry season. The farmers at the head end of the system were from upper castes. As only a few studies have been conducted in this field, a major emphasis will be given to these access issues in the coming phase 3 of the PARDYP project.

Processes Leading to Water Availability Concerns

Reduced water availability may be the result of low natural water availability, high water demand, mismanagement of water resources, inappropriate land management, or any combination of these.

Seasonality of precipitation is the main factor. Very skewed rainfall patterns with a distinct wet season during the monsoon months from June to September and a dry season from October to May in the case of Nepal and India (Figure 8.1) are obvious factors. In the most western catchment, the Hilkot catchment in Pakistan, winter precipitation plays a vital role in the availability of water resources. Snowfall in January is particularly important for these areas mostly for replenishing soil moisture. However these annual snowfall events have not happened in the last few years. In 1998, the Chinese catchment received rain throughout the year with slightly higher values during the monsoon months. However, in the following year a drought occurred with no rainfall from October to May. A similar drought situation was observed in the catchments in Nepal and India.

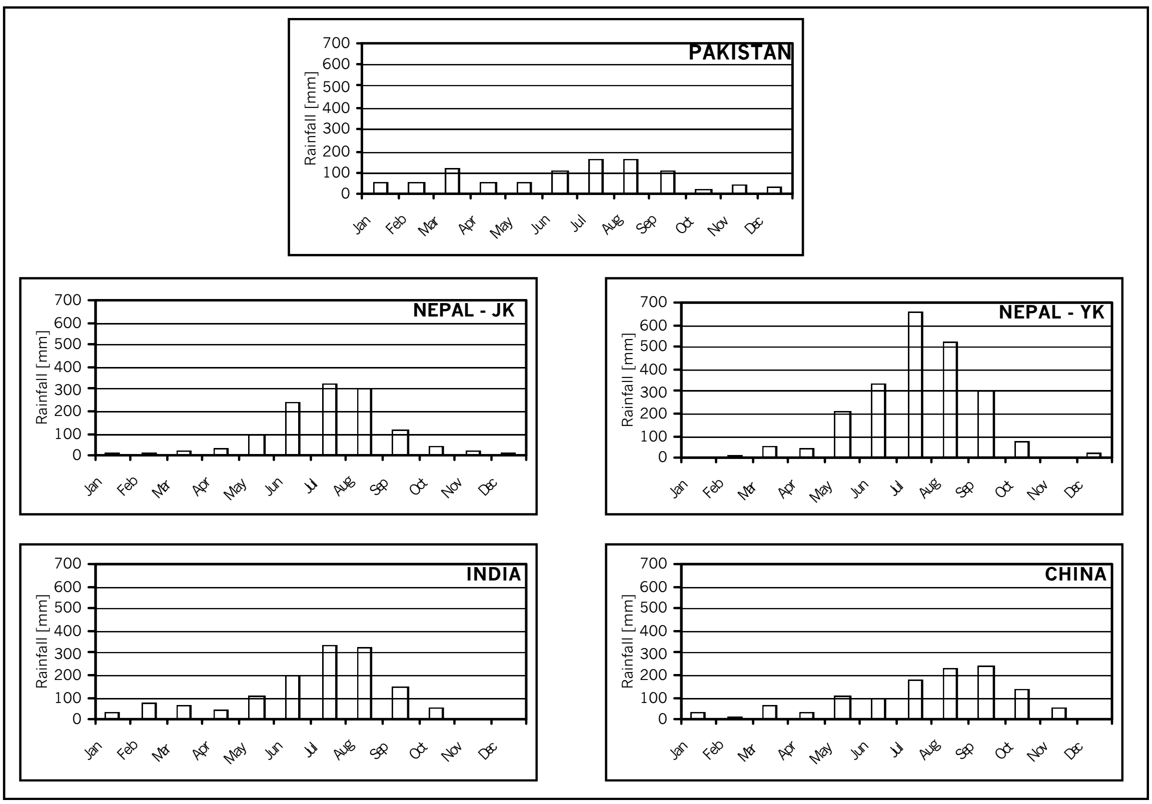

Figure 8.1: **Annual rainfall distribution in the five PARDYP catchments**

It is the months from October to May where rainfall is most variable in all catchments and farmers cannot count on good moisture conditions for their crops. Moisture conditions have an impact on all cropping systems in the four countries. During the second half of the dry season crops can only be grown on irrigated land. However, the timing of the end of the dry season greatly affects the planting of the main monsoon crop, for example, rice and maize in the Pakistan, India, and Nepal catchments, and maize in the Chinese catchment.

The three years' data from the Hilkot catchment in Pakistan show a dramatic reduction in rainfall over the last few years, from 1200 to 800 mm, which is mainly the missing precipitation from the winter season in the form of snow (Figure 8.2). However although these data are disturbing, it is not possible to tell yet whether this trend will continue or whether it is a temporary aberration. Even so, these data and the dramatic change in water yield from springs over the last five years, show how vulnerable these areas are to climatic variability and also to potential climate change in the future. For tropical Asia, the Intergovernmental Panel on Climate Change (IPCC 1998) suggested the following impacts of climate change on water resources.

- The Himalayas play a critical role in the provision of water for continental monsoon Asia.
- Increased temperature and increased seasonal variability in precipitation are expected to result in accelerated recession of glaciers and increasing danger from glacial lake outburst floods.
- Run-off from rain-fed rivers may change in the future. A reduction in snowmelt water would result in a decrease in dry-season flow of these rivers.
- Large populations and increasing demands in the agricultural, industrial, and hydropower sectors will put additional stresses on water resources.
- Pressure will be most acute in drier river basins and in those subject to low seasonal flows.

The removal of forests seems to have had an impact on water availability in the Indian catchment. In India the replacement of broad-leaf forests (oak and elder species) with

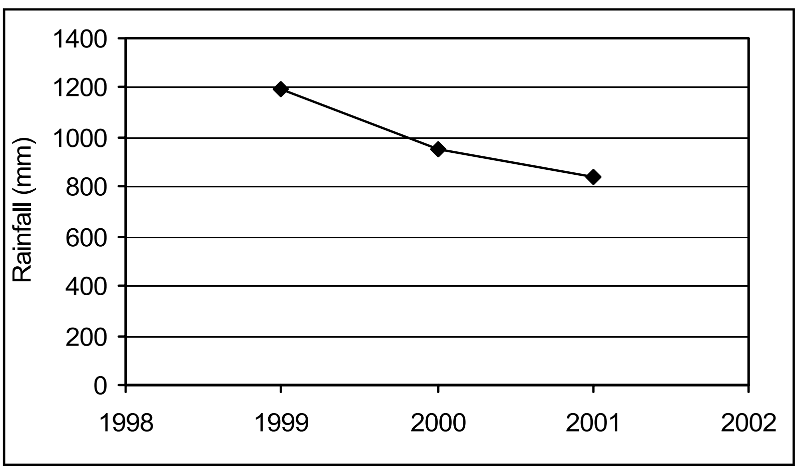

Figure 8.2: **Rainfall (mm) trend in Hilkot, Pakistan, over the last three years**

tea has had a negative impact on water availability (Verma et al. 2003). As the land use change only occurred some five years ago, no long-term improvement in household water availability has been identified yet. The monocultures of pine trees (*Pinus roxburghii*) in the same area have further contributed to the increased water shortage (Verma et al. in preparation).

The perceptions of trends are also very different in the five catchments. There are no trends visible in the long-term rainfall of the catchments in Nepal, for example. In terms of water demand, increasing populations are putting major stress on the available resources, including forests, soil, and water. The population in the Indian catchment has increased in the different villages between 1950 and 1991 from 40% to 160%. In the Jhikhu Khola catchment, the population increased by 3.5% annually during the period 1947-1996. According to the data of 1996, the population density in the catchment is 437 people/km^2. In the Yarsha Khola catchment, population growth rate was 2.7% between 1981 and 1996 with a population density of 386 people/km^2 in 1996. In the Chinese catchment of Xizhuang, the population doubled between 1950 and the present and the current population growth rate is about 2% (Xu et al. 2000). Increasing population has not only had a direct impact on water consumed, but also on water requirements for agriculture and food production. In this context the increase in cropping intensities is also an important factor. In the Jhikhu Khola catchment, cropping intensity has reached an average of about 2.6 with a maximum of 4 crops on irrigated land (Shrestha and Brown 1995).

Improvements in sanitation can also add to the existing pressures. In the Bhetagad catchment in India the numbers of households with flush toilets has increased dramatically over recent years. This development is still on-going and to date 50% of the households have flush toilets (Figure 8.3).

The issue of water mismanagement has been voiced as a problem in all catchments. A case study of one of the largest drinking water schemes in the Jhikhu Khola catchment

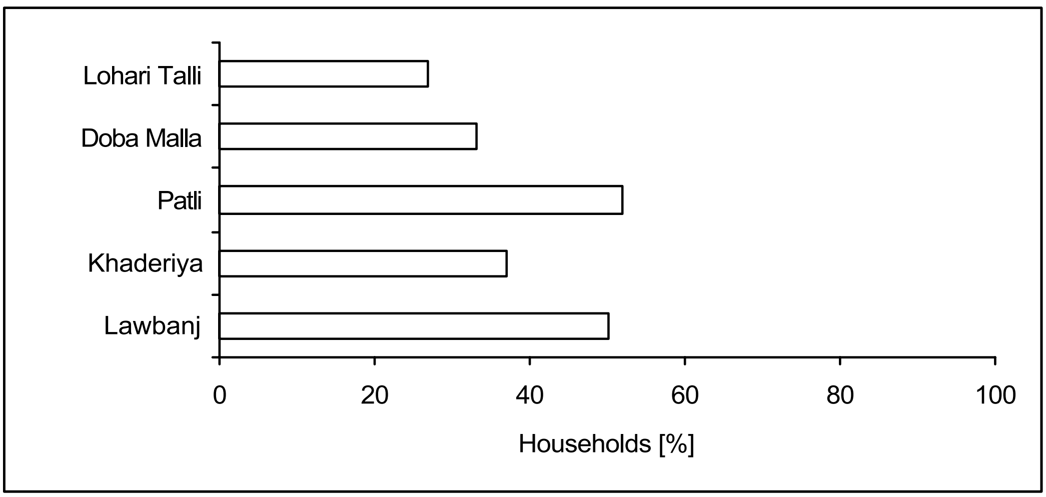

Figure 8.3: **Percentage of households in different villages with flush toilets in Bhetaged catchment, India**

in Nepal has shown that most feeder pipes have leaks. Furthermore some of the distribution tanks have deteriorated to the extent that polluted surface water is leaking into the system. The main reasons for this mismanagement are conflicts in the water users' association. Since the system was handed back to the government line agency, local efforts to keep the system running are limited.

In India adverse policies are held responsible for conflicts between the upstream and downstream users. Irrigation systems as well as the related laws and regulations are the reason for water losses and unequal distribution of water.

In the Hilkot catchment in Pakistan, 31% of the irrigation systems do not have any distribution regulations. In 38% of the systems, distribution is based on time and the remaining 31% work on a demand-based distribution system. Both systems without regulation and demand-based irrigation systems are subject to unequal distribution of water between the farmers at the head end of the system and the farmers at the tail end.

In an irrigation water scheme in the Jhikhu Khola catchment in Nepal, losses of up to 90% were identified between the head and the tail end of the system (Nakarmi 1995). Interestingly, there is often a caste difference between the head and the tail end, with higher castes residing and cultivating land at the head end and lower castes at the tail end, where water often becomes scarce. The quality problems were shown by the results of microbiological as well as chemical testing of a number of springs and other public water sources in the Jhikhu Khola catchment (Bajracharya et al. 2001).

Mitigation of Water Scarcity

Mitigation of water scarcity can be achieved by balancing water supply, water demand, and water quality management options. Both technological as well as institutional mechanisms are proposed in the different watersheds.

In the India catchment, protection through spring sanctuary development is proposed. For this purpose a technology package for catchment area protection of springs was developed by the GB Pant Institute of Himalayan Environment and Development. This appropriate and scientifically sound package has been tested in the Garhwal Himalayas (India) several times and is being implemented in several parts of the Indian Himalayan region. In the same region, infiltration wells with simple hand pumps have been tested. This approach is based on the observation of the drying up of springs. At the location of these springs an infiltration well is constructed to collect the infiltrating rain, which is later lifted by means of a hand pump.

The PARDYP team in Nepal has mainly looked into technological options for increasing water supply by means of water harvesting, and minimising water demand by using alternative irrigation methods. For drinking water, roof water harvesting is an option in areas along the watershed divides, where rainfall is the only convenient water source. To date, PARDYP has mainly focused on household-based options, rather than on community-based options. Tests and demonstrations have been conducted with ferro-cement water jars of 2000 l capacity as recommended by the Rural Water Supply and Sanitation Support Programme (RWSSSP 2000). These jars are household based and have proven to be very effective, not only for water storage during the dry season, but also for making water available close to the house during the wet season and therefore improving hygiene and reducing women's workload (Sharma 2001). As a result of these demonstrations, four families constructed four tanks at their own expense and without external support. In addition, six smaller units were constructed by local farmers with some seed money from PARDYP in four households.

For irrigation, tests were done with a 10,000 l tank harvesting surface runoff from degraded areas and road surfaces and applying this water to cash crops with drip irrigation (Adhikari et al. 2003). Other studies on water use efficiency, economic benefit, and impact on workload were conducted using drip irrigation for bitter gourd (Prajapati-Merz et al. 2003) and cauliflower (Von Westarp 2002). Other approaches to reducing water scarcity include fog harvesting and the use of locally available groundwater; these are discussed in Merz et al. (2003).

PARDYP Pakistan introduced drip irrigation on a small tomato plot of 250m^2 during the dry period from May until the first week of June 2002. Five rows were laid out across the slope with a row-row distance of 75 cm. The number of plants/row ranged between 20 and 25 with a plant-plant distance of 30 cm. The yield obtained was 5 t/ha as compared to a control yield of 2 t/ha from a farmer's field nearby. Most of the plots in the surrounding land suffered due to scarcity of water during that period and as a result many farmers got nothing from their fields. The results showed that farmers could get good returns from their vegetable plots even with a small amount of water if they adopted drip irrigation systems for their fields.

Water harvesting was also implemented in China where water availability is a major constraint for maize in the pre-monsoon season. Maize is an important crop for the local farmers, as they can exchange two bags of maize for one bag of rice. Personal observations were made of farmers carrying water from distant sources to irrigate plant by plant during the transplantation of young maize seedlings. Surface runoff water harvesting in small tanks of size 1.5-6 m^3 adjacent to the agricultural fields has provided water both for initial irrigation as well as irrigation in the case of drought conditions. From 2000 to 2001 an increase in maize yield of 13% was observed. For wheat an increase of 16% was reported for the same plot of 0.6 mu (~0.04 ha).

Conclusions

Water availability is a major concern according to local people as well as the results from the long-term observations of PARDYP in five watersheds across the HKH. The reasons for this scarcity are the natural settings as well as inadequate management of the resources in the catchments. There are no signs of increasing water availability to date. Water resources are believed to be becoming scarcer as a result of increasing demand by an increasing population, higher living standards, and potentially decreasing natural water availability due to climate change. Mitigation measures include technical, social, and institutional mechanisms; PARDYP has mainly looked at the technical possibilities. In the next project phase greater attention will be given to the social and institutional aspects. An important question is the degree of government involvement as well as household-versus community-based solutions. Access to water resources will be at the centre of the discussion in this next phase.

A more detailed and refined account of the content of this paper and other key issues identified in the five PARDYP catchments is in preparation in the form of a CD-ROM. First drafts can be obtained from the corresponding author; the final CD-ROM is expected to be complete in early 2004. This detailed review aims at taking stock of the current knowledge of water-related key issues in the catchments. This supports the efforts in the coming phase of the project related to improved water management and improved water quality. First decisions on the programme of the water and erosion studies have been made on the basis of this exercise. The programme will include a focus on treatment of microbiological contamination, in-depth studies of the irrigation systems in all catchments, and alternative irrigation methods such as drip and sprinkler irrigation.

Acknowledgements

All the data and information, where not otherwise specified, are taken from the country CD-ROMs prepared for the PARDYP Water and Erosion Synthesis compiled by the authors of this paper. The authors would like to acknowledge the financial support of the Swiss Development Cooperation (SDC), the International Development Research Centre (IDRC), and the International Centre for Integrated Mountain Development (ICIMOD). The work of all country teams in the PARDYP project is acknowledged. The data collection would not have been possible without the efforts of the local readers; a very special thanks therefore goes to them.

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9 REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEMS FOR COMMUNITY-BASED FORESTS – Resources Mapping in the Jhikhu Khola Watershed

Bhuban Shrestha[1] and Bikram Raj Tuladhar[2]

Abstract

There is a growing need for large-scale maps and data in developing countries for the quantification, management, and planning of forest resources at community level to address emerging needs and the demands of a rapidly growing population.

This paper demonstrates how remote sensing, global positioning systems (GPS), and digital elevation models (DEMs) can be used to produce large-scale geometrically correct orthophotos. Furthermore it describes the potential for the application of advanced geographical information systems (GIS) technology in participatory community-based forest resource inventories in the middle mountains of Nepal .

Geometrically corrected orthophotos were used to conduct a detailed community forestry inventory in a middle mountain watershed in order to provide better management and planning of the forest resources by the local communities. An intensive field survey was conducted in 36 community forests in the watershed, with the participation of forest user groups.

Introduction

A key problem in developing countries is the absence of large-scale accurate maps and datasets. Large-scale spatial information is very important for proper planning and development at different administrative levels, for example, communities, watershed, district and regional levels. Due to poor data availability, many plans and development programmes are designed without this basic information and thus the ability to document and plan at a large-scale spatial level. This is particularly problematic at community and watershed level. For example, His Majesty's Government of Nepal has handed over the forests to forest user groups (FUGs), but has not set any clear boundaries. Hence many cases of conflict over the community forest boundaries occurred between the different FUGs and surrounding land users.

The People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas project (PARDYP) in Nepal has paid particular attention to large-scale information use. The production of orthophotos to document, map, and quantify natural

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resources is an illustrative example. This large-scale information helps towards understanding processes, trends, and interactions of present as well as future benchmark studies.

An orthographic photograph image, also called an orthophoto, is a geo-referenced image produced out of normal remote sensing images or normal aerial photographs. It has the geometric properties of a map but at the same time the quality of photographs, representing detailed and accurate terrain features at a specific moment in time. Normal aerial photographs or remote sensing images are distorted. This distortion is caused by a combination of camera angles and undulating topographic landscapes. The amount of distortion depends on the distance to the image centre and the morphology of the landscape.

The digital orthophoto is created by scanning an aerial photograph with a precision image scanner. The scanned image file is digitally rectified to an orthographic projection using image-processing software. This process requires ground control points (GCP), parameters on the camera position, and an accurate digital elevation model (DEM).

Orthophotos contribute significantly to the production of accurate maps and the images generated can be used to create comprehensive spatial databases in many different thematic areas. Using the orthophoto a community-based natural resource survey was conducted in the Jhikhu Khola watershed, Nepal. The orthophoto was used to delineate village development committee (VDC) boundaries, to map the forest resources, to locate existing services, and to record soil data.

The objectives of this study were

- to produce orthophoto images for the entire 111 km^2 Jhikhu Khola watershed;
- to delineate community forest boundaries and quantify forest types on a detailed level;
- to link the derived forestry information to a geographic information system (GIS) in order to address queries and perform scenario analysis.

Study Area

The Jhikhu Khola study area was selected within the Kabhrepalanchok District. The watershed is located in the middle mountains about 45 km east of Kathmandu along the Arniko Highway and covers a total area of 11,141 ha. The altitude of the watershed ranges from 800 to 2100m above sea level. Due to its wide variation in topography, the climate, composition of natural vegetation, land use, and ethnic groups are very diversified. Land cover comprises 55% agriculture, 30% forest, 6% grass, 7% shrub, and 6% others (Shrestha 1998).

Methodology

The quality of the final orthophoto depends on several major factors such as the accuracy of the DEM, the clarity of the aerial photos, the scanning resolution and quality, the GCP accuracy, the camera model, and the mosaicing. Therefore, it is important to be precise with all of these factors. Scanner distortions should be taken into account when using the orthophoto for more accurate mapping purposes. However, if digital aerial photos are available, scanners are not required. When mosaicing photos together it is sometimes difficult to entirely remove the tonal differences. This is more apparent when using photos taken in different weather conditions or at different times of day.

GCP

The processing of the orthophoto with complete coverage of the Jhikhu Khola watershed started with the identification of a minimum of six GCP on each of the 23 aerial photographs acquired in December 1996. These points were visited with a global positioning system (GPS) receiver and their locations were determined. The GPS locations were re-projected to the national map coordinate system, which rendered the locations of the control in the appropriate coordinate system with a relative accuracy of about 2m.

Scanning aerial photos

The aerial photographs (scale of 1:20,000) from 1996 were scanned on a normal desktop scanner with a resolution of 600 dpi (dots per inch). This corresponds with a ground resolution of about 0.85m at nominal scale. It is important that the fiducial marks of all four corners appear clearly in each scanned image.

DEM

A 25m interval contour map produced at 1:20,000 and a topographical map of the Jhikhu Khola watershed were used as the source for the DEM. The triangulated irregular network (TIN) module of ArcInfo GIS software was used to interpolate the digitised contour lines into a continuous raster surface.

Orthophoto generation

The imagery was ortho-rectified using the DEM, the GCP, and the scanned imagery with state-of-the art image processing software. The absolute accuracy of the final products was about 10m in the lower parts and 20m in the steep upper parts of the watershed. The main source of error was inaccuracies in the DEM, which was produced from a 1:20,000 contour map based on limited ground control. Finally, the images were assembled into a seamless orthophoto mosaic of 1m resolution. This resulting image can be used as background in any GIS application. The orthophoto image has the obvious advantage that any section of it can be printed on a normal black-and-white printer and taken to the field to map the forests and discuss management issues with the FUGs.

Field survey

An intensive field survey was conducted in 36 community forests in the watershed, with the participation of FUGs. The community forest boundaries were drawn on transparent overlays on top of the enlarged 1:5,000 scale aerial photographs. Water-based coloured pens were used and this enabled the rubbing out of boundaries during the FUG discussion and re-drawing once consensus was reached (see Figure 9.1).

PARDYP Nepal

Figure 9.1: **Community members drawing boundaries on the aerial photographs**

Once the teams had identified the community forest boundaries, additional surveys were conducted on forest species composition, forest crown cover, forest maturity classes, and forest types.

GIS

All collected field information, which was based on the rectified orthophoto, was digitised and geo-referenced in a GIS for detailed analysis and for addressing queries. Thematic maps on forest species composition, forest types, forest crown cover, and maturity types including the forest boundaries of each community forest were prepared, to be used for better management of the existing forests.

Results and Accuracy

Forest covers about 30% (3358 ha) of land in the Jhikhu Khola watershed (Shrestha and Brown 1995). There are 36 formal user groups identified in the watershed, with a total forest area of about 1,500 ha, nearly half of the watershed forest area (Figure 9.2). The total area of community forest coverage involves 20,000 people of approximately 5,200 households. The individual community forest areas range from 2 to 173 ha. The number of participants in community forest management has been increasing and people are highly motivated to become more involved in the protection, management, and utilisation of community forests.

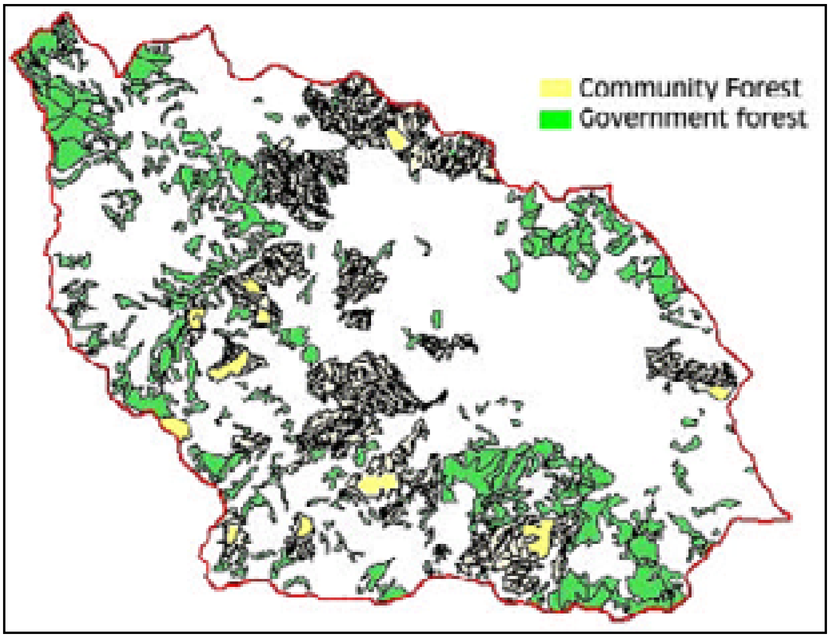

Figure 9.2: **Areas of government and community forests**

The accuracy of the orthophoto product was checked within the Dhaireni community forest using three commonly used land survey methodologies: chain survey, plane table survey, and GPS/GIS/Orthophoto. The district forest office of Dhulikel performed a chain survey of the community forest boundary and the plane table survey was based on a detailed topographical survey at 1:50,000. Using the GPS methodology, the total area of the Dhareni forest was found to be 17.6 ha, the plane table approach resulted in a total area of 17.1 ha, and the chain survey resulted in an area of 9.8 ha. This shows that the GPS and tacheometry methodology have quite similar results, whilst the chain survey showed an unacceptable deviation.

In a different study the conclusion was drawn that chain survey methods have an accuracy of ± 43%, whereas the orthophoto along with GPS/GIS/Orthophoto have ± 3% differences with the plane table survey.

The chain survey method has been widely used in boundary delineation in the Forest Department. It is a method of surveying in which only linear measurements are made on the ground. It is only suitable for small areas of open ground with simple details. The chain survey method may prove tedious when applied to the survey of a dense forest, pond, or other areas (Clark 1967), whereas the plane table survey is a method for surveying peculiar features with a high accuracy at a detailed level in any kind of survey. Differential correction and projection to the national map coordinate system provided a relatively high accuracy of about 2m, but due to the unavailability of large-scale digital terrain models, it was not possible to produce the desired accuracies. The main source of error was inaccuracies in the DEM topographical map, which was produced at a scale of 1:20,000 with limited ground control. The absolute accuracy of the orthophoto is about 10m in the lower parts and 20m in the steep upper parts of the watershed (Bitter and Shrestha 2000). Although there are some limitations, it has a consistent error throughout the whole study area and all research was conducted in the same way, which increased accuracy substantially.

Community Forest Mapping

Increasingly there has been a need for obtaining more quantitative information for forest management purposes. PARDYP, in collaboration with the Department of Forest, the District Forest Office, Dhulikhel, Kabhrepalanchok district, and the FUGs conducted a detailed community forest inventory, using GPS, GIS along with aerial photography, and orthophotos. The purpose was to identify and quantify the forest resources, spatial forest resource status, forest crown coverage, maturity classes, dominant species composition, and major forest types along with the socioeconomic characteristics of FUGs for the entire watershed. Participatory techniques have been the primary tool for obtaining community forest and resources information.

The aerial photographs (scale 1:5,000) were successfully transferred into rectified orthophoto images for GIS analysis following discussion with users and rectification of the images (Figure 9.3).

People's perceptions on community forestry were linked to orthophoto images along with GIS in order to examine perception of the boundaries and the socioeconomic characteristics of the watershed. A socioeconomic survey was conducted together with

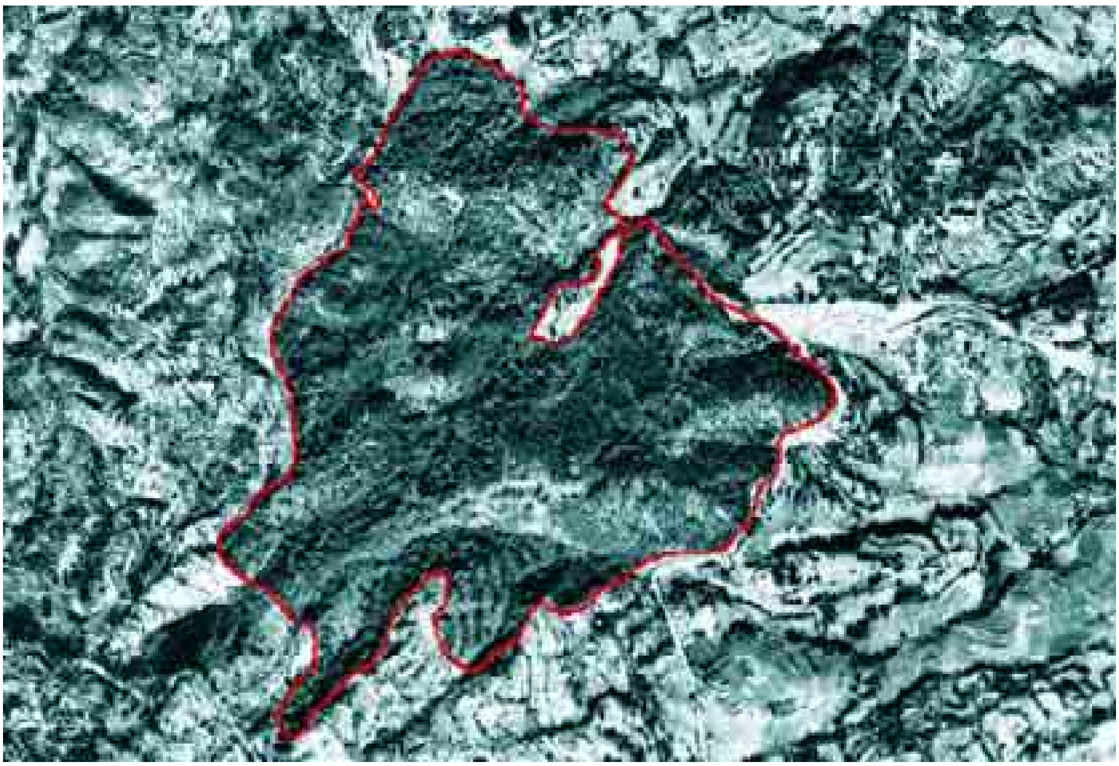

Figure 9.3: **Orthophoto image of Jhikhu Khola watershed (scale 1:12,500).**
Thuliban community forest in ward numbers 3, 4 and 7 of Panchkhal VDC covers a total area of 61 ha and serves five major villages totalling about 422 households with a total population of 2,448. The average population density of the community forest is 40 people/ha^2. Brahmin and Chhetri are the dominant ethnic groups, comprising about 80% of the population Community forest boundaries were delineated with the active participation of FUGs and field verification.

a detailed forestry inventory to gain understanding of the social characteristics of community forests. With the participation of FUGs, 36 community forest socioeconomic surveys were conducted in 8 VDCs, within the Jhikhu Khola watershed.

Conclusions

Because of their favourable potential and characteristics, orthophotos can be applied in a wide variety of thematic areas. In other words, orthophotos provide valuable high-resolution information for resource planners, researchers, and local communities and can therefore play a more important role in land surveys than conventional maps.

Orthophoto images are very versatile and were used for all kinds of community-based natural resources surveys, including demarcation of VDC boundaries, location of existing service centres, soil surveys, spring surveys, socioeconomic surveys, and dug well surveys. The method was found very useful for identifying the true geographical location during the socioeconomic survey, and the use of GIS helped in understanding of people's spatial perceptions and problems.

GIS is a useful tool for enabling the participation and empowerment of FUGs by providing them with improved information for informed decision-making. The use of GIS enhanced the participatory process in this work. It allowed quantitative and qualitative information to be combined to provide resource management information that was both relevant to the communities' needs and detailed enough to determine sustainable forest management.

Specifically, the information collected provides a framework for the FUGs to come up with operational plans and to select silvicultural practices that best suit the management units. The FUGs can identify areas for plantation activities, select appropriate species according to soil types, and estimate the quantity of timber, fuelwood, grasses, and shrubs that can be harvested on an annual basis. Boundary conflicts between FUGs can be solved easily using the information collected.

Acknowledgements

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10 PARTICIPATORY REHABILITATION OF DEGRADED LANDS FOR RURAL LIVELIHOOD SUSTAINABILITY AND IMPROVED BIODIVERSITY – A Case Study from the Indian Central Himalayas

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Abstract

In the middle mountains of Uttaranchal of the Indian Central Himalayas, there is a paucity of information about the biophysical rate of recovery when degraded areas are rehabilitated through peoples' participation, and the impact that the recovery has on the livelihoods of the rural communities. This study presents an analysis of change in terms of floral communities and associated change in soil character within an area of land under rehabilitation that was previously used extensively for grazing. The time-series evaluation showed that between 1993 and 1999, the average soil moisture increased from 12.3 to 21.3%, total soil organic carbon from about 1.0 to 1.5%, and soil pH from 5.9 to 6.3. The plant species richness increased from 28 in 1993 to 54 in 1999. Although the number of C_4-type plants increased from 2 (in 1993) to 10 (in 1999), their Importance Value Index decreased from a value of 149.7 to 137.4 during the same period. The site also recorded a significant increase in grass production from 2.7t in 1993 to 8.9t in 1999, which meant increased availability of fodder for the villagers, especially during lean periods, and a reduction in the fodder-related expenditures by about IRs 1,000 [3] per household.

Introduction

Located in the Western Himalayan Ecoregion of India, the newly created mountain state of Uttaranchal (29°5'-31°25' N and 77°45'-81°E, altitudinal range 300-7,817 masl), covers an area of 53,485 km^2 and has a large human population (8,479,562 or 22% of the total in the Indian Himalayan region). The region is associated with one of the most productive agricultural zones of the planet, the Gangetic Plain, and contributes significantly towards the livelihood sustainability of nearly 400 million people. Due to extensive forest cover (3,430,038 ha) the region plays an important role in providing ecosystem services such as landscape and watershed stabilisation, including soil

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3 In 1999 US $ 1 = IRs 43

protection and regulation of hydrological processes. However, the region presently faces serious environmental threats, due to increasing population, major changes in land-use and land-cover patterns, and a rapid depletion of natural resources (Maikhuri and Rao 2002). Depletion of any resource can interrupt the flow of energy, nutrients, and water within an ecosystem, which, on account of this depletion, gradually reverts to an early stage of succession (Bradshaw 1987).

Rural communities living in the hills of Uttaranchal have diverse cultures and are mostly agrarian in nature. Because the quality and quantity of natural resources are so vital in the traditional lifestyles of these people and because of the importance of livestock, fodder, fuelwood, and timber demand in the region is very high. Fodder scarcity, in terms of quantity and quality, has become a major issue causing women, including girls, who are traditionally assigned the task of collection, to travel increasingly longer distances. Due to poor quality of fodder, livestock quality is deteriorating and there is an increase in mortality rate. Free and continuous overgrazing is reducing the water permeability of the soil and accentuating soil erosion. There is also destruction of forests for agricultural expansion to support a growing human population in the region. As a result, many of these cleared areas have reverted to secondary growth when left abandoned.

To overcome these problems, rehabilitation of degraded lands or wastelands in the fragile mountain environment of Uttaranchal is one of the potential options for sustainable development. Experiences in ecological restoration of degraded community lands in the region are limited and the ongoing alterations in the human and natural environment urgently demand the generation of effective land and water management options with people's participation as a prerequisite (Kothyari et al. 1991; Ramakrishnan et al. 1992; Kothyari et al. 1996). This time-series study (from 1993 to 2001), conducted in a remote village (Arah) of Uttaranchal, showed the potential benefits and impacts of rehabilitating degraded community lands with an approach comprising both traditional and scientific knowledge.

The Study Area

The study area, Arah Village, covers 99 ha, and is located in Bageshwar District of Uttaranchal. The region is characterised by a variety of sun-temperate-type microclimates mainly governed by geographical coordinates and altitudinal variations. The temperature of the area drops to 0°C during winter and reaches a maximum of 37°C during summer. The area receives moderate precipitation, with a mean annual value of 1,380 mm.

Arah was (and still remains) a semi-remote village, as it is not linked to a road. Based on the village survey conducted in 1993, it was found that some essential amenities were present including a branch post office, primary school, junior basic school (2 km from the village), a rural electricity supply, and a drinking water supply. Other essential amenities like health care and veterinary centres, seed and fertiliser distribution cells, and telecommunication facilities were located at least 5 km away at Garur (nearest roadhead town). The whole village was largely dependent on this town for daily needs and on farming for their 'subsistence' livelihood (Figure 10.1).

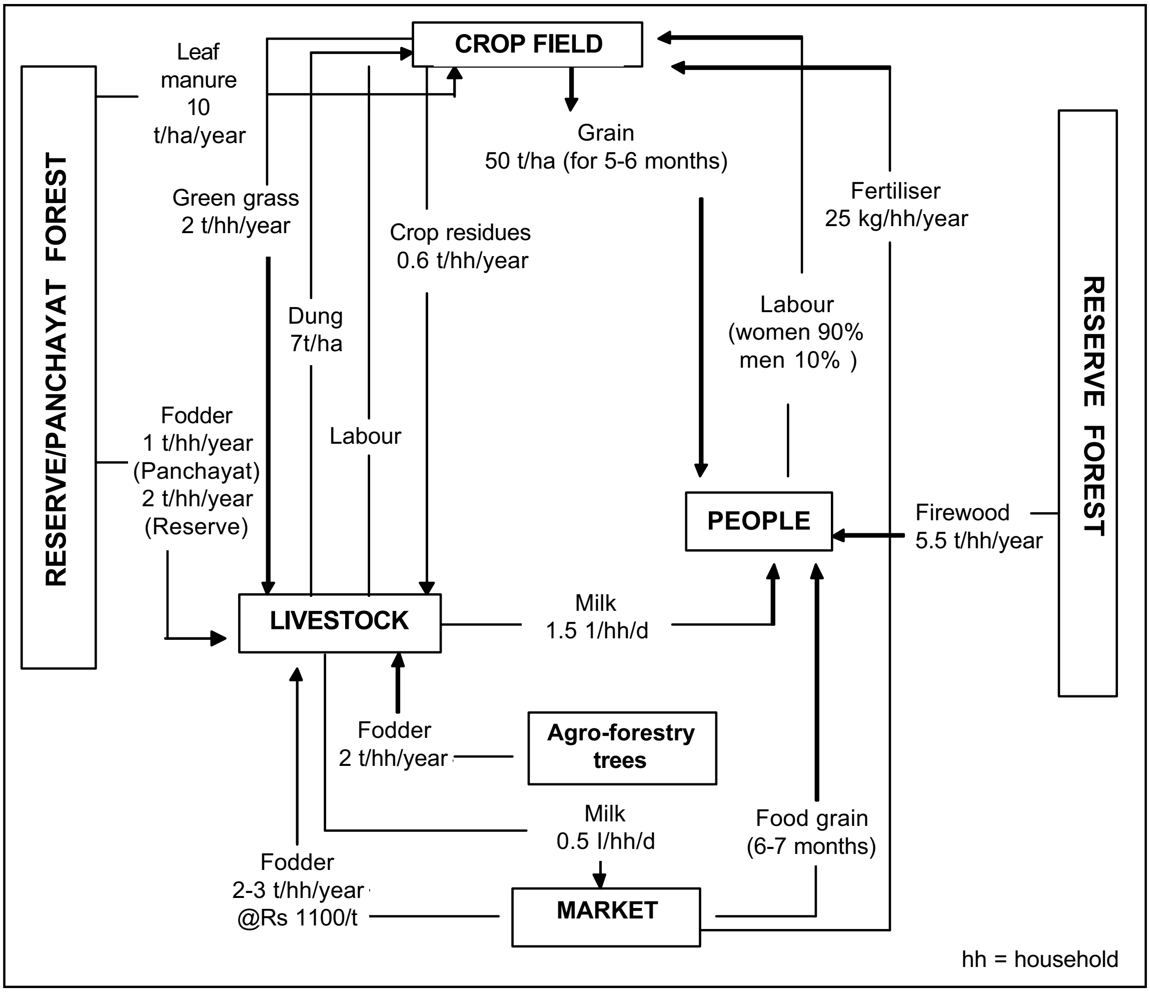

Figure 10.1: The farming system of Arah (1993)

The village had four social institutions actively involved in the management of the natural resources as described below.

Village Panchayat – This elected body headed by the gram pradhan (village chief) acts as a link between the State Government and the villagers for ensuring development of the village.

Van Panchayat – The second highest elected body in the village is the van panchayat (forest panchayat), headed by the surpanch, which manages community land and other natural resources such as forest, grassland, and springs. Approximately 16.5 ha of panchayat van land was being managed by this body, whose main function was to ensure equitable distribution of different usufructs, for example, fodder and leaf litter. This institution took the lead in facilitating the smooth operation of the rehabilitation project.

Dairy Cooperative – A 'parag', a government-sponsored cooperative, along with a number of its units (village milk collection units), was partially functional within the village. However, daily collection of milk from the village was extremely low (10-15 l/day during winter and 30-45 l/day during the rainy season).

Yuva Mangal Dal – This informal group of young people (below 35 years) was actively involved in executing various social and religious functions within the village. Their services were also efficiently utilised during the implementation of the rehabilitation project.

The Study Site and Land Use History

The study site (Balgara, about 9 ha) was located about 1 km from the main settlement, more than 60% households of Arah had customary rights in it. The per-capita landholding size varied, but not significantly. According to the villagers the site had an interesting land use history before the initiation of the project.

Until 1950:	under forest, dominated by *Pinus roxburghii*
During the 1960s:	site cleared for agricultural activities
Until 1975:	agriculture practised, partially under irrigation
Between 1975 and1993:	area abandoned as a result of fragmentation of land holdings, distant location from the main village, increase in the out-migration of men from the village, scarcity of water for irrigation, and destruction of crops by monkeys. The area reverted into grassland and then became an open grazing area.

From 1993 onwards, because of the interest shown by the villagers in carrying out rehabilitation activities, the site was selected for a rehabilitation project with funding from the International Development Research Centre (IDRC, Canada) and ICIMOD (Nepal). The GBPIHED (India) implemented the project. The concept of degraded land consolidation and subsequent community-based development was introduced for the first time in this part of Uttaranchal. The project promoted plantations of different fuelwood, fodder, nitrogen-fixing and timber species, based on the preferences of women as well as GBPIHED research findings in the area of land rehabilitation. Initially, open grazing within the site area was completely checked with the help of the Van Panchayat and the villagers. From 1997 onwards the site was managed by the village community and jointly monitored by PARDYP, India; PARDYP, ICIMOD; and the villagers of Arah.

Methodology

In 1992, during the general meeting of the Van Panchayat, a proposal was passed by the villagers of Arah for rehabilitation of the site. The villagers themselves clearly defined their contributions towards the project goal as follows.

- Open grazing would be stopped at the site.
- Villagers would provide an abandoned house at no cost to the team.
- The community would plant broad-leaved species, mainly fodder species.
- Initially, harvesting and distribution of grasses (ground vegetation) would be as per the norms fixed by the village Van Panchayat.
- Before the project withdrawal in 1996, a village society would be formed for future management and development of the site.

Other activities carried out at the site aimed at sustaining the plantation-related activities and promoting similar programmes elsewhere by different groups of people are described below.

Water harvesting

Scarcity of water was identified as one of the basic causes of land abandonment. Therefore, two polyethylene-lined underground tanks were constructed, with local people's participation, at relatively low cost. The main focus was on harvesting wastewater. The water collected proved to be sufficient for the nursery and newly planted trees. Irrigation was applied through plastic pipes (siphon method).

Soil amendment

Considering the requirements of the site, soil amendments were made with limited mechanical and biological means. Renovation of damaged terraces, pitting for planting desired tree and grass species, and digging and ploughing of terraced areas, were some of the mechanical activities. For improving the soil fertility, nitrogen-fixing crops and tree species were planted and compost preparation was done by vermiculture and bio-composting methods.

Soil erosion control measures

Over the years, a few gullies had formed at the site and, therefore, small check dams were constructed using local stones. However, there are now reports of effective bio-engineering methods to replace such mechanical methods (Agrawal and Rikhari 1998). The run-off from higher sensitive locations at the site was diverted to permanent rivulets.

Nursery development and plantation

To reduce the cost and the damage associated with transportation of planting material from distant locations, nurseries of the required species were set up at the site. The species selected (as per the participatory matrix developed) were *Alnus nepalensis, Albizia lebbeck, Bauhinia retusa, B. verigata, Dalbergia sissoo, Dendrocalamus hamiltonii, D. strictus, Ficus nemoralis, F. macrohylla*, *Debregeasia longifolia, Grewia optiva, Quercus glauca, Q. leucotrichophora,* and *Thysanolaena maxima* (broom grass). In the first year, nitrogen-fixing crops, such as soybean, lentils, and gram, were introduced along the margins as a soil fertility improvement measure.

Bio-composting

Compost prepared from a mixture of weeds, agricultural waste, cow dung, mud, and leaf litter in deep underground pits covered in polyethylene supplemented traditionally composted organic manure. The chopped leaf litter, weeds, and agricultural by-products, mixed with cow dung (when available), mud, and waste paper, were tightly packed into the underground pit and covered with a polyethylene sheet to protect against rain water and surface run-off. By this method, not only was there complete decomposition of weeds and other bedding material, but also the time requirement for preparing manure of the usual quality was reduced by about 2 months; by traditional methods the time required for complete decomposition of the raw material (chir pine leaves) is approximately 1 year.

Meetings, training, and awareness activities

Apart from development and research activities, formal and informal meetings and training camps were organised for the farmers, women, school children, non-government organisations, army personnel, and other government officials. For example, the Garur Block and the Soil and Water Conservation Department were interested in nursery development, plantation technologies, and new approaches for community-based natural resources conservation and management practices.

Key Results

Soil characteristics

A significant increase in average soil moisture content (from 12.3 to 21.3%) was recorded during the study period (1993-1999), while pH showed a small but significant improvement (from 5.9 to 6.3). A gradual increase in organic carbon (C) (from 1.02 to 1.48%) was a positive indication of improvement in soil fertility as was the increase in total nitrogen (N), and available phosphorous (P) and potassium (K) during the same period (Table 10.1). Soil moisture content has a positive correlation with the soil microbial population responsible for the decomposition of organic matter in the soil, therefore enabling plants to have increased access to nutrients (Kothyari and Dhyani 1995).

Table 10.1: **Temporal changes in the soil characteristics of Balgara during the study period**

Years	Moisture (%)	pH	Organic C (%)	Total N (%)	Available P (kg/ha)	Available K (kg/ha)
1993	12.3	5.9	1.02	0.0119	7.2	134
1994	19.9	6.2	1.08	0.012	8.9	157
1995	20.1	6.3	1.12	0.0216	9.2	189
1996	20.6	6.4	1.44	0.0191	9.2	181
1997	21.2	6.4	1.44	0.0205	11.1	190
1998	21.4	6.3	1.45	0.0213	11.4	192
1999	21.3	6.3	1.48	0.0257	11.7	183

Overland flow and sediment output

This study was carried out between 1995 and 1999 by establishing erosion plots (5x2m, n=3) at the site. The total overland flow of 41.01 m^3/ha in 1995 gradually decreased to 27.09 m^3/ha in 1999. Sediment loss also decreased from 0.43 t/ha to 0.37 t/ha. Gradual reduction in overland flow and sediment losses was possibly due to improvement in vegetation cover (ground as well as canopy) as found in similar studies in the Indian Central Himalayas by Pandey et al. (1983) and Pathak et al. (1984).

Soil microorganisms

Soil microbial studies conducted at the site following the methods of Warcup (1950) and Subba Rao (1977) showed a gradual increase in microorganism density (Table 10.2). Microorganisms play a key role in breaking down non-available forms of nutrients into forms that plants can take up (Aune 1995; Aune and Lal 1995; Mishra 1966). Thus the gradual increase in soil microorganisms might have helped increase the soil fertility of the site.

Table 10.2: **Temporal changes in the fungal species' colony-forming units (per gram of dry soil) identified from the study site**

Species	1993	1994	1995	1996	1997	1998
Absidia sp.	0.13	0.33	0	0	0	0
Alternaria alternata	0.51	0.55	0.61	0	0.25	0.63
Aspergillus niger	0.13	0.64	1.35	1.76	2.39	2.29
Aspergillus flavus	0	0.66	0.37	0.23	0.12	0
Aspergillus fumigatus	0.64	0.64	0.73	1.06	0.37	0.25
Aspergillus sp.	0	0	0	0.23	0.88	0.88
Botrytis sp.	0.38	0.93	0	0	0	0
Cladosporium sp.	0.25	0.66	0.87	0.95	0.62	0.5
Colletrotricum sp.	0.25	0	0	0	0	0
Curvularia sp.	0	0.11	0	0	0	0.12
Drechslera sp.	0	0	0.24	0	0	0
Fusarium sp.	0	0	0	0	0.12	0.25
Gliocladium sp.	0	0.33	0	0	0	0
Helminthosporium sp.	0.38	0.44	0	0	0	0
Hormodendrum sp.	0	0.11	0	0	0	0
Mucor sp.	0.13	0.11	0.12	0.58	0.62	0.55
Penicillium expansum	2.19	1.21	2.69	2.84	2.27	2.29
Penicillium chrysoginium	0	0.11	0.75	0.12	0	0
Penicillium sp.	0	0.87	0.12	0.58	0.75	1.26
Paecilomyces sp.	0	0	0	0	0.5	0.76
Rhizopus sp.	0	0	0.12	0.58	0.37	0.25
Trichoderma koningi	0.88	0.55	1.24	1.41	1.26	1.52
Trichoderma harzianum	0.64	0.33	0.36	1.06	0.5	0.13
Monila sp.	0	0.11	0	0	0	0
Verticillium sp.	0.25	0	0	0	0	0
*White sterile mycelia**	0.64	1.22	1.86	1.65	2.51	2.29
*Grey sterile mycelia**	0	0.37	0.75	0.83	0.37	0.88
*Black sterile mycelia**	0	0	0	0	0.75	0.38

* Specific identification was not possible because there was no sporulation. The study was only carried out up to 1998

Changes in natural vegetation composition

Phytosociological studies conducted following Misra (1968) and Saxena and Singh (1982) showed that the species richness of the Balgara site increased from 28 in 1993 to 54 in 1999 (Table 10.3). Also, the number of C_4-type species increased from 2 to 10 during the same period. However, the importance value index (IVI) of C_4 plants decreased from 149.7 to 137.4 (Table 10.4). The predominant species at the site was *Imperata cylindrica* (C_4 grass species, local name siro) with an IVI range of 102.2-128.4, the highest value was recorded in 1993. In contrast, the total IVI of C_3 species increased from 150.3 to 162.6, and their number from 26 to 40 during 1993-1999.

Table 10.3: **Time series changes in the IVI of the species recorded at the Balgara site**

Species	1993	1994	1995	1996	1997	1998	1999
Euphorbia prolifera	11.24	10.80	5.35	5.32	4.11	3.21	1.24
Indigofera dosua	38.76	43.80	45.47	44.64	44.74	44.98	43.00
Gnaphalium hypoleucum	4.20	2.10	1.48	1.44	1.19	1.08	1.22
Erianthus rufipilus	19.11	17.70	17.21	16.21	16.26	16.34	17.00
Imperata cylindrica	128.45	122.10	121.76	112.74	110.24	108.23	102.24
Chrysopogon serrulatus	21.27	20.10	14.54	11.71	11.05	9.15	9.80
Adiantum lanulatum	1.00	2.20	2.53	2.79	3.84	3.46	3.78
Origanum vulgare	3.00	2.00	3.66	4.20	3.94	3.90	2.19
Cheilanthus albomarginata	1.27	1.30	2.18	2.73	3.94	3.89	3.00
Gloriosa superba	2.00	1.90	1.40	1.14	1.98	1.79	2.24
Oxalis corniculata	6.00	7.80	8.46	7.53	7.56	7.89	7.54
Potentilla fulgens	4.06	5.02	6.47	5.16	5.21	5.01	4.96
Crotalaria semialata	3.23	5.30	3.83	5.58	4.16	4.90	3.80
Micromeria biflora	8.00	8.60	8.26	8.49	9.94	8.56	6.60
Phyllanthus simplex	2.00	2.00	2.64	1.05	1.04	1.21	1.64
Calamintha umbrosa	3.00	2.08	2.26	2.57	2.96	2.89	2.10
Craniotome furcata	1.00	1.00	0.00	1.14	0.00	0.00	0.00
Cassia mimosoides	7.60	11.45	11.31	11.22	9.45	9.46	8.76
Flemingia sambuense	1.00	1.10	0.00	1.20	0.00	0.00	0.00
Pareitaria debilis	2.00	2.30	3.86	3.18	1.61	0.78	1.45
Desmodium triquetrum	10.00	11.30	14.07	10.74	8.14	8.67	9.40
Begonia picta	3.56	3.30	4.06	4.29	4.40	3.56	3.54
Drosera peltata	6.21	4.30	1.23	0.18	0.16	0.12	0.00
Artemisia parviflora	2.04	2.10	2.35	1.26	0.15	0.34	0.29
Erigeron canadensis	4.00	4.70	3.66	3.78	2.94	2.99	3.44
Polygala abyssinica	1.00	1.50	0.85	0.24	1.89	1.34	2.78
Scrophularia calycina	3.63	1.01	1.13	1.80	1.08	1.34	2.98
Crotalaria sessilifera	1.00	2.00	1.38	2.19	1.90	1.07	1.56
Barlaria cristata	0.00	0.00	1.38	1.89	1.64	1.34	1.60
Centranthera nepalensis	0.00	0.00	1.42	1.47	1.49	1.34	2.20
Fimbristylis miliacea	0.00	0.00	2.15	1.98	0.87	1.34	3.90
Erigeron bonariensis	0.00	0.00	1.53	0.66	0.94	0.90	1.62
Androsace rotundifolia	0.00	0.00	2.63	1.95	1.42	0.90	2.90
Dicanthium annulatum	0.00	0.00	0.00	1.86	2.94	2.34	3.60
Arundinella nepalensis	0.00	0.00	0.00	0.36	1.89	1.67	2.74
Bothriochloa pertusa	0.00	0.00	0.00	0.90	1.90	1.78	2.90
Setaria glauca	0.00	0.00	0.00	1.08	1.25	2.89	3.40
Cyperus compressus	0.00	0.00	0.00	2.40	2.42	2.23	3.20
Fimbristylis ovata	0.00	0.00	0.00	0.48	1.19	1.90	2.84
Cynoglossum zeylanicum	0.00	0.00	0.00	1.20	0.00	0.00	0.00
Valeriana wallichi	0.00	0.00	0.00	1.44	1.96	2.09	2.80
Justicia pubigera	0.00	0.00	0.00	0.93	0.00	0.00	0.00
Polygonum nepalensis	0.00	0.00	0.00	0.84	1.38	1.01	1.03
Cyanotis vaga	0.00	0.00	0.00	1.05	1.06	0.56	1.08
Lindernia sessilis	0.00	0.00	0.00	0.90	1.84	0.34	1.46
Euphorbia hirta	0.00	0.00	0.00	0.21	0.00	0.00	0.00
Zornia gibbosa	0.00	0.00	0.00	1.65	2.94	1.98	2.44
Evolvulus alsinoides	0.00	0.00	0.00	1.86	3.36	2.32	2.14
Justicia simplex	0.00	0.00	0.00	0.42	0.00	0.00	0.82
Lindernia crustacea	0.00	0.00	0.00	1.68	2.74	0.89	1.00
Heteropogon contortus	0.00	0.00	0.00	0.00	3.36	3.98	4.40
Bidens pilosa	0.00	0.00	0.00	0.00	2.96	3.13	2.46
Conyza stricta	0.00	0.00	0.00	0.00	0.00	0.67	1.44
Crotalaria albida	0.00	0.00	0.00	0.00	0.00	0.12	0.24
Arthraxon nudus	0.00	0.00	0.00	0.00	0.00	0.15	0.00
Lespedaza gerardiana	0.00	0.00	0.00	0.00	0.00	0.78	0.00
Antirhinum orontium	0.00	0.00	0.00	0.00	0.00	0.56	0.00
Apluda mutica	0.00	0.00	0.00	0.00	0.00	0.23	1.20
Pacteilis triflora	0.00	0.00	0.00	0.00	0.00	0.00	0.04

Table 10.4: **Comparison of the changes in the IVI of C_4 and C_3 species reported from Balgara (Arah)**

Species	1993	1994	1995	1996	1997	1998	1999
Imperata cylindrica	128.45	122.10	121.76	112.74	110.24	108.23	102.24
Chrysopogon serrulatus	21.27	20.10	14.54	11.71	11.05	9.15	9.80
Fimbristylis miliacea			2.15	1.98	0.87	1.34	3.90
Dicanthium annulatum				1.86	2.94	2.34	3.60
Arundinella nepalensis				0.36	1.89	1.67	2.74
Bothriochloa pertusa				0.90	1.90	1.78	2.90
Setaria glauca				1.08	1.25	2.89	3.40
Cyperus compressus				2.40	2.42	2.23	3.20
Heteropogon contortus					3.36	3.98	4.40
Apluda mutica						0.23	1.20
Total IVI C_4 plants	149.72	142.2	138.45	133.03	135.92	133.84	137.38
Total IVI C_3 plants	150.28	157.8	161.55	166.97	164.08	166.16	162.62

Species composition within any ecosystem is strongly influenced by multiple factors, including soil characteristics (Tilman and Wedin 1991), grazing (Rana and Rikhari 1994), and climate (Teeri and Stowe 1976). This investigation provided important information about changes that occur due to overgrazing and land degradation. The dominance of C_4 plant species and their changing status from 1993 to 1999, associated with changes in edaphic characteristics, conforms with other reports, which compared plant community differences in relatively productive and unproductive sites (Piper 1995).

Growth performance of the planted species

Despite land being degraded, the planted species had a high survival rate (more than 90%) and a good growth (Table 10.5). This was evident from the fact that the villagers started to harvest *Grewia optiva (*bhimal*), Bauhinia vahlii, and Thysanolaena maxima* from the fourth year onwards.

Biomass production (natural grass)

Grass production from the site increased many fold during the period (Table 10.6). Before 1993, grass production was negligible due to open grazing and low nutrient and moisture status. A total of 2.7t (worth IRs 4,050) of grass was harvested during the post-monsoon period in 1993, which increased up to 8.9t (worth IRs 17,800) during 1999, (rates correspond to the value of the same quality of grass in the open market in that year).

Green leaves harvested from the planted species also increased from 12 head loads/year (in 1996) to 60 head loads/year (in 1999). The value of green leaves (head load) were also evaluated (Table 10.7) based on the money or butter that the villagers would pay or exchange for a known amount of green leaves of the same quality. Due to this increased grass production, most of the participating families could save up to IRs 1,000 per year, as they did not have to buy grass from other sources during the lean periods. Women's workload was also reduced due to this increased fodder availability from a nearby source.

Table 10.5: **Growth performance (height and girth) of species planted at Balgara**

Species	1993	1994	% change	1995	% change	1996	% change	1997	% change	1998	% change	1999	% change
Quercus incana													
Diameter (mm)	7.35	10.14	37.6	13.17	29.88	20.05	52.24	29.27	45	29.72	1.53	32.4	9.09
Height (cm)	12.3	29.9	143	62.06	108.56	112.8	80.8	142.4	26	175	22.8	204	15.57
Quercus glauca													
Diameter (mm)	7.31	9.49	29.82	13.04	37.41	21.29	53.26	31.28	46	33.45	6.93	35.4	5.8
Height (cm)	19.5	38.1	95.3	80.03	110.34	181.5	125.9	189	4	220	16.4	269	22.27
Grewia optiva													
Diameter (mm)	5.16	11.36	120.15	19.52	71.83	36.83	38.68	43.7	18	47.11	7.8	54.9	15.56
Height (cm)*	23.4	60	181.69	159.93	99.91	300.34	86.51	329.57	9	400	21.37	320*	
Ficus macrophylla													
Diameter (mm)	8.91	13.01	46.01	18.98	46.38	21.04	10.85	24.65	17	28.91	17.28	36	24.56
Height (cm)	21	40	9.04	69.14	72.85	90.31	30.62	173	91	210	21.8	248	18.09
Ficus nemoralis													
Diameter (mm)	10.13	15.46	52.61	21.73	40.56	35.65	52.68	38.25	8	41.24	7.81	45.6	10.6
Height (cm)	24.9	58	133.33	92	58.34	154	67.74	215	39	240	11.63	267	23.75
Debregeisia longifolia													
Diameter (mm)	9.21	13.41	45.6	20.26	51.08	31.98	57.84	40	25	51.9	22.92	67.34	29.17
Height (cm)	25.1	60	139.04	100.42	67.36	152	51.36	177.5	16	245	38.02	305	24.48
Ougeinia delbergioides													
Diameter (mm)	7.19	14.23	97.91	18.72	31.56	23.35	24.73	26.78	14	37.08	38.46	45.8	23.46
Height (cm)	25.3	52	105.53	91.89	76.71	140	52.36	192.3	37	200	4.04	232	16
Bauhinia retusa													
Diameter (mm)	8.1	17.25	112.9	24.67	43.01	29.22	18.44	34.76	18	35.49	2.1	49.3	38.87
Height (cm)*	40	79.5	98.75		88.05	266	71.24	359.66	44	460	21.73	370*	
Albizia lebbeck													
Diameter (mm)	6.62	12.19	84.14	19.01	55.94	21.42	12.67	29.1	35	34.01	16.87	36.8	8.2
Height (cm)	36	69.5	93.05	143.5	106.47	181.75	26.65	230.13	10	240	19.92	286	19.16
Dalbergia sissoo													
Diameter (mm)	8.42	13.67	62.35	22.83	66.54	39.63	76	47.87	20	49.28	2.94	54.09	9.71
Height (cm)	30.5	102.1	234.74	207.36	103.09	312.33	50.62	336	7	372	10.71	437	17.47
Thysanolaena maxima													
Diameter (mm)						7.01		7.96	13	8.01	0.63	8.56	6.86
Height (cm)						90.11		95.23	5	140	47.9	147	5
Dendrocalamus													
Diameter (mm)										36.01		38	3.54
Height (cm)										465		513	3.63

* These species were lopped, a traditional practice.

Table 10.6: **Natural grass biomass (dry weight) at the rehabilitation site (Balgara)**

Year	Quantity (t) *	Rate/t (IRs)**	Total amount (IRs)
1993	2.7	1,500	4,050
1994	4.8	1,500	7,200
1995	6.4	1,800	11,520
1996	7.8	1,850	14,430
1997	8.4	2,000	16,800
1998	8.8	2,000	17,600
1999	8.9	2,000	17,800

*Average weight of a heap is 300 kg; **Rate of dry grass fixed by the community; in 1993 US$ 1 = IRs 31, in 1999 US$1 = IRs 43

Table 10.7: **Green grass from planted species (leaves of *Grewia, Bauhinia*, and *Thysanolaena*) harvested by the farmers**

Year	Quantity (head loads)	Value (IRs)/head load (equivalent to 1 kg butter)	Total value* (IRs)
1996	12	140	1,680
1997	17	140	2,380
1998	45	150	6,750
1999	60	150	9,000

* Value calculated as per the traditional market system

Impact on rural livelihoods

The programme was assessed on the basis of the sustainable livelihood (SL) framework (Scoones 1998; Turton 2000). The participatory rehabilitation activities had implications for all the five types of assets defined in the SL framework.

Human capital

The capacity and knowledge of the Van Panchayat and the villagers – including women – belonging to Arah as well as other villages of the Gurur-Ganga Watershed, in terms of new approaches to efficient land and water management, were increased. Similar approaches and technologies have been replicated by many other villages, for example, Khaderiya, Doba, and Majherchaura (Kothyari et al. 2001, 2002).

Social capital

In 1996 the villagers formed a society comprising women and men of different ages for the management and monitoring of the site.

Financial capital

A fund was established at the post office (Arah) by the participating households for the maintenance of the site and for raising a nursery of preferential species. In 1997, about 40 households bought saplings of quality fodder species from the nursery for planting on their private land. Further, a survey conducted in 1999 showed that on average each participating household saved up to IRs 1,000 by purchasing less fodder from the market.

Natural capital
There was a significant increase in plant and microbial biodiversity, and in soil fertility. Soil erosion and water run-off was reduced. Due to increased availability of quality fodder, the productivity of livestock was higher; in 1999 the total amount of milk being sold from Arah through 'Parag' was about 120 l/day, as compared to about 20 l/day in 1993.

Physical capital
About 9 ha of degraded land was rehabilitated.

Other impacts

The project provided important feedback to the main executing agency (ICIMOD) and its regional partners (for example, GBPIHED) for developing guidelines and policy-related briefs for enabling effective land utilisation practices in the Hindu Kush-Himalayas. The project findings also gave field-based information about the causes and impacts of land degradation in mountain ecosystems, which helped in the formulation of a regional watershed project for the mountains of the Hindu Kush-Himalayas (PARDYP).

Conclusions

In recent years India, including Uttaranchal, has looked to watershed development as a way to realise its hopes for sustaining natural resources and improving the livelihood of rural communities. In the Central Himalayan region, the failure of afforestation and reforestation efforts on degraded land, a vital component of any mountain watershed, is attributed to wrong policies, which ignore people's essential needs and hence leads to their non-cooperation. This assessment showed that by taking a participatory approach, rehabilitation of degraded lands in the region, and elsewhere, has the potential to create conditions conducive to enhanced rural livelihoods, while conserving natural resources.

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11 FIELD ASSESSMENT OF EROSION AND SOIL PRODUCTIVITY FROM THE PERSPECTIVE OF THE LAND USER

Michael Stocking[1]

Abstract

Rapid and participatory ways of assessing soil erosion and its impact are needed in order better to represent the perspective of land users and how they make decisions on investing in conservation. A recently published 'Handbook for the Field Assessment of Land Degradation' is reported, which promotes a farmer-perspective approach that is realistic, better integrated, and more practical than standard assessments. Indicators are used that capture the time-scales of significance to farmers that focus on their concerns and are relatively simple to operate. The example of 'armour layers', the residue of stones left behind after sheet-wash, is described. These types of assessment provide more policy-relevant experiences of soil erosion and its impact, leading to a better future for the sustainability of land resources.

Introduction

Soil erosion and the consequent loss of productivity have long been recognised as processes that need not only biophysical examination, but also socioeconomic understanding (Boardman et al. 2003). These processes relate to topics such as declining food security (Scherr and Yadav 1996), social impacts on poor people (Young 1994), and the increasing costs to agriculture (Pretty et al. 2000). Soil erosion by water and changes in soil quality present substantial threats to the integrity of some lands (Cleaver 1997). In turn, soil erosion is a component of the wider problem of land degradation that is now part of the international campaign for tackling global environmental change. Because of this potential challenge to land resources and to the viability of human societies, soil erosion has been the subject of alarming statistics. For example, the Global Assessment of Land Degradation (GLASOD) project calculates that 22.5% of all productive land has been degraded since 1945 and that the situation is becoming rapidly worse (Oldeman et al. 1990). Soil erosion is the major part of that threat.

Yet, at the same time, few people have a clear idea of the nature and extent of soil erosion and productivity decline. Because there has been so much controversy surrounding the process and its global implications (for example, 'desertification', see Thomas and Middleton 1994), little attention has been paid to the field level and to how farmers perceive the problem. Routinely, farmers describe how soils are getting thinner

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and 'worn out' and how yields are declining. Worldwide, they readily appreciate the problem and the costs that it incurs but often with a very different perception to that of the scientists or professionals who presume to advise them.

This chapter reports on a project to develop and evaluate a set of 'Guidelines' (later published as a 'Handbook') for field assessment of the processes leading to land degradation (Stocking and Murnaghan 2000, 2001, 2003). There are few similar manuals available, the closest in concept to that reported here being Herweg (1996) and Herweg et al. (1999). The project arose from the need expressed by field workers for a readily accessible and practical guide. Traditional techniques have usually involved bounded field plots and measurements of soil loss and runoff into collecting tanks. But these are cumbersome methods, yielding only limited information even after several years of monitoring. So, when undertaking fieldwork with collaborators, most of whom are from (and work in) developing countries, the present author has been on the alert for simple, direct, and useful measures of the dynamics of the processes leading to land degradation. The more one looks, the more is the evidence in the field that has been unseen in the past. The evidence may only amount to small accumulations of soil, or thin layers of residual stones on the surface, both easily overlooked. However, these are 'real' pieces of evidence occurring in actual fields being used by farmers; they represent the outcomes of processes usually instigated by land use practices. So, they have great value – a value that is enhanced by the fact that many measurements can be accomplished much more rapidly than by traditional techniques. Rapid rural appraisal (RRA) and participatory rural appraisal (PRA) have tended to be dominated by social or economic enquiry. This Chapter will present the evidence that change in natural resource quality is also amenable to the benefits of RRA and PRA approaches.

Advantages of a Farmer-perspective Approach

There are three main advantages of adopting a farmer-perspective approach to land degradation assessment. First, measurements are far more realistic of actual field level processes. Secondly, assessments utilise the integrated view of the ultimate client for the work, the farmer. Thirdly, results provide a far more practical view of the types of interventions that might be accepted by land users. To exemplify the various components, Figure 11.1 presents a model of the farmers' domain in relation to the professional perspective with respect to changes in soil productivity and their transmission into policy. If there is to be a policy-relevant outcome, it is essential that items of particular importance to farmers be addressed and then integrated into professional analysis.

Realism

The problem with most techniques of scientific monitoring of erosion processes is that they intervene in the process itself. Measurements may simply reflect the intervention rather than the process in its real field setting. Runoff plot results, for example, are partly a product of creating rigid boundaries and the changes this induces in the erosion process. Even a simple erosion pin (a long thin stake forced into the ground,

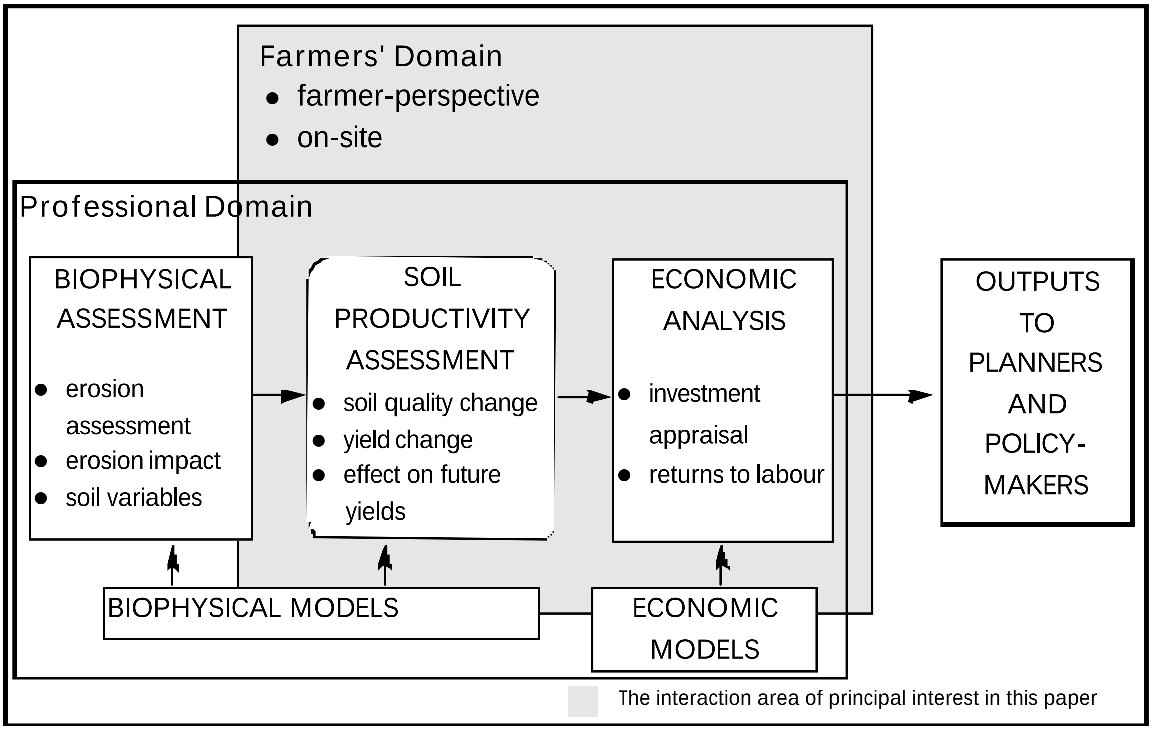

Figure 11.1: **Soil productivity in the context of providing information useful to planning and policy,** Source: Stocking and Clark (1999)

against which lowering of the level of topsoil can be measured) has its problems. The insertion of the stake may crack the soil, altering the local hydrology and resistance to erosion. The stake itself affects runoff around it, possibly causing down-slope eddies in the water current. Stakes are also very likely to be interfered with by small boys and inquisitive cattle. The required accuracy of measurement to 0.1 mm of changes in ground surface is difficult to achieve.

Conversely, most of the field techniques here rely on the results of processes that have not been altered by the technique of monitoring. So, accumulations of sediment against a barrier such as a boundary wall of a field are 'real' accumulations that would have occurred whether or not an observer was trying to measure them. In addition, measuring the height of a mound of soil protected by a tree, relative to the general level of the soil surface influenced by erosion since the tree started to grow, is a 'real' difference that is impossible to ascribe to inaccuracies introduced by the technique of measurement. There may be other explanations for the tree mound but these are no more serious than alternative explanations in other more interventionist techniques. Realism is also enhanced by simple field techniques in that indicators often used by farmers are being employed. The pedestals under small stones and the existence of coarse sand and gravel deposits in fields are both frequently identified by farmers as the result of rain-wash.

Integration

The results derived from field assessments tend to integrate a wide variety of processes of land degradation. This is most evident in changes in soil productivity as measured by farmers' assessments of historical yield. Many scientists may see this as a disadvantage, covering up the causative influences on yield reduction. Yields are a product not only of soil erosion, but also of past and current management, seed sources, climate, pests, and general vagaries of nature. However, land degradation (of which soil erosion is a major process) is a very broad concept, including not only attributes of the physical environment, but also the way in which the environment is managed and how nature reacts to human land use. So, integration is essential if the researcher is to present the outcome of a set of processes that farmers really face. The scientific method of deconstructing natural processes into their singular elements for study and then reassembling them to regain complex reality has dubious validity in ecological systems where it is the interactions between components that are far more influential.

Take the example of how vegetation controls soil erosion. Directly, vegetation introduces organic matter into soil, which renders the soil less erodible. But, indirectly, and of far greater universal importance, is the way that a cover of vegetation intercepts raindrops. The energy of the drops is dissipated in the structure of the plant, rather than being used to dislodge soil particles. These interaction effects are vital to capture if accurate assessment of the severity of erosion is to be made.

Practicality

Probably the most important criterion is that farmer-perspective assessments are more practical. They bring together the long experience of the farmer in using the field and of noting what happens – experience that could not possibly have been accumulated by the researcher as an occasional visitor. The researcher can also learn much about how farmers respond to the effects of land degradation from in-field experimentation by farmers. Farmers experiment in many aspects – they try new varieties, vary planting dates, and test different fertility treatments and conservation measures.

Practicality also extends to the application and use of the results. If, for example, the farmer has been involved in collection and processing of field data on soil erosion and its impact on productivity, then ownership of the results is far more clearly identified with the farmer than the researcher. A condition for this to work, however, is the willingness and responsiveness of the researcher to allow the land user to take the lead in the participatory process. This participatory element has been found to be essential in most rural development work. Furthermore, results of such assessments will be much more relevant to the issues facing land users. Change in soil-productivity that affects future yields is a constant concern to many marginal land users. So, assessments that use yield as the indicator variable will much more closely relate to farmers' priorities and be much more likely to induce solutions that combat soil erosion through yield-enhancing measures.

A further practical attribute of field-level farmer-perspective assessments is that they are quick and simple. Many more observations can be accomplished in a short-time than through the more complex procedures of standard monitoring. Having the possibility of multiple data points enables a much better sampling of the enormous number of permutations of field types, management regimes, crops, and land uses. The number of permutations is a real problematic issue for researcher-centred methods. Standard empirical approaches, such as experimental plots, cannot possibly cope with the range of crops, management methods, and soil types with which farmers have to deal. They deal with 'snapshots' and very limited sampling of the conditions, hoping that in some way the sample might be representative. They look for homogeneous units, into which experimental results might be applied, while acknowledging that such units are imposed by the researcher onto real-life variability. By the time the results are processed, conditions may well have changed – a new variety, adopted management techniques, and altered market prices, for example. All these will affect the viability of farming and may not be reflected in empirical analysis. Farmer-centred methods should alternatively examine the factors that determine variability and decision taking in heterogeneous environments where predictability is uncertain. Using field assessments ensures a better focus on the issues important to farmers.

Lest it be thought that field assessments are only advantageous, it must be stressed that they do have some limitations. Absolute accuracy can be compromised because field instruments such as a ruler marked in millimetres cannot identify small changes. However, this failing can be compensated for by taking many measurements, certainly many more than would be available by standard techniques. In addition, because farmer-perspective assessments tend to integrate the effect of a variety of often-unknown processes, it is very difficult to extrapolate the results to unmeasured conditions. If, for example, it were known that aluminium toxicity causes yield declines after a crop that allows high erosion, then these same conditions would likely prevail at another broadly similar geographical location. But farmer-perspective assessments usually contain only limited information on causative relationships. Furthermore, it has been claimed that farmer-perspective assessments are less reliable. It is true that many means of controlling reliability are unavailable to the researcher. How does one know the farmer is telling the truth, for example? Different methods give different representations of absolute levels of soil erosion.

Because of space limitations in this chapter, only one example of a field assessment technique is given here. The interested reader is referred to the 'Handbook' for more techniques, as well as ways of combining indicators to derive more robust conclusions as to the status of land degradation (Stocking and Murnaghan 2001, 2003 [in Spanish]).

Field Technique Example: Soil Loss Indicator

Land degradation, including soil erosion, encompasses a vast array of biophysical and socioeconomic processes, which make its assessment difficult to encapsulate in a few simple measures. It occurs over a variety of time-scales, from a single storm to many decades. It happens over many spatial scales, from the site of impact of a single raindrop through to whole fields and catchments. Without extreme care, measurements undertaken at one set of scales cannot be compared with measurements at another.

This is why field assessments should use indicators that do the following.

- Capture time-scales that have significance for the farmer, usually from one growing season through to four or five years. Some land users do have concerns for long-term sustainability, provided that immediate food needs are assured.
- Focus on the concerns of land users, primarily the way that land degradation makes farming more difficult and the impact of degradation on productivity.
- Concentrate on relatively simple measurements, some of which may be quantified into absolute rates of soil loss, but none of which should be taken in isolation. Farmers themselves use indicators such as soil depth and evenness of the standing crop.

A summary list of erosion and productivity indicators is given in Table 11.1. The example chosen here is the 'armour layer technique' (see Box 11.1). An armour layer is the concentration, at the soil surface, of coarser soil particles that would ordinarily be randomly distributed throughout the topsoil. Such a concentration of coarse material usually indicates that finer soil particles have been selectively removed by erosion. Farmers commonly remark how they have to dig in this coarse material when preparing the land for planting.

In the example described in Box 11.1, an average armour layer depth of 1 mm, where the fraction of coarse particles in the original soil is 20%, gives a calculated erosion rate of 52 t/ha. From the farmer, the field assessor can determine the length of time the soil has been undisturbed, so deriving a short-term soil loss rate.

Conclusions

Field assessment techniques have considerable advantages over standard experimental approaches to measuring soil loss and changes in soil quality. They enable a much closer record of processes that are actually happening in the field, because they do not create the sort of disturbance and interference to biophysical changes that occur when bounded plots or laboratory samples are taken. They also allow a much closer involvement of farmers and local communities, to the extent that field assessment techniques could be described as giving a more clearly focused farmer perspective. If conservation professionals want their recommended technologies to become accepted by farmers, then this perspective of land users is essential to obtain.

The approach adopted in this chapter is recommended to those who, without any need for natural science training, wish to assess soil erosion rapidly in the field in partnership with farmers and land users. The purpose of such assessment, as illustrated in Figure 11.1, is to link with economic/financial analysis and to provide policy-relevant experiences for the future sustainability of land resources. Of course, the steps from economic analysis towards policy-relevant analysis are themselves fraught with difficulty. However, with a strongly farmer-centred assessment of soil erosion and impact on productivity, the opportunity to develop improved contributions to policy must be greatly enhanced.

Table 11.1: Field techniques for erosion rate and impact assessment: examples drawn from field work in Tanzania, Sri Lanka, and Bolivia

Measurement	Technique	Observations	Perceived by farmers?
Short- (up to one year) and medium- (2-5 years) term net soil loss	(1) Erosion pins (2) Rainfall simulation from bounded plot (3) Stone pedestals (4) Grass/herb pedestals (5) Armour layer (6) Sediment in drains (7) Volume of in-field rills	(1) Micrometer gauge; problems over site selection, accuracy, and pins being stolen (2) Artificial site and rainfall conditions (3) Need to know length of time soil is undisturbed (4) Difficult to interpret (5) Need stones in soil (6) Often only coarse material; fines completely removed (7) May miss sheet erosion	(1) No – lowering of surface rarely perceived (2) No – artificial (3) No – not seen (4) Sometimes observed and described (5) Rarely (6) Yes – seen by farmers (7) Sometimes described
Long-term (more than 5 years) net soil loss	(8) Tree mounds (9) Topsoil depth	(8) Prone to exaggerated rates (9) Useful for comparative view of similar positions on catena	(8) No – not described (9) Yes – common impact mentioned by many and related to crop growth
Sediment movement down slope	(10) Gerlach troughs (11) Semi-circular sediment traps – plastic lined	(10) Problems over site selection and size of sampling bottle (11) Prone to damage by cattle	(10) No – sediment wash across slopes rarely seen (11) as 10
Mean annual soil loss (over more than 10 years)	(12) Erosion prediction models (USLE; SLEMSA, Eurosem etc)	(12) Not really a field technique. Model variables may require field observation and, most importantly, local validation	(12) Definitely no
Gully erosion	(13) Markers and gully profiles (14) Time-series aerial photos	(13) and (14) Process highly discontinuous in space and time; best assessed over longer term and often available for 30+ years from local people and photos	(13) and (14) Gullies widely described as problematic; observation on past gully positions and loss of fields, roads etc.
Impact on soil quality	(15) Soil depth – erosion phases (16) Comparison of clays and organic matter in sediment with topsoil (17) Soil colour comparison	(15) Long-term historical erosion; may also include natural colluvial process (16) A field method of determining enrichment ratio (17) For each soil type, Munsell colour can be related to nutrient content	(15) Yes – often mentioned (16) Possibly – but little evidence to date (17) Yes – in many indigenous classifications, but not necessarily related to erosion
Impact on yields	(18) Observations of plant growth with soil depth (19) Farmers' assessments of yield variations	(18) Difficult choice of variables: height, cover, tillers, flowers – needs validation and relating to yields (19) Drawing of size of crops from different fields found useful	(18) Yes – widely seen as important and related to harvesting and crop prices (19) Yes – often mentioned and perceived

Source: Stocking and Clark (1999)

BOX 11.1: **The Armour Layer Technique**

An armour layer forms where raindrops or the power of the wind detach finer particles, leaving behind a coarse residue of stones, resistant aggregates (such as lumps of ferricrete), and sand. It is most likely to form on soils that have both a stony and coarse fraction as well as a fine clay to silt fraction.

Field measurement consists of digging a small hole to reveal the undisturbed armour layer. Using a ruler, the depth of the coarse top layer is measured (see Figures 11.2 and 11.3). Where the depth of the armour layer is less than 1 mm, it is best to scrape the stones from a small area of about three times the size and then measure this depth and divide by three. This helps to reduce the inaccuracies in trying to measure very small depths of stones. Several measurements at different places in the field should be made in order to calculate the average depth of the armour layer. The approximate proportion of stones and coarse particles in the topsoil below the armour layer is then judged by taking a handful of topsoil from below the armour layer and separating the coarse particles from the rest of the soil. In the palm of the hand, an estimate is made of the percentage of coarse particles in the original soil. Again, this estimation should be repeated at different points in the field. The depth of the armour layer is then compared to the amount of topsoil that would have contained that quantity of coarse material. The amount of finer soil particles that has been lost through erosion can then be estimated. These calculations tell us the amount of fine particles that has been lost since the soil was last disturbed, for example since it was tilled or weeded.

Michael Stocking

Figure 11.2: **Measuring an armour layer in the field with farmer and researcher**

Figure 11.3: **Detailed view of assessment of depth of armour layer**

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12 STIMULATING LOCALLY INITIATED AND SUSTAINABLE LIVELIHOOD CHANGE – New Relationships between Local Professionals and Rural Communities in the Central Andes[1]

David Preston[2], Raimundo Montaño[3], and Rosario Condori[3]

Abstract

We examine ways in which locally initiated and sustainable changes in household natural resource use strategies were developed over a three-year period through an initial partnership with three communities and a small team of local professionals. This has led to work with a further six communities. Evidence suggests that this partnership may lead to longer-term continuation and further independent development of these strategies. This will enable households in the future to manage their livelihoods and their environment with minimum external intervention. If such work evidently offers sustained and productive change, it may establish a better foundation on which more conventional development programmes can be built. Our experience shows both pitfalls and potential for this type of change of approach in a specific geographical context, but it also suggests the extent to which this is relevant in a much wider context. We conclude by suggesting that meso-level institutional actors may become involved in enabling these approaches to be applied over much wider areas, in particular small farmers' unions and municipalities, once they realise the benefits of investing in productive actions.

Introduction

Rapid social and economic change that affects most rural Andean communities creates specific needs in relation to their use of existing natural resources. The needs of people living in such communities are not obvious to urban-based professionals, they are complex and vary according to the social and economic configuration of the individual, community, and region. To help such communities, the policies of governments and non-government organisations (NGOs) need to be based on knowledge of what people and communities want, on understanding the complexity of household livelihood strategies, on consulting and listening to the poor, and on recognising that community participation should be active rather than passive.

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There are frequently differences between community needs, as expressed by community members freely out of the context of any agency offering assistance, and what outside agencies offer. This is equally true for NGOs sympathetic to the need to discover community priorities, and national and regional governments. All arrive with a particular set of organisational priorities, often influenced by those of overseas donors. Such livelihood change, driven from above, is likely to be unsustainable, because little local impetus has been developed, except among the chosen beneficiaries, and local ownership of the work is limited.

The adoption of livelihoods as a concept by many international agencies should ensure recognition that rural household survival is frequently dependent on both farming and non-farm work as well as on work in far distant places, often foreign countries. Farmers prioritise farming activities that can best be fitted into livelihoods that include migration. In Central Andean communities, migration to cities and areas of commercial faming has long been an important part of life for men and women (Hinojosa et al. 2000; Preston 2002). To households in such areas, labour input minimisation of rural natural resource management is frequently just as important a goal as risk minimisation or production maximisation. For example, previous research by one of the authors (Preston 1998) presented evidence of a shift in emphasis in livelihood strategies from sheep (needing daily attention) to cattle (left to graze high mountain pastures unattended) during the course of the twentieth century. This could reflect the increasing importance of largely male migration and the use of cattle for banking some of the migrant earnings.

The focus on poverty reduction by both national government and donor agencies has caused more development action to be directed towards poor regions or localities. Identifying and targeting the poor communities within poor regions as well as the poorest people within communities is more difficult. A further challenge is therefore how best to communicate with those most marginalised within and by communities – and discriminated against by reason of age, gender, and location (reported in Preston 2003).

The now widespread belief in the value of participative methods to identify needs and ensure more local involvement in actions has created awareness of the need to listen to village people. But the listening is often superficial, largely because such an approach is alien to the background and experience of many local, national, and international professionals. In addition, the poorest people do not necessarily attend community meetings, at which new initiatives are introduced and discussed: they cannot afford to leave their work to attend. Such meetings are dominated by those with most voice – the better off, male, and articulate. As the growing literature critical of participative methods demonstrates (White 1996; Cleaver 2001), there are many ways in which the role of the facilitator may become dominant and the extent to which all sectors of communities can take part in consultations is often uncertain. Therefore, there is a need to develop new ways of working with communities that allow those in all sectors (socially, culturally, and geographically defined) of communities to talk, listen, and discuss effective ways of working together and separately to strengthen household livelihoods.

Recent writing by social scientists on ways of improving collaboration with rural communities has tended to focus on international, national, and regional organisations[4] (de Janvry et al. 1993; Bebbington 1996; and others). Much of this literature concentrates on the use of existing structures at a regional and national level to initiate changes at a community level. In the Central Andes, communities are real and long-lasting social institutions although they are often modified by migration to form transnational communities (Portes 1996; Roberts et al. 1999; Appendini et al. 2001; Preston 2002). This chapter proposes that grass roots changes on sustainable natural resource use can be effectively developed at household and community level and extended to other households and communities and beyond. This involves the use of existing organisational structures, specifically municipalities and small farmers' unions, to enable local professionals (LPs) to link more effectively with rural people.

In this chapter we examine ways in which the facilitation of locally initiated and sustainable changes in household natural resource use strategies were developed over a three-year period through an initial partnership with three communities and a small team of LPs. This has led to similar work with a further six communities. We also identify evidence that suggests that this partnership may lead to longer-term continuation and further independent development of these strategies. This will enable households in the future to manage their livelihoods and their environment with minimum external intervention. If such work evidently offers sustained and productive change, it may establish a better foundation on which more conventional development programmes can be built. Our experience shows both pitfalls and potential for this type of change of approach in a specific geographical context, but also suggests the extent to which this is relevant in a much wider context. We conclude by suggesting how meso-level institutional actors may become involved in enabling these approaches to be applied over much wider areas.

Resource Use in South-West Tarija

The work that stimulated the writing of this chapter, focused initially on three communities in the south-western part of Tarija, southern Bolivia, close to the border with Argentina. This is an area of temperate valleys at 2000-2600 metres above sea level (masl), bordered at the west by a high plateau (3700 masl), structurally and ecologically similar to the altiplano that extends from north-west Argentina through Bolivia to southern Peru. Two of the communities are situated in the valleys and the third is on the altiplano. Previous research in these areas between 1992 and 2000 had examined the natural resource use strategies and their incorporation into household livelihoods (Preston and Punch 1996; Beck et al. 2001). Research methods used during the earlier research included monthly monitoring of a series of poor, middle-income, and better-off households over the whole of this period. This allowed an exceptionally high level of understanding of the dynamics of these livelihoods and, in particular, of the ways in which migration (frequently to Argentina) is incorporated into everyday life. It also allowed the identification of frequently expressed needs of rural households that might

4 In this paper the term 'organisation' is preferred rather than the frequently used 'institution'. Institution is used to refer to societal shared belief or practice such that religion is an institution while the Church of Christ is an organisation.

be satisfied by collaboration with LPs from the city of Tarija. It was this work that laid the foundation for this research.

In the majority of the rural communities in south-western Tarija, household livelihoods are maintained by farming, livestock, and waged work in Argentina and in lowland Bolivia. Both crops and livestock provide basic subsistence for households. They are used for domestic consumption, but also for sale in urban markets or for exchange of products from a different ecological zone at one of the seasonal regional fairs that are still important trading occasions throughout the area. Local domestic production is largely subsistence oriented and cash income to enable the acquisition of manufactured goods (including clothes, radios, and cooking oil) is the result of seasonal migration. At times of crisis, after droughts, floods, or damaging hail or frosts, even more people migrate and their earnings provide the necessary income to make up for temporary shortfalls in domestic production.

In the valleys, whether in the main valleys around Tarija or in the valley of the Río San Juan del Oro on the western border of Tarija department (Figure 12.1), most households have fruit trees (quinces, peaches, and grape vines) and fields (sometimes irrigated) growing maize, potatoes, and beans, and most keep cattle, sheep, and/or goats. The poorest households have no irrigated land, but often have a few goats and maybe sheep. The better off (in the Tarija valleys) have more than 15 cattle as well as sheep and irrigated land. On the altiplano, all households have sheep, some as many 350-400 (2 households have 700-900), and a small number of cattle, goats, and donkeys. Small areas on the lower hillsides, which are less frost prone and near springs, are cultivated for potatoes and beans.

Grazing throughout the valleys and altiplano involves the use of multiple ecological zones. Livestock move horizontally and vertically within the communities, depending on the season, using communal pasture resources (Figure 12.2). In addition, in the dry season those with more than about 15 head of cattle take them on foot to the eastern slopes of the hills where rainfall is higher and ample pasture exists. This land is either owned by Tarija valley households or, more commonly, pasturage is paid for and local people look after the cattle. Tarija valley households with small numbers of cattle take them during the dry season to the upper Andean mountainsides to which they have customary access. Sheep from communities in the Río San Juan valley are taken to the adjacent altiplano communities to be cared for during the wet season when there is pasture available and crops are growing in the valleys.

Our earlier research suggests that, in the Tarija valleys, the number of sheep has decreased and the number of cattle increased during the past century (Preston 1998) and that, on the altiplano, sheep numbers have not increased during the period following the agrarian reform of 1953 (Preston et al. 2003). There is, similarly, little evidence of current environmental deterioration associated with grazing. In the Tarija valleys, our research on soil erosion and changing soil quality suggested that areas of active erosion are very limited in extent and that much erosion is ancient (Warburton et al. 1998; Maas et al. 2000). There is evidence that the areas under cultivation have

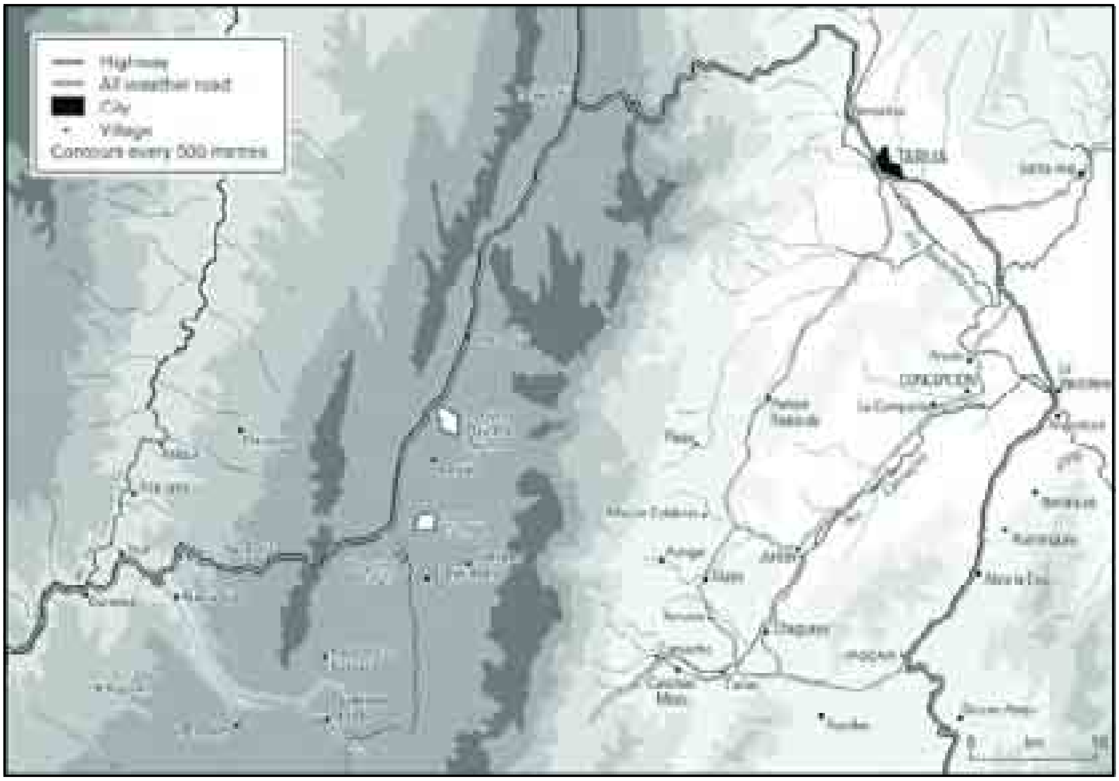

Figure 12.1: **South-west Tarija**

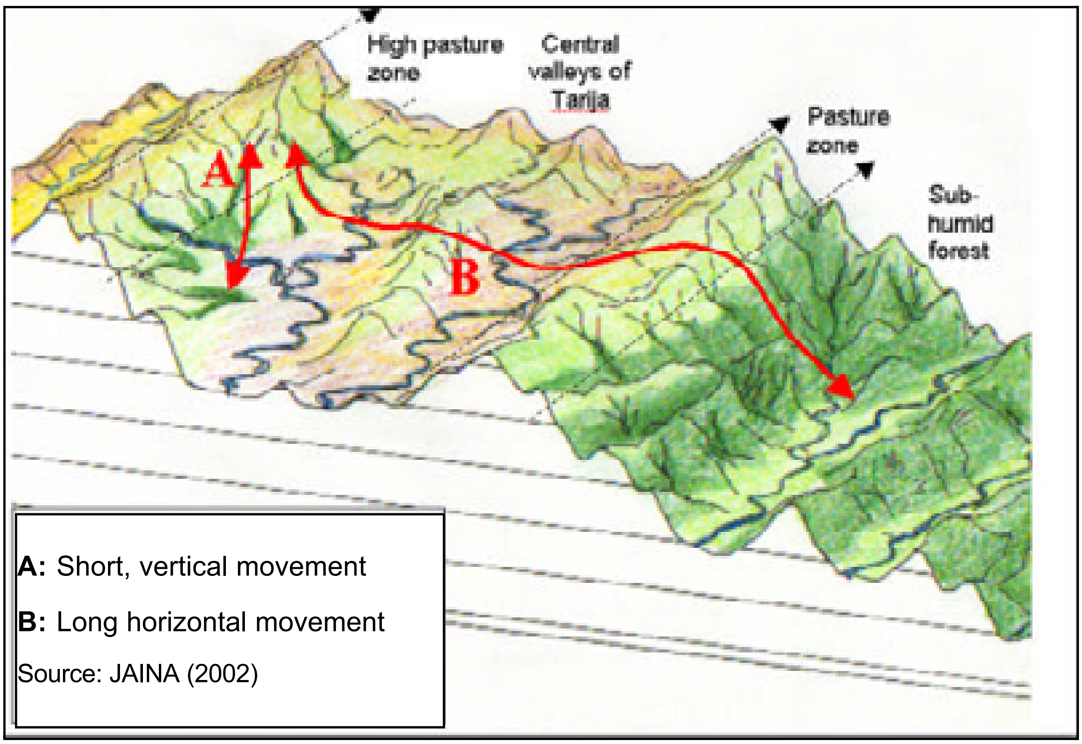

Figure 12.2: **Livestock movements**

decreased in recent decades and former cultivated areas have been colonised by churqui (*Acacia caven*) under which grazing is possible and soils in such areas are better than those currently cultivated (Salm 1996).

The current research focuses on the links between communities and LPs and the ways in which these links can best be used to enhance management of natural resources to sustain household livelihoods. The work with communities was carried out by two to three LPs working in association with a major Tarija NGO, Protección del Medio Ambiente Tarija (PROMETA), that manages protected areas (similar to national parks). PROMETA manages the Sama protected area, which includes the altiplano community with which we collaborated. PROMETA engages in small projects aimed to improve livelihoods and enhance the natural environment, such as introducing camelids as grazing livestock and attempting to introduce vegetable growing on the altiplano. In such activities there was synergy with our research. In addition we were associated with Radio Tarija, the local radio station popular with farmers, which is managed by a separate NGO, Fundación Acción Cultural Loyola (ACLO).

Methods of Work

Initial contact with the two valley communities was facilitated by their previous collaboration with the UK research staff. There had been no previous contact with the third altiplano community, although the ecological zone was well known from previous work. These differences and the nature of the communities resulted in different interactions between the LPs and the community. Both valley communities engaged vigorously in workshops and resulting actions. In the altiplano community people were more reserved and interactions were best in smaller groups. Women in valley communities took an active part in community meetings: in the altiplano they responded best to personal and small group discussion. In each community half-day workshops were held at which groups discussed and recorded the major issues with regard to natural resource use, that needed attention, as well as the potential and specific problems of each locality within the community.

Community priorities were established after the LPs attended a normal monthly community meeting, where the ways in which they could be helped in improving natural resource management were discussed; then workshops were organised, usually immediately after the following monthly meeting. At this workshop community members took part in a series of activities to enable them to identify individual and group priorities that were then further discussed and conflated into priority actions representing the interests of the community as a whole. Reflecting the particular skills of the two LPs (a fruit and vegetable expert and a veterinarian), actions to reduce loss of revenue from diseases to fruit and livestock figured prominently on the list of priorities. However, both LPs stressed the need to hold workshops to discuss more general issues relating to any crops or livestock.

Following the discussion about strategies to involve as many people as possible in the different localities in the community, farmers readily identified areas where actions could be carried out collectively. Each group nominated one person to lead when LPs were organising the workshops (at a community level or by group) and to be held responsible for any leaflets produced, and instruments loaned (knapsack spray, syringes for de-worming) and for recording group members who were absent or otherwise unable to take part in collective and household-level actions. Group representatives reported their progress and evaluated the results of past actions at the monthly community meetings to maintain a regular dialogue.

Further workshops were held to introduce specific actions, such as treating fruit tree pests and internal and external animal parasites. At the workshops descriptions of the pests and diagnostic symptoms developed by farmers were used in their own vocabulary, and reflections were invited on the best action for local people. A crucial element in the work was linking farmer knowledge to scientific knowledge, to identify particular plant and animal diseases. Farmers joined in designing small experiments, such as collecting insect larvae believed to cause abortion in order to catch the insect on hatching for scientific identification. Walking with groups of farmers through fields and orchards was a very productive way of learning about local preoccupations and explaining disease cycles and transmission paths and the value of collective action. Initially, knowledge about traditional methods of treating some crop and livestock diseases was gathered, but most rural people felt that the use of such knowledge was now limited and they had no confidence that its use would be effective[5].

Further meetings, as well as discussing actions in the fields, reiterated the need to evaluate the results of the first actions: How many pests remained, Where and Why? and make decisions on further action. The necessity of collective action was easily recognised as many diseases spread more rapidly when entire localities are not treated at the same time. The philosophy of this work, that knowledge should be banked, reflected upon, and related to one's personal situation and acted upon by individuals seeking changes from which they may benefit individually and/or through collective action (influenced by the writing of Paulo Freire and others) was summarised in a document that was circulated among agencies and other professionals in Tarija (Preston et al. 2002).

Each of the communities started trials of a number of new practices (different varieties of potatoes, maize, broad beans, and potential fodder crops) on the land of one group member (see Table 12.1) with the resulting crop (if judged successful) shared between group members for their subsequent planting. The success of groups varied according to a range of personal factors, but all groups succeeded in demonstrating new crops or varieties that might be grown locally.

In some communities, schools were involved with the development of nurseries for growing trees, vines, and vegetables. Teachers and children joined community members

5 Separate research is needed to verify the effectiveness of local knowledge, however few the number of people who still remember 'old people's' remedies. Similarly a wide range of human illnesses used to be treated with local plants. Advertising and the attitude in other projects have eroded confidence in local knowledge.

Table 12.1: **Community gardens**			
Community	**Winter**	**Summer**	**Participants**
Chorcoya	Broad beans, potatoes, oats		Each community group
Atacama	Lettuce, cabbage, broccoli, onions, radishes, broad beans	Tomatoes, melon, small squash, cucumber	Parents, teacher, school children
Buenavista		Tomatoes, melon, small squash, maize, cabbage	Parents, teacher, school children
Rupaska	Lettuce, cabbage, onions, radishes, broad beans		Parents, teacher, school children
Tacuarita	Lettuce, cabbage, onions, radishes, broad beans	Maize, tomatoes	Community

in short workshops about best practice in maintaining the nursery and garden. In addition, LPs taught classes on environmental principles in each of the community schools at the request of the teachers. Trees will be used in various ways, to plant on river sides as part of improvements of flood protection, for timber and fuelwood in places not suitable for crops, and fruit trees will be used to replace trees in established orchards and for others wishing to start new orchards. The basic principles of planting and care, including grafting for fruit trees and vines, were explained in workshops and at regular field meetings to monitor the development of the plants. Table 12.2 shows the number of trees planted. In the altiplano community two native tree species (queñua (*Polylepis*) and kishuara (*Buddleia*)) have been planted in a small area where stone walls have been built to see whether crops can be grown in an area containing prehistoric terraces.

Table 12.2: **Trees planted in community nurseries**		
Community	**Tree type**	**Number of seedlings**
Juntas	Peaches	1300
	Eucalyptus	1500
Armaos	Peaches	300
Tacuarita	Peaches	1000
Rupaska	Peaches	300
Atacama	Grapes	300
Chorcoya	Kishuara	25
	Polylepis	25
Ñoquera	Peaches	100
Tojo	Peaches	915
	Eucalyptus	1500
	Chacatea	900

As part of the programme to use local knowledge and to build on it for community-wide use, Fairbairn and Morales Arlando (2001) mapped the soils of the altiplano community, Chorcoya, in consultation with farmers and graziers from the different localities in the community. Soils were described using local terms as well as the results of laboratory analysis.

Broadcasting work

The purpose of being associate with Radio Tarija from the outset was to report to people in rural communities the work being done in the initial three locations. During the first

18 months of the project, monthly broadcasts were recorded that included informal talks about the priorities identified by the communities and the work done with them to experiment with new natural resource management strategies. Use was made of visits to Tarija by people from communities for them to talk about the work.

This was a very effective way of announcing the nature of the work being undertaken to a broader public. People regularly visited the project office in Tarija and sent letters asking whether the LPs could visit their community. In most cases this was impossible but people not too far away from one of the initial communities were invited to visit and to take part in workshops. Each of the communities was very willing to welcome people from nearby communities to take part in the work and this enabled visitors to consider whether there was enough popular support for such work that a collective invitation could be sent to ask for the work to be extended to include them. This was the basis on which work was extended to five of the communities with which we collaborated (Table 12.3).

Table 12.3: **Collaborating communities**

Community	Collaboration started	Remarks
Juntas	3/00	
Armaos	7/02	
Tacuarita	1/02	
Chorcoya	3/00	
Ñoquera	4/02	
Tojo	3/00	
Atacama	7/00	
Buenavista	8/00	Visits only possible during dry season
Rupaska	11/01	Visits only possible during dry season

Another effective method of informing a wider rural audience of the work in progress was through participating in some of the seasonal fairs that are attended by over 1,000 people. These seasonal fairs are primarily a way of engaging in exchange and monetary transactions but some NGOs publicise their work and we organised with our participating communities to have a stand with produce and display panels, with farmers and LPs on hand to demonstrate produce and talk about the work. Both LPs and farmers managing the displays were impressed by the level of interest; produce was sold out within hours and groups from different communities talked about ways of starting similar work.

Reaching the excluded

During the initial work with the communities, it was recognised clearly that some households were not represented at meetings or came but took little part. These included people who lived far away or who were too busy to attend meetings (because they are wage labourers or single parents with small children or have several household members absent working elsewhere). Some are, or feel, excluded because they are poor, are of little account, or are just not listened to. Specific strategies were devised to try to include these people.

We visited households that community leaders had identified as having the fewest resources. In the evening or free moments during the day, the project staff visited them individually to chat, ask where they farmed, what work they did for money, and in what ways they thought they might improve their livelihood. After several such visits, the LPs felt more welcome and it became easier to discuss their household needs and whether the workshops had identified priority areas potentially useful to them. Some children from these households did come to the workshops to learn a particular skill, pruning peach trees, that could be useful either to practise on their own trees (although few of the poor had fruit trees) or to enable them to work for others and be paid. As we established personal relations with some households they sought advice and sometimes they joined groups for specific action.

A consultant psychiatrist visited one community to spend time with individuals and groups of people who have few resources and to discuss with them (individually and in groups) what being poor meant, in particular with respect to being looked down on by others in the community (Romero 2002). This work used a skilled professional from outside the LP team to investigate in greater depth the self-perception of such people and the sorts of barriers that might exist to prevent them benefiting from the collaborative work. The report identified categories of people who felt marginalised (for example, older widows) and some of the handicaps that such people face. A young man imaginatively described "not daring to dream" of a better life. Changes in attitudes in all social strata in the community are a necessary precondition to initiate change. For this reason a summary of this report was presented at a community meeting, which led to a lively discussion about how to encourage more widespread recognition of the ways in which the community itself needs to act to reduce social exclusion. Some of the most personal comments, supportive of the approach, were made to the LPs after the meeting, indicating both the depth of feeling and the difficulty of listening to those with fewest resources other than in a more separate context.

Two actions were initiated as a direct result of discussions with those people who had the least resources. In both cases groups of such people were encouraged to discuss how they might collectively experiment with a new strategy that could initially provide more food for the household and, later, offer a source of income. In Tojo, after considering possibilities outlined by one of the LPs, a group of women from 12 different households drew up a plan to use 100 laying hens as a basis for food for the household, selling eggs in the community, and selling eggs in woven rush baskets to travellers passing on the highway. It was understood that the hens would need special care (a leaflet was produced by the LPs for guidance) and that some of the chicks reared from the eggs would be given to others wanting to continue the experiment. Although the cost of the hens was borne by the project, the group drew up their own formal request. After eight months, over 75% of the hens had survived and two-thirds of the eggs sold, locally and in the nearest (frontier) town. In the second action Anglo-Nubian goats were given to a group of five households of an isolated part of one community, Juntas, with the intention of experimenting with partly stall-fed goats and ultimately with improving milk production so cheese can be made. This action has only recently started.

Gender action

In the valley communities, women are active both in community actions and in forming groups that propose activities that specifically include women. In the altiplano community, women are more reticent and speak little in community meetings. Because it is they who customarily care for the principal livestock (sheep), they are participating fully in relevant livestock-based actions. One of the team of professionals is a woman and she is regularly consulted about women's affairs, whether or not they relate to project actions. This facilitates women being drawn into debates at general meetings about proposals and whether they adequately meet the needs of women. Even so, issues relating to domestic conflicts, often involving some of the poorest households, are discussed, particularly in the valley communities and LPs are regularly consulted about possible action that the community might take to help resolve such problems.

Links Back to NGOs and LPs

An important part of the strategy, to ensure that the acquired experience was available and used by other organisations and individuals, was the preparation and diffusion of technical reports. These reports were distributed among municipal offices, NGOs, in particular those who attended meetings that we organised (see below), and other projects working in similar areas. All reports and instructive literature for farmers are also freely available on the project website (http://www.geog.leeds.ac.uk/groups/andes/fragenv.htm). No evidence of their use in the town was collected but farmers in all communities have commented on the instructive sheets and often asked questions based on having studied them. We organised three meetings of government organisations and NGOs working in Tarija through their coordinating organisation United Nations Institute for Training and Research (UNITAR), where the results of the work were exchanged and issues of common interest addressed. Such meetings offer an opportunity of getting to know the project staff, questioning methods and actions, and learning about other work. The exact impact of such meetings is difficult to assess but some of the attendants remarked on the high value of such meetings, which are not often organised in Tarija.

The links with our main partner NGO (PROMETA) strengthened during the course of the project. Their work is conservation-led but small projects have developed within that framework to bring benefits to communities within the protected areas. While their professional staff are well trained and versed in conservation needs, their approach to community work is strongly top-down and community participation is seen as a probable outcome rather than a necessary precondition of actions. As field staff recognised the esteem with which rural people regarded our work in the communities, they consulted our LPs on strategies and for technical advice and requested visits from them during our routine work in the protected area. This resulted in our staff being asked by PROMETA to run workshops to explain our participatory methods and on best practice in facilitating community collaboration.

In a small urban centre, such as Tarija, much inter-personal communication between professionals takes place informally. Our Bolivian coordinator (Montaño) is well known and widely respected in the region and word-of-mouth contact has undoubtedly been the most effective way of both spreading information and learning how our work is viewed in the local 'aid' community.

Results After Three Years

The aim of the work reported here was to help people in poor rural communities to find ways to improve the use of natural resources by developing stronger links with local professionals (LPs). We can readily observe the consequences of different natural resource use strategies. The actions undertaken with the initial three communities during a period of three years have resulted in increases in production and active engagement in collective experimentation to find new possibilities for strengthening livelihoods.

The most striking results of community actions have been larger (5-15 fold) crops of peaches and grapes (Table 12.4). While individual estimates of pre-2000 harvests were made, estimates of current harvests are based on reports of the community groups. The yields in 2002 were similar to those in 2003.

Table 12.4: **Changes in fruit harvested (kilograms of fruit harvested per tree/vine)**

Community	Fruit	Before 2000	2003	Percentage Increase
Juntas	Peaches	2.35	30	128
Tojo	Peaches	4.62	30	649
	Grapes (on tree)	10.0	150	1500
	Grapes (on trellis)	1.0	5	500

Source: Data from community working groups

Veterinary work, following the identification of the range of livestock diseases affecting animals in communities, has focused on reduction of parasites. The programme of de-worming, which included initial sampling of faeces to determine the parasite load, was applied to a large proportion of livestock, mainly by the households owning them. Livestock are perceived in the communities as much healthier (better weight gain, lower mortality during the dry season) and there is recognition that this is the consequence of both individual and collective action to control disease (Table 12.5). There are no quantitative data to support this perception. Lower rates of de-worming in some communities are attributable to animals being absent for periods, grazing pasture in other communities, and therefore being less accessible for treatment.

Table 12.5: **Proportion of livestock de-wormed 2003**

Community	Cattle	Percentage de-wormed	Sheep	Percentage de-wormed	Goats	Percentage de-wormed
Juntas	458	79	40	88	559	77
Tojo	6	100	616	94	152	100
Chorcoya	293	100	14,991	51	0	
Atacama	59	93	74	59	202	89
Tacuarita	603	84	570	71	499	72
Rupaska			1962	70	633	56
Ñoquera	135	96				

Data from reports to veterinarian at community and group meetings

We developed farmer experimentation, for example, with fruit trees grown without irrigation and vegetables grown on the altiplano without greenhouses (invernaderos) that previous projects felt necessary as well as with collecting seeds from native pasture grasses (on the altiplano) to be sown in protected areas to improve forage availability during the dry season. Broad beans were successfully grown on the altiplano through sowing seeds at a greater distance apart than usual to maximise sunlight reaching the plants (see Montaño 2002)

Future research agendas have also been identified to engage problems that were identified to which there is no ready solution. Certain important livestock diseases, *Haematuria irritans* (probably linked to bracken eaten in the eastern forest pasture) and *Muyu muyu* (larvae of an insect causing spontaneous abortion when eaten inadvertently) – affect animals in all the communities to varying degrees, and strategies for disease avoidance are uncertain and unproven.

An important component of the work with every community was the incorporation into the debate and resultant actions of some of the households with fewest resources. In addition we tried to ensure that women as well as men and younger people as well as older people were part of debates about desirable changes. Some of the methods employed have been described. The assessment of the impact of changed natural resource use strategies cannot be seen adequately in one or two years and the impact on households with different levels of access to resources can only be judged on the basis of detailed household information covering the period before, during, and after the adoption of changed natural resource strategies. The ways in which the more powerful in communities dominate debate and ensure that they derive most benefit from changes cannot be overcome without fundamental changes in social relations. However, participation in de-worming of livestock in three communities for which we have good household data does not show consistent differences between households with very few or very many animals, suggesting an uptake that did not discriminate against the poor.

Actions with relation to households with few resources and communities as a whole have attracted the participation of women and men, although the balance reflects in part traditional divisions of labour. Because a number of men are absent, working elsewhere, women's roles in the valley communities are more important than they might otherwise be. In Tojo, women have held important posts in the community administration during the past three years and women's attendance at and participation in community meetings and workshops in other valley communities is noteworthy. Specific actions intended to help poorer households have included women, in particular single-parent households.

A principal objective of the research was to find ways of diversifying and strengthening the links between communities and LPs. The methods used have succeeded in creating a range of links with LPs. Firstly, personal links were established with the initial three communities. Many households are known by name and during visits, when passing along a road or a path people come to talk and discuss a range of topics, many of which have little relation to the work programme. This is a function of the feeling of friendship and quite different from contact designed to extract information or services. Contact on the basis of friendship and familiarity is a good basis for facilitating consultation on a range of issues and LPs are accustomed to being consulted as acquaintances as much as professionals.

A second level of linkages has been established through community members visiting the LPs' office in Tarija with less hesitation. Farmers come to the city infrequently but regularly. We have a record of 35 visits by rural people to our offices during 2002. This makes it easier for contacts with LPs to be proactive in response to farmer need rather than the farmer responding to a visit to their community by an LP.

A third level of link between farmers and LPs is through farmer experiments. Here the action is initiated in conjunction with the LP, but management of the action is largely in the hands of the farmer. Thus experiments in community (or group) gardens or nurseries are supervised by local farmers, and occasional visits by LPs serve as guidance or consultation rather than as a spur to action (Table 12.1). Clearly different levels of ownership of the experiments exist, reflecting the personalities involved in the work. The coming and going of people from the community working away sometimes make continuity of management difficult. The gardens in two valley communities (Tojo and Atacama) are notable for showing plenty of signs of independent community action between our visits. Plants are taken for planting elsewhere, some other seeds have been sown, and gardens are well maintained.

A fourth level of linkage for mutual support and encouragement is horizontal, between communities, independent from LPs. It is this level that demonstrates best the potential for an on-going process of extending knowledge to other households and communities as a sustainable action. In both Juntas and Tojo, partly on account of their location on roads with traffic, farmers come as a matter of course on business and to see what is happening in the fields and the gardens as well as for socialising. Evidence of inter-community consultation is fragmentary but it does occur, to borrow a sprayer, to check the dosage for de-worming small animals and to look at the new chickens and discover what their owners think about them. Inter-community meetings, such as for small farmers' union sub-centrales, and workshops organised by this project occur regularly and, although they are often for specific purposes, those attending observe new crops and other evidence of change and learn about new ideas and practices. It is necessary, therefore, to consider other channels that can be used to respond to the needs of rural households and communities and enable them to use the technical skills of LPs. Two such channels are the municipalities and the small farmers' union organisations.

Municipal Involvement in Development

In the past decade, municipalities have been given more power and a budget that can allow them to assist in realising at least some of the aspirations of their inhabitants. The chief executive officer of a municipality is the mayor. They are elected and candidates are selected by political parties. Although some municipalities have an excellent record of helping the development of projects for the benefit of the population and of obtaining further external funding, there is no cadre of professional public servants (even though such people now exist at national government level) and appointments to most posts in the mayor's office are political. Unless the same party remains in power for several terms, there is limited opportunity for the accumulation of experience by office holders who change after each election. Contracts for work and for relevant fact finding are awarded as much on the basis of friendship and political affiliation as the probability that the work will be well done. Even so, the municipality does have a development function and through its links with the departmental government it can participate in concerted actions.

Each municipality has to present an annual operation plan (AOP) that responds to the priorities expressed by communities in the municipality. Research to determine what communities want is carried out by social scientists and the reports are public documents. Nevertheless they are not necessarily the principal basis on which investment decisions are made (Hinojosa 2003). Infrastructural works far outnumber productive projects because they are more visible and more rapidly completed. New school buildings (with the mayor's name on a plaque on the wall recording his wise act in proposing it) are more common than school gardens or a project providing better quality breeding stock for sheep herders. Technical staff work for the mayor for short periods, usually linked to specific projects. Support staff are mostly for secretarial, accounting, and planning work, but some mayors appoint technical staff. Their role is to establish links with the rural communities and our LPs were invited to accompany a municipal professional in the field in order to discuss our methods of engagement with communities.

Community leaders do request assistance from the municipality to satisfy local needs but there is no clearly recognised way in which such requests are received and processed. Municipal responses do not even necessarily take account of the priorities in the AOP (Hinojosa 2003). The absence of a cadre of LPs working for the municipality limits its potential for linking communities.

Alternatives to Municipalities

Bolivia has one long-standing and politically powerful rural institution, the small farmers' union, established as part of the '1952 Revolution and Land Reform' throughout the highland and valleys. In the communities with which we collaborated, the monthly community meeting also served as the meeting of the small farmers' union (*sindicato*). Here reports on workshops and plans for future meetings were always discussed, as were other similar activities. The next level of the hierarchy of unions is the sub-central, where representatives of 15-20 communities report on national and regional union activities and discuss matters of common concern. Few NGOs use the sub-central as a means of communicating simultaneously with all the sindicatos in one area and only limited use has been made in Tarija of sub-centrales as intermediate organisations that can play a positive role in stimulating positive economic and environmental change. As Bebbington (1996) has noted, the general tendency in Latin

America is to focus on "community-level grassroots groups rather than regional organisations". A focus on sub-regional groupings, which sub-centrales are, is unusual. Discussions about the sindicatos actively stimulating actions to meet community needs were held at successive meetings of the sub-central for the Río San Juan communities but active cooperation seems difficult to achieve. This is mainly because communities are not accustomed to being consulted and asked to generate their own wish list for changes or problems that need to be overcome. They are more used to professionals arriving with their own list of actions than seeking an open discussion about community needs.

We believe that there is potential to use both small farmers' unions and municipalities, as administrative organisations in touch with communities in different ways, to assist in meeting their development needs. Discussions both with municipal staff and with leaders of small farmers' unions have suggested that this potential is recognised, but in the absence of prior experience of such a role, a stimulant such as a policy initiative from national government to encourage experimenting with such actions is unlikely.

Ways for LPs to Facilitate Change

Our work has demonstrated that changes in the use of natural resources can be facilitated and encouraged as a result of collaboration between people in rural communities and LPs. Such changes can help to make household livelihood strategies more sustainable and take into account the role of migration for causing labour shortages. Changes are also stimulated by the creation of good relationships between people in communities and LPs. The experience in south-west Tarija suggests that a series of elements may be key to such changes and provide ways by which other people and communities can also experiment on the basis of a sound link with LPs. These elements are described below.

Apply a bottom-up basic philosophy applicable and relevant to rural people, their livelihoods, and farmer experimentation

Acceptance of the primacy of local experience and farmer perception of issues relating to their use of natural resources by LPs is necessary in order to encourage people to be receptive to seek better ways of managing their resources. This bottom-up approach must also make available modern scientific knowledge as a basis for experimentation and not promote acceptance of practices proven elsewhere until it has been convincingly demonstrated that they are locally applicable.

The criteria used by rural people to evaluate new practices necessarily include the extent to which new practices can fit into the range of activities that comprise a household livelihood that incorporates work away from the community by men and women, in particular the young. Thus an apparently perverse avoidance of labour-intensive activities makes sense in the context of prolonged absence of many people from the community.

Participative workshops facilitated by sensitive LPs are still capable of producing priorities for changes in natural resource use but they may represent the views of only part of the community consulted. During the process of experimentation and continuous learning, it is important to visit households in different parts of the community to involve them in the exploration of alternative natural resource use strategies. This is an attempt for a bottom-up approach to truly represent the interests of all sectors and strata. Non-attendance at meetings and workshops does not necessarily indicate lack of interest. It may rather reflect social exclusion. It is undesirable to create a privileged group of innovators in the hope that their use of new practices will be imitated by others.

Use existing structures, NGOs, municipalities, and sindicatos in the context of work from the bottom up

An important principle that was adopted with some success was to use existing structures at a community level. The regular community meeting, usually organised by a group of leaders representing different organisations, is a natural forum to initiate debate and obtain feedback on community evaluation of project progress. Attendance at such meetings also reveals a wide range of community preoccupations.

The use of higher-level groups such as the sub-central of the small farmers' union and the municipality has been explored with less success. Not all small farmers' unions are accustomed to being proactive with regard to possible resource use change, but all, to a varying extent, are well linked to their grass roots membership. Municipalities are more highly politicised and regular changes of leadership and the arrival of a small new management team, which occur whenever a different party wins an election, make long-term continuity difficult. LPs were deeply sceptical of the ability of the newly organised regional structures to help the majority of small- and medium-scale producers (Hinojosa 2003). Even so such groups should always receive reports of community-level work and be invited to consider its relevance at a municipality level.

Scale up through local and regional fairs and radio broadcasts

By locating project work at a community level, for it to have a more widespread impact, it must reach other areas on the basis of propinquity and shared needs. In areas where inter- and intra-regional seasonal trade fairs remain an important economic and social institution, they can be used to spread knowledge about new practices. Broadcasting reports of community-level work also enables people from other communities to attend meetings and workshops in other communities. This helps rural people learn from each other's experience.

Potential Roles for LPs

The potential role of LPs such as agronomists, veterinarians, and entomologists, is much more varied than that which most professionals currently occupy. While rural teachers, perhaps by virtue of residing in rural communities, often fill a variety of roles in their community, LPs usually live in the city or at least on an agricultural experimental station and travel to communities for clearly defined purposes that are not usually open ended. They often come to perform a specific task set by the organisation of which they are part. Their capacity to respond to individual or community needs is thereby circumscribed.

Some LPs have a deep commitment to working for communities and are good at listening to local people's views and needs. Many act in response to community needs irrespective of their organisationally defined task. They are willing to learn from community or individual experience and compare the experiences of the many areas in which they have worked. The value of such human resources needs to be more explicitly recognised. It is highly desirable that, from a rural community point of view, such professionals can be willing to act outside their organisational role in order to work even more effectively with local people.

Employers of LPs can gain from them having varied roles. NGOs, municipal departments, and national government organisations can enable and even encourage LPs to fulfil their primary roles effectively, but also to recognise that it is possible to achieve even more by being willing to act in a wider variety of ways, using both professional and personal skills.

The LPs themselves can also help to strengthen their links with rural communities by understanding that the esteem in which they are held by both rural people and the organisations that employ them can be maximised by being willing to listen to and act with rural people. The responsibility for realising these potential roles lies equally with the professionals themselves, who should promote their ability to fill a broader role, and with the organisations that employ them: they should recognise the benefits of having a cadre of skilled professionals, able to fill a variety of roles and thereby capable of adapting to the specific needs of each new task or project to which they are assigned.

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13 THE USE OF BIOPHYSICAL AND SOCIOECONOMIC TOOLS IN SOIL FERTILITY AND ORGANIC MATTER

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Abstract

Agriculture is the main source of livelihood for most people in hillside areas of Nepal, and soil fertility is largely maintained through the use of organic manure. Discussions with farmers indicated five principal soil fertility management practices (manure, chemical fertiliser, compost based on leaf litters, growing legume crops, and in-situ manuring). Farmers identified five soil productivity indicators (crop productivity, soil characteristics (particularly soil colour), management requirement, species of weeds, diseases, and pests, and termites). Historical trends (increasing crop intensification, decreasing livestock numbers, increasing use of chemical fertilisers, reduced labour availability, and change in the climate over the last 30-40 years) showed a decline in soil productivity. Scored causal diagrams on soil fertility drawn from focus group discussions indicated that the primary causes of declining soil fertility and crop productivity are a decrease in available manure, increased cropping intensity, low use of chemical fertilisers, and change in climate.

Scientific evaluation confirmed that altitude, farming system, and land types affected the availability of soil nutrients. Organic C, total N, available P and exchangeable K increased in less intensive farming systems, which were at higher altitudes. These nutrients as well as available Fe, Mn, and B in soil significantly increased in rainfed upland (bari) compared with irrigated lowland (khet). Covering manure with black plastic sheets resulted in faster decomposition as well as increased total N and exchangeable K. Covered manure applied to summer rain-fed maize and upland rice as well as irrigated lowland spring maize increased grain and straw yields between 13% and 36% when compared with uncovered manure.

Both farmers' indigenous knowledge and their criteria were as useful as scientific evaluation in assessing soil fertility improvements. Therefore, farmers' knowledge and criteria should be considered when monitoring soil fertility and crop productivity in farmer trials.

Introduction

The hills of Nepal cover a range of agroecological zones within which agricultural production is determined by a combination of altitude (400-3500 masl), rainfall (1500-

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5000 mm/year) and aspect (Turton et al. 1996). Farming systems in the hills are characterised by the inter-relationship between crops, livestock, and forestry, where soil fertility is largely maintained by application of farmyard manure (FYM) and compost (Sthapit et al. 1989; Riley 1991; Subedi and Gurung 1991; Tamang 1992; Gregory 1995; Turton et al. 1996; Vaidya et al. 1995; Mathema 1999; Shrestha et al. 2000). Trees and crops provide fodder and bedding materials for livestock and livestock provide draft power and manure for crops. Field surveys have shown that application of FYM, compost, chemical fertilisers, and soil nutrients carried down from the forest and villages in the first spring flood water, inclusion of a grain legume in the crop rotation, mulching with weeds, forest litter, or crop residues, use of short fallows, slicing and burning of terrace risers, in-situ manuring, green manuring, burning of trash, and collecting leaf litter are practices used by the farmers to maintain soil fertility in the hills (Suwal et al. 1991; Joshi et al. 1994; Joshi et al. 1995). However, organic manure mixed with bedding materials is the main source of nutrients.

Important recent changes in rural Nepal include: reduction in livestock numbers, forest degradation, reduced labour availability, community forestry development, and stall feeding of cattle (Turton et al. 1996). Many farmers feel that continuous application of chemical fertilisers without addition of FYM is causing the soil to deteriorate and crop productivity to decline (Mathema 1999). Soil and nutrient losses by erosion and leaching have also contributed to a decline in soil fertility (Tripathi 1999; Tripathi et al. 1999). A search for soil fertility improvements needs to incorporate social as well as technical factors if improvements for farmers are to be realised (Gregory 1995).

Hence the objectives of this study were to develop simple robust methodologies for assessing soil fertility taking into account both biophysical and socioeconomic factors. The project has worked closely with farmers using both farmers' and scientific knowledge to assess soil fertility-enhancing technologies that farmers have selected themselves.

Materials and Methods

Farmer evaluations

Farmers' perceptions of soil fertility and selection of soil fertility enhancing treatments

Participatory rural appraisals (PRAs) were conducted in four different agroclimatic zones: Bhakimli (600-2200m, high hill), Upper Pakuwa (1000-1600m, mid hill), lower Pakuwa (600-1000m, low hill), and Chambas (<600m river basin), to gain an appreciation of farmers' perceptions of soil fertility, management practices, and crop productivity trends. In each area, groups of 15-20 farmers (men and women) participated in group discussions and as part of a participatory process were invited to test improved soil fertility management options that they considered suitable for their conditions. Farmers from each of these areas visited the Agricultural Research Station, Lumle (ARS/Lumle) to discuss and view the options available. As a result they chose to test the use of plastic sheets to see if this improved manure quality and increased crop yields as well as to compare leaving legume crop roots in the soil rather than removing them before planting the next crop.

The participatory process included the use of scored causal diagrams, transect walks, pair-wise ranking of alternative soil fertility technologies, historical trends analysis, and resource ranking of farmers. The processes were important for building relationships with farmers that provided further opportunity to work closely with them in a joint evaluation of the soil fertility enhancing options.

Farmers' evaluation during FYM decomposition

This involved continuous assessment of manure decomposition using farmers' criteria, both individually and as groups, to see if there were differences between covered and uncovered FYM. The criteria were colour, smell, moisture content, rate of decomposition, uniformity of manure, temperature, texture (hard or soft), weight of the manure, and some indicator of quality as the manure was moved to the field. During transport from the heap or pit to the field and while spreading and incorporating the manure, farmers noted any increase or decrease in labour requirement.

Testing black-plastic covered and uncovered FYM

In all the four agroecological zones, farmers tested black-plastic covered and uncovered FYM on either summer maize or upland rice in rain-fed upland (bari) and spring maize in irrigated lowland (khet) applied at the normal rates used by farmers This trial was undertaken by 10 farmers in each zone on an area of $100m^2$. During the crop growth period, farmers judged crop performance and recorded their observations at different growth stages. At maturity the crop was harvested separately from each plot and yields recorded. All farmers considered the cost of the black plastic at NRs 50[3] affordable, many indicating that they could in fact use other material that would cost nothing.

Farmers' evaluation during the growth of the crop and mid season

Differences in crop condition were noted (1) at crop emergence – colour and crop stand, (2) at first weeding – plant stand, (3) at tasselling – stem thickness, colour, and size of ear were compared together with any difference in termite damage, and (4) at harvest – the weights of grain and straw were established. Grain and straw yields were sampled from the whole plot and yields/ha determined at 12% moisture content. Further comparative soil analysis was undertaken after harvest to determine any residual soil fertility differences in farmers' plots.

Farmers' field days

Before crop harvest, farmers organised field days facilitated by researchers at each site to show the response of the covered and uncovered manure in upland rain-fed summer maize and upland rice and spring maize. Representatives of the District Agriculture Office, non-government organisations (NGOs), chairmen of the Village Development Committees, high-school head teachers, and district-level media representatives were invited and interacted with local farmers. At each site, three to four groups of farmers (men and women) with a leader nominated by each group presented their group findings.

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3 In 2002 US$ 1 = NRs 78

Scientific evaluation

Field survey

Two-hundred-and-sixty composite surface soil samples (0-20 cm) were collected representing river basin, and low, mid, and high hills of both rain-fed upland and irrigated lowland. The samples were collected from different areas of Tanahun, Gorkha, Parbat, Myagdi, and Palpa districts. Information on altitude, aspect, land form, land type, soil colour, drainage, soil type, fertility rating, and distance from a motorable road were gathered.

Laboratory analysis

Samples were air dried, crushed, and passed through 2 mm sieves. Soil pH (1:2.5, soil:water), organic C (Walkley-Black), total N (Kjeldahl), available P (Bray and Kurtz), exchangeable K (1M ammonium acetate extraction), and available B (hot water extraction) were analysed in the laboratory of ARS/Lumle. Available micronutrients (Zn, Fe, Mn, and K) were analysed in Cemat Water Laboratory, Kathmandu, Nepal, using an atomic absorption spectrophotometer.

Testing improvements in the quality of FYM

Existing manure heaps or pits were divided into two equal halves. Half of the FYM was covered with a black plastic sheet and the remaining half was left uncovered as normal. Each day from November 2000 to February 2001, farmers placed equal amounts of FYM either under the plastic covered or on the uncovered pits or heaps. Comparative nutrient analysis of covered and uncovered FYM was made at the time of FYM application in the field. In March, after 3 months of preparation, plastic-covered and uncovered FYM samples were collected from each farmer before field spreading and analysed for pH, and N, P, and K content. In total, 40 samples (10 from each area) were analysed in Lumle laboratories. At the same time soil samples were analysed for each farmer's test plot before the manure was spread to ensure that there were no major differences in soil fertility between treatment plots.

Results and Discussion

Participatory analysis

Farmers' perception of soil fertility management

The group discussions identified five principal soil fertility management practices, namely manure mixed with leaf litter and bedding (FYM), composts (primarily leaf litter), legumes either grown on their own or intercropped, chemical fertilisers, and one method of in-situ manuring sometimes used in Bhakimli but now declining in practice. Although there were slight differences between the four areas, FYM was regarded as the best source of soil fertility, chemical fertilisers ranked second, composts third, and legumes fourth (Table 13.1).

At Chambas and Lower Pakuwa, chemical fertiliser was given as high as or higher priority than manure, as a result of more intensive cropping systems and greater

Table 13.1: **Summary matrix ranking of the main soil fertility management practices**					
Inputs	**Chambas**	**Lower Pakuwa**	**Upper Pakuwa**	**Bhakimli**	**Overall Rank**
Manure					
Organic matter added to manure	1	2	1	1	1
In-situ manuring	NU	NU	NU	5	5
Compost					
Primarily leaf litter	3	3	-	3	3
Legumes					
Beans, black gram, soybean, cowpea, pea, interplanted or relay cropped	3	4	3	4	4
Chemical fertilisers					
Primarily DAP and urea	1	1	2	2	2
Note: 1=most preferred, 4=least preferred, NU=not used, DAP = diammonium phosphate					

availability of khet land. Where bari land predominated, manures were seen as the best option. The use of compost was seen as necessary to supplement when FYM and chemical fertiliser were unavailable or unaffordable.

Farmers' indicators of soil fertility

Focus group and individual farmer discussions in the case study areas provided more detail with farmers' descriptions of higher and lower soil fertility and productivity against each indicator. It was confirmed that farmers use a variety of inter-related criteria to characterise their soils with soil colour being dominant. Other factors included texture, depth consistency, internal drainage and moisture retention capacity, temperature regime, slope, aspect and elevation, and management implications (such as source of water, labour requirement, compost and/or chemical fertiliser required, and yield), all related to soil health and production potential. In fact, farmers considered that with sufficient water, manure, and labour, and a suitable climate and appropriate management, any soil can be made fertile and productive.

Pair-wise ranking of these criteria by farmers provided detail on the priorities for each indicator. This differed slightly from area to area but overall the highest ranking was given to indicators associated with crop productivity, especially crop growth, followed by soil characteristics, especially soil colour and hardness, management requirements, pests, and manure requirement (Table 13.2).

Productivity trends observed by farmers

Historical trends observed by farmers included (1) increasing intensification over the last 30 years; (2) decreasing livestock numbers and therefore insufficient manure for all crops; (3) increasing use of chemical fertilisers with increasing problems of soil hardness and ploughing difficulties; (4) reduced labour availability due to children being at school, young people not wanting to work on farms, increasing migration, and an ageing rural population; (5) an increase in pests due to intensification; and (6) a change in climate with rain no longer falling at the most optimal time, resulting in increased soil erosion (Box 13.1).

Table 13.2:	Indicators and ranking identified through pair-wise ranking in farmer discussion groups						
	Indicator	**Lower Pakuwa**	**Upper Pakuwa**	**Chambas**	**Bhakimli**	**Average**	**Overall Rank**
Crop productivity	Crop yield	2	6	3	3	3	1
	Crop growth and colour	4	1	1	1	2	
	Grain fill	1	3			2	
	Late rice/early maize	8	3			8	
	Taste of grain		3			3	
Soil characteristics	Soil colour	3	6	3	3	4	2
	Soil depth		8			8	
	Soil hardness	10	5	6	3	6	
	Soil moisture	8	1	7	6	5	
Management requirements	Ease of work	4				4	3
	Labour requirement	6	10			8	
	Ploughing time			1		1	
	Manure requirement	6				6	
Indicator species	Weeds	10	9	3	2	6	4
	Diseases and pests		10	9	7	8	
	Termites			8		8	
Note: 1=most preferred, 10=least preferred							

Reasons for declining productivity

Scored causal diagrams derived from focus group discussions held in each agroecological site indicate that the primary causes of declining productivity and soil fertility were a decrease in manure availability (ranging from 50-75% depending on area), increased cropping intensities (30%), low use of chemical fertilisers (10-25%), and a change in climate (more erratic rainfall). Other primary reasons included an increase in cropping intensity with reduced fallows, lack of irrigation (at Chambas, Tanahun), and low adoption of improved technologies.

An example from Lower Pakuwa shows the relative percentages of causal factors for each primary cause (Figure 13.1). In this situation, the reasons for lack of manure included lack of labour (18-50%) (due to out migration, children being at school, and young people not wanting to work on farms), and insufficient livestock (due to inadequate fodder, cash, and labour to look after the livestock). The reasons for low use of chemical fertiliser (10-25%) included high cost, non-availability, transport problems, increased soil hardness, the need to apply increasing quantities, as well as inadequate knowledge of their use.

The views of men and women were difficult to distinguish because they wished to participate and contribute as a community rather than as sub-divisions of their communities.

Box 13.1: **Historical trends**

Intensification

- 30 years ago only rice was grown on khet land and maize-millet on bari land. Now there are three crops on khet (rice, maize and wheat) and three crops on bari (maize, millet, wheat).
- With one crop, production was very good; as more crops have been grown, productivity has declined. The increase in crop production occurred as a result of rapid population growth.
- 30-40 years ago, there was fertile soil due to high organic matter but now it has decreased due to deforestation.

Livestock Numbers

- 30-40 years ago there were more livestock. The rich had many animals but everyone has the same now.
- Farmers used to apply only organic fertiliser but now farmers are using chemical fertiliser.
- Animals used to be grazed on fallow lands, now they are controlled.
- Lack of grazing land has caused a decrease in number of livestock.
- Due to community forestry restrictions the number of livestock has decreased. Animals are all stallfed now.
- There is insufficient manure for all crops, so rice yield has decreased compared with 30 years ago.

Chemical Fertilisers

- Soil becomes bad if only chemical fertilisers are applied. If both manure and fertiliser are applied it is good for soil fertility.
- Now DAP and urea are used for wheat.
- When urea is used alone in high quantities, the crop lodges but with a mixture of FYM and urea, there is a good crop. If urea is not used, there is low yield.

Labour Availability

- Labour has decreased due to children being at school. Young people do not want to work in the field.
- More people migrate looking for work.
- Now there are only old people living in the villages.

Change in Climate

- Rain no longer falls at the most optimal time. There used to be more winter rain and snow.
- 30-40 years ago, it used to rain on time but now the weather is reversed.
- Hailstones sometimes damage crops.
- Soil erosion is increasing.

Increase in Pests

Insect pests have increased because three crops are now grown per year.
Crops do not ripen well because of high cropping intensity.
Post-harvest losses have increased.

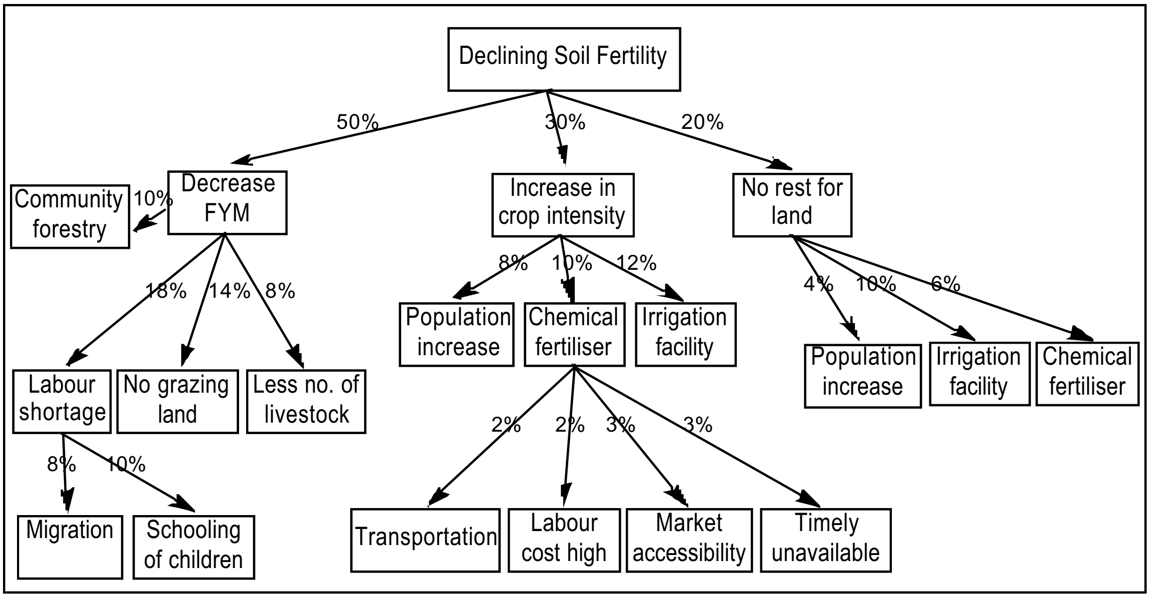

Figure 13.1: Scored causal diagram (Lower Pakuwa, Parba)

Farmer's field days

Eighty farmers took part in farmers' field days at Chambas and 35 farmers each at Pakuwa and Bhakimli. The group leaders at the three sites reported similar comments after visiting the field demonstration. They indicated that the covered manure resulted in better crop growth than the uncovered manure and that residual effects of the previous season's legume roots (black gram and peas) resulted in better crop growth than when legume roots had been removed. This indicates that the roots of legumes enhanced soil fertility from the previous season.

Scientists' evaluation

Impact of altitude and farming system on plant nutrients

This is not the effect of altitude, it is the impact of altitude on the farming system, which influences use and therefore nutrients. As altitude increases, the temperature decreases and the cropping intensity decreases. Thus the utilisation of plant nutrients slowly decreases as we go higher up. Soil pH, organic C, total N, available P, and exchangeable K were affected by altitude and the farming system at that altitude (P=<0.001). The highest pH (6.1) was recorded at <600m altitude. Organic C, N, P and K values increased at higher altitude (Table 13.3). Altitude did not affect the micronutrients (Zn, Fe, Mn, and Cu) except B (P=0.05), which increased at higher altitudes.

Effect of land types on plant nutrients

Organic C, available P, exchangeable K, and available Fe, Mn, and B differed significantly (P=0.01-0.001) (Table 13.4) between lowland and rain-fed upland; but pH, total N, and available Zn and Cu did not (P = 0.11-0.44). Organic C, available P, exchangeable K, and available Fe, Mn, and B in soil were significantly higher in rain-fed upland than in lowland, indicating that rain-fed uplands are more fertile than lowlands

Table 13.3: **Plant nutrients at different altitudes in the western hills**										
Altitudes m	**pH**	**Organic C (%)**	**Total N (%)**	**Avail-able P (mg/ kg)**	**Exchange-able K (cmol/kg)**	**Avail-able Zn (mg /kg)**	**Avail-able Fe (mg/ kg)**	**Avail-able Mn (mg/ kg)**	**Avail-able Cu (mg/ kg)**	**Avail-able B (mg/ kg)**
<600	6.05	1.07	0.15	30.2	0.40	0.91	174.0	46.3	1.29	0.50
600-1000	5.80	1.59	0.17	43.8	0.32	1.05	179.4	55.9	1.42	0.55
1000-1600	5.64	2.24	0.22	98.1	0.42	0.87	194.6	61.5	1.59	0.65
1600-2200	5.66	2.90	0.27	202.2	0.45	0.85	174.2	68.4	1.68	0.66
Mean	5.79	1.95	0.20	93.6	0.40	0.92	180.6	58.0	1.50	0.59
SD	0.11	0.13	0.01	18.1	0.06	0.16	10.5	10.5	0.29	0.07
P-value	0.001	<0.001	<0.001	<0.001	0.10	0.56	0.10	0.30	0.56	<0.05

Table 13.4: **Effect of land type on plant nutrients in the western hills**										
Land type	**pH**	**Organic C (%)**	**Total N (%)**	**Avail-able P (mg/ kg)**	**Exchange-able K (cmol/kg)**	**Avail-able Zn (mg /kg)**	**Avail-able Fe (mg/ kg)**	**Avail-able Mn (mg/ kg)**	**Avail-able Cu (mg/ kg)**	**Avail-able B (mg/ kg)**
Khet	5.72	1.82	0.20	63.3	0.22	0.98	163.4	30.4	1.41	0.51
Bari	5.80	2.13	0.21	116.1	0.52	0.88	195.5	78.3	1.58	0.65
Mean	5.76	1.98	0.21	89.7	0.37	0.93	179.5	54.4	1.50	0.58
SD	0.070	0.123	0.010	14.7	0.036	0.112	7.2	6.7	0.20	0.05
P-value	0.32	0.013	0.114	<0.001	<0.001	0.34	<0.001	<0.001	0.4	0.004

Testing quality improvement of manure

Mean N, P, and K content of each of the ten samples of covered and uncovered manure at Chambas, Pakuwa, and Bhakimli are presented in Table 13.5. Manure analysis indicated that N, and K content tended to be higher in covered manure, confirming that covering manure did enhance the nutrient content, most probably through a reduction in gaseous and moisture losses. P content was similar in both the samples. Farmers indicated that 3-month-old covered manure was equivalent to 10-month-old uncovered manure indicating faster decomposition when covered.

Table 13.5: **Mean, N, P, and K content of plastic covered manure and uncovered manure at four agroecological zones**						
Agroecological zones	**N (%)**		**P (%)**		**K (%)**	
	Covered	**Uncovered**	**Covered**	**Uncovered**	**Covered**	**Uncovered**
Bhakimli (high hill)	2.19	2.07	0.62	0.57	1.99	1.98
Upper Pakuwa (mid hill)	1.56	1.3	0.38	0.34	1.93	1.79
Lower Pakuwa (low hill)	1.57	1.44	0.37	0.41	1.81	1.38
Chambas (river basin)	1.42	1.39	0.58	0.58	1.87	1.68
Mean	1.69	1.55	0.49	0.48	1.90	1.70

Effect of covered and uncovered manure on crop yields

Covered manure produced significantly higher yields on bari land (7.01 t/ha) than uncovered manure (6.05 t/ha) at Bhakimli (Table 13.6). Similarly, significantly higher yields of maize on bari were recorded with covered manure at Upper Pakuwa (1.44 t/ha compared with 1.06 t/ha for uncovered manure). However, spring maize grain yields on khet at Lower Pakuwa were not significantly increased although covered manure overall gave on average a greater yield (2.99 t/ha compared with 2.65 t/ha). At Chambas, upland rice grain on bari using covered manure gave a significantly higher yield (3.34 t/ha compared with 2.77 t/ha). An increase in straw yields was also noted.

Table 13.6: **Mean grain and straw yields of summer maize in bari (Bhakimli, Upper Pakuwa), spring maize in khet (lower Pakuwa), and summer upland rice in bari (Chambas)**				
Agroecological Zones	**Grain Yield (t/ha)**		**Straw Yield (t/ha)**	
	Covered	**Uncovered**	**Covered**	**Uncovered**
Bhakimli (bari)	7.01	6.03	-	-
Upper Pakuwa (bari)	1.44	1.06	9.82	7.48
Lower Pakuwa (khet)	2.99	2.65	10.24	8.33
Chambas (bari)	3.35	2.77	3.84	3.29
Mean	3.70	3.13	7.96	6.37

Conclusions

We can draw three sets of conclusions from this work.
Farmers have an in-depth knowledge of their soils; they use a large number of inter-related indicators related to crop growth, soil characteristics, and management requirements for planning and managing their crops. They are also aware of the factors contributing to declines in soil and crop productivity and are keen to try out soil fertility-enhancing technologies appropriate to their situations. As a result farmers selected low-cost soil fertility-enhancing options to improve crop productivity.

Manure prepared by covering with black plastic and applied to rain-fed summer maize and upland rice as well as irrigated spring maize increased grain as well as straw yield by 13-36% and 17-31% respectively. Leaving pea root residues in the soil (not uprooting) increased both maize and stalk yields by 26% and 3% respectively in the high hill conditions of Bhakimli (Myagdi). Organic manure/compost is necessary for conserving soil moisture, maintaining soil fertility, and sustaining or increasing crop productivity in maize-finger millet, rice-wheat, and upland rice-black gram systems.

Farmers' assessment and scientists evaluation of soil fertility management led to similar conclusions. This means that farmers' criteria can and should be used in farmer testing of soil fertility enhancements.

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14 INTERVENTIONS TO MINIMISE NUTRIENT LOSSES FROM BARI LAND (RAIN-FED UPLAND) IN THE MIDDLE HILLS OF THE WESTERN DEVELOPMENT REGION OF NEPAL

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Abstract

Bari land (rain-fed upland bench or sloping terraces) in Nepal is increasingly becoming a focus of concern in terms of soil fertility decline and management. Understanding the circumstances leading to high erosion and leaching losses, and the areas particularly affected by high losses, are essential prerequisites for attempting to improve soil conservation. Participatory research was conducted with farmers in three contrasting agroecological regions: Nayatola (20-25° slope, l000-1500 mm annual rainfall); Landruk (bench terraces 0-5° slope, 3000-3500 mm annual rainfall); and Bandipur (bench terraces 0-5° slope, 1100-1500 mm annual rainfall). The research aimed to develop soil and water management interventions that control erosion without resulting in high leaching and so are effective in minimising total nutrient losses. Interventions tested include the control of water movement through diversion of run on, planting fodder trees and grasses on terrace risers on bench terraces in high rainfall areas, and strip cropping in non-terraced sloping fields of low to medium rainfall areas. The interventions were effective in reducing soil loss from bari in comparison with existing farmer practices, but no effect was observed on nutrient losses in solution through runoff and leaching.

Introduction

Bari land comprises non-irrigated terraces on flat and sloping lands, and occupies most of the cropped area in the middle hills of Nepal. The function of the terraces is to maximise water availability within the physical constraints of the slope and the cropping pattern (Carson et al. 1986). The eastern part of the country has narrow bench terraces with low slope angles and the western part has large outward sloping terraces. Maize (*Zea mays* L.) is the main crop on bari and occupies 667,000 ha in the country, 192,940 ha in the western development region alone (Joshi 1998). However, soil fertility is declining in bari, thought primarily to be due to low applications of farmyard manure and soil erosion (Turton et al. 1995). Maize cultivation practices accelerate surface soil loss. Soil losses from rain-fed terraces and sloping farmland vary from 5 to 20 t/ha per year, with organic matter, nitrogen, phosphorous, and potassium losses of 150-600, 7.5 - 30, 5-20, and 10-40 kg/ha per year respectively (Partap and Watson 1994). In the

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study area, Gardner et al. (2000) reported that the greatest erosion was from bench terraces in a high rainfall area (Landruk, of Kaski District) and the least from sloping field cultivation in a low rainfall area (Nayatola, Palpa). They recorded soil losses in surface runoff of 2.5 t/ha per year, the losses of nitrate-nitrogen and potassium through runoff were comparatively low but losses through leaching were 45 and 180 kg/ha per year respectively.

A wide range of soil and nutrient conservation technologies are available that are appropriate to the Nepalese middle hills. Underseeding of white clover into maize fields considerably reduces surface runoff during May to June (when rainfall erosion is low) without decreasing maize yields (Goeck et al. 1989). Better soil cover in the crop fields improves water infiltration and increases crop yields by reducing erosion and stabilising soil minerals and organic matter (Barry et al. 1995). Grass strips are found to be useful for reducing soil loss in runoff (Lewis and Nyamulinda 1996). The adoption of technology depends upon the local farming environment. The intercropping of legume crops, mulching, and diversion of runon water from fields are practised in hill farming. Selecting technologies on the basis of local crop management could control soil erosion and lead to wide adoption. The main objective of this study was to investigate the effect of traditional cultivation practices on soil fertility and the effectiveness of locally appropriate technologies for maintaining inherent soil fertility of bari land in the middle hills of the western development region by controlling nutrient losses in solution form and in sediment movement.

Methodology

Site selection

Participatory research was conducted with farmers on bari land in three contrasting agroecological regions in the middle hills of the western development region of Nepal (Figure 14.1). On the basis of the survey results, Landruk was selected as a site representative for high rainfall areas with bench terracing cultivation systems. Nayatola was selected for low to medium rainfall with sloping land cultivation systems, and Bandipur was selected for low to medium rainfall with diversified cropping systems. The main features of these sites are given in Table 14.1.

Table 14.1: **Characteristics of the research sites**

Sites	Terrace slope angle	Rainfall (mm)	Common cropping systems
Landruk	0-5°	3000-3500	Maize/millet or maize + legume/wheat or barley + mustard
Nayatola	20-25°	1000-1500	Maize/wheat or barley + mustard + winter legume
Bandipur	0-5°	1100-1500	Maize-fallow-fallow or upland rice-blackgram and citrus orchard

Experimental design

Interventions were chosen by participatory rural appraisal and local knowledge acquisition. The interventions were designed to test basic principles of the relative influence of runoff and runon in causing nutrient loss and the relative merits of barrier and cover effects in the prevention of such losses in different conditions. A limited range of farmers were involved in the testing of interventions, because of the necessary costs

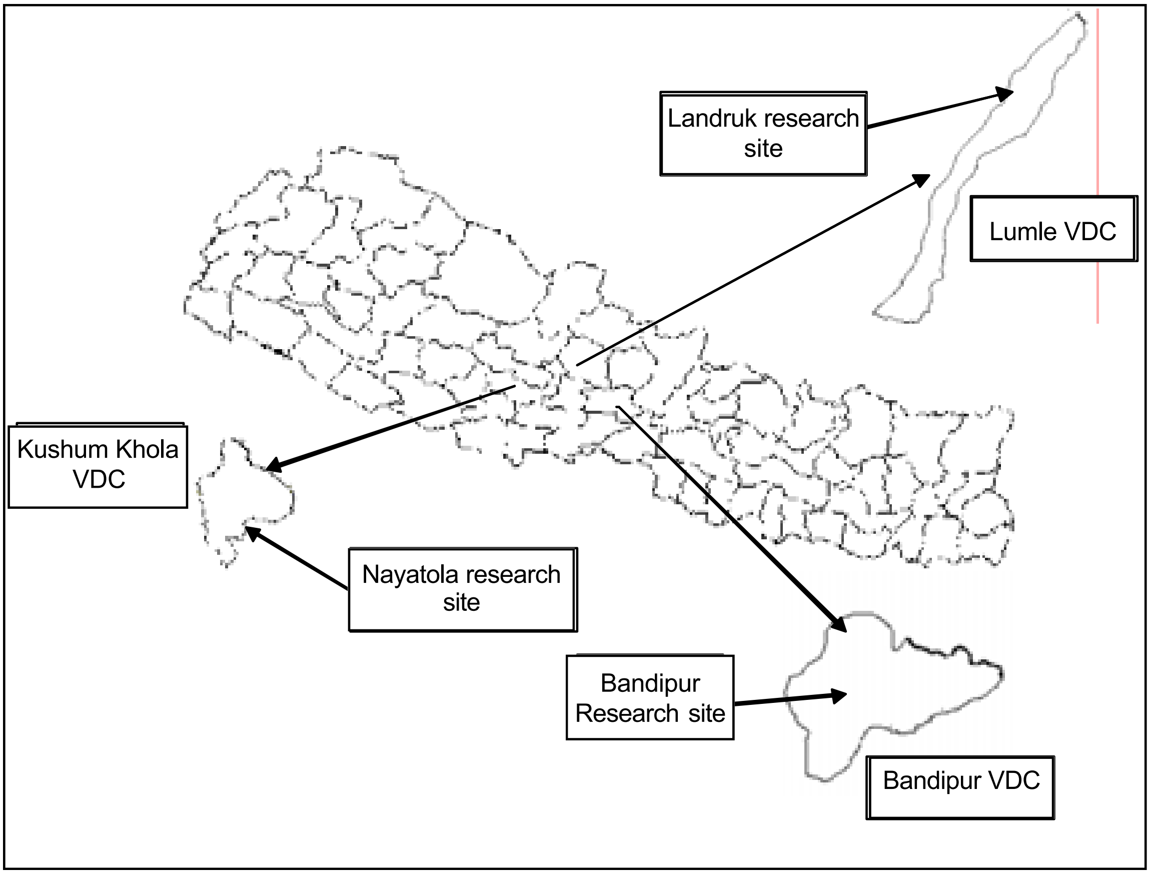

Figure 14.1: **Map of Nepal showing research sites**

and rigour of experimentation. However, a broader spectrum of interventions and farmers were involved in less rigorous farmer-managed trials (Shrestha et al. this volume). The interventions tested at different sites and crops are given in Table 14.2. Plots were 20m by 5m (long axis down slope) and replicated in 5 blocks at Landruk and Nayatola. *Setaria anceps* was planted in the terrace risers and *Flemingia congesta* was planted on the top of the riser in the second intervention at Landruk. *Flemingia congesta* did not perform well, because of its slow initial growth under Landruk's climatic conditions. Thus, in the next year only *Setaria* was planted across the whole riser. At Nayatola, strip crops were compared with the farmers' practice. Observations of soil and nutrient losses from different existing farming systems were continued in previous soil erosion research plots (Gardner et al. 2000) at Bandipur. The interventions were compared with the farmers' practices in which maize was grown without strips (Nayatola) and maize was grown without diversion of runon and with native grass (not planted) in terrace risers (Landruk).

Measurement of rainfall, runoff, erosion, and leaching

Surface runoff volumes and nutrient content were monitored on a weekly basis in standard runoff plots. The experimental plots were enclosed by metal sheets on all sides to prevent lateral water movement (except for the upper border in the open plots at Landruk). The edge of the metal sheet was raised about 0.3m above and extended 0.2m below the surface of the soil. A 5m long trough was located at the lower end of

Table 14.2: **Treatment combinations studied at different sites**

Sites	Treatment	Crops 2000	Crops 2001	Crops 2002
Landruk	Runon diversion	Maize/millet (*Eleusine coracama*)	Maize/naked barley (*Hordeum vulgare Var. nudum*)	Maize/millet
	Runon and grass planting in terrace risers	Maize/millet	Maize/naked barley	Maize/millet
	Control (runon in farmers' practice)	Maize/millet	Maize/naked barley	Maize/millet
Nayatola	Maize + ginger (with mulch) Strip cropping	Maize and ginger (*Zingiber officinale* Roscoe)	Maize and ginger	Maize and ginger
	Maize + legume strip cropping	Maize and cowpea (*Vigna ungulata*)	Maize and soybean (*Glycine max* (L.))	Maize and field bean (*Phaseolus vulgaris*)
	Farmers' maize practice (control)	Maize	Maize	Maize
Bandipur	Wide terraced	Maize-fallow	Upland rice fallow	Maize-fallow
	Young citrus orchard	Maize and soybean intercropping	Maize and cowpea intercropping	fallow
	Narrow terraced, maize based	Maize-fallow	Maize-fallow	Maize-fallow
	Narrow terraced, maize based	-	Maize-fallow + grass planted in risers	Maize-fallow + grass planted in risers
	Old citrus orchard	Fallow	Fallow	Fallow

the plot and connected with polythene pipe to a drum, in which total runoff from the experimental plot was collected. Eroded sediment was estimated in runoff samples of 0.5 l collected from each drum after vigorous stirring. A sample of clean solution from the last drum containing runoff was also taken for nutrient analysis. Infiltrated water was collected in lysimeters constructed and inserted in such a way as to collect leachate from the top 40 cm layer of the soil. They were constructed from polythene pipes of 11 cm diameter and 25 cm length and filled with soil. A leachate collection cup was fitted in the end of the pipe and 2 small, soft tubes of 5 cm diameter passed out through the pipe, remaining above the soil surface and allowing leachate to be pumped out. These lysimeters were inserted in the runoff plots (3 per plot) 15 cm below the surface of the soil. Rainfall amounts and intensities were recorded over the monsoon period (May-October) using both automated and manual recorders.

Results

Leachate and nutrient losses

At Landruk, the total annual rainfall was 3193 mm in 2000, 3691 mm in 2001 and 3440 mm in 2002 (Figure 14.2). The total leachate was higher in closed plots than in open plots, though the differences were only significant in 2000 (Figure 14.3).

In closed plots, the losses of nitrate-nitrogen (N) and exchangeable potassium (K) due to leaching were higher in all the seasons of 2000 (early, mid, and late) than in the farmers' practice (Table 14.3) (although not at a significant level [$P = 0.29$]). This was due to the fact that there was no control of rainwater in the farmers' practice, whilst the

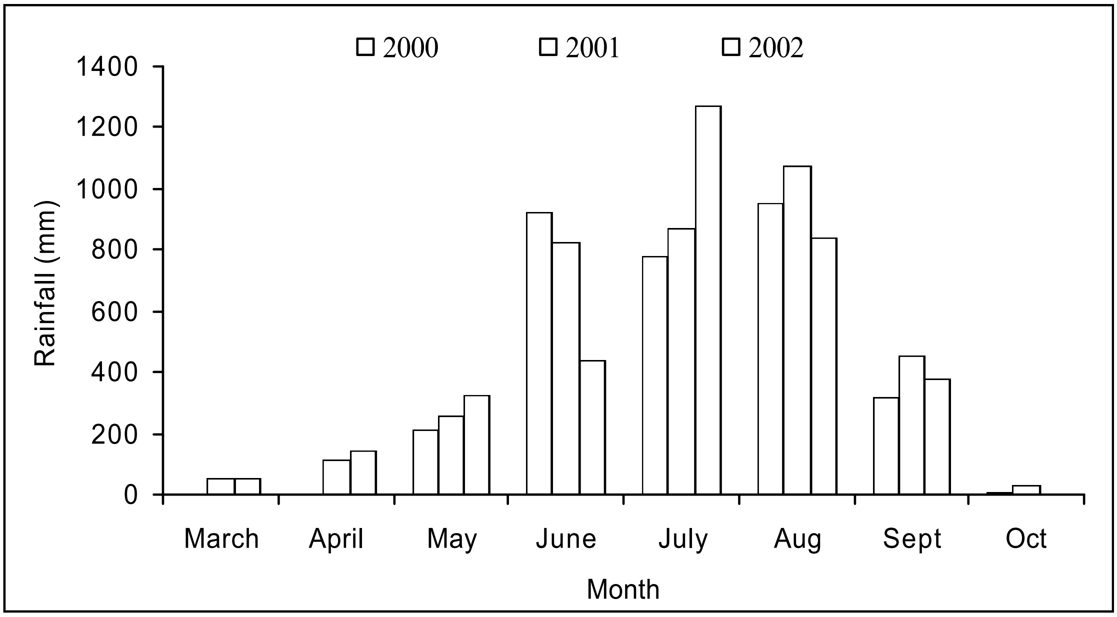

Figure 14.2: **Rainfall amount and pattern at Landruk during 2000-2002**

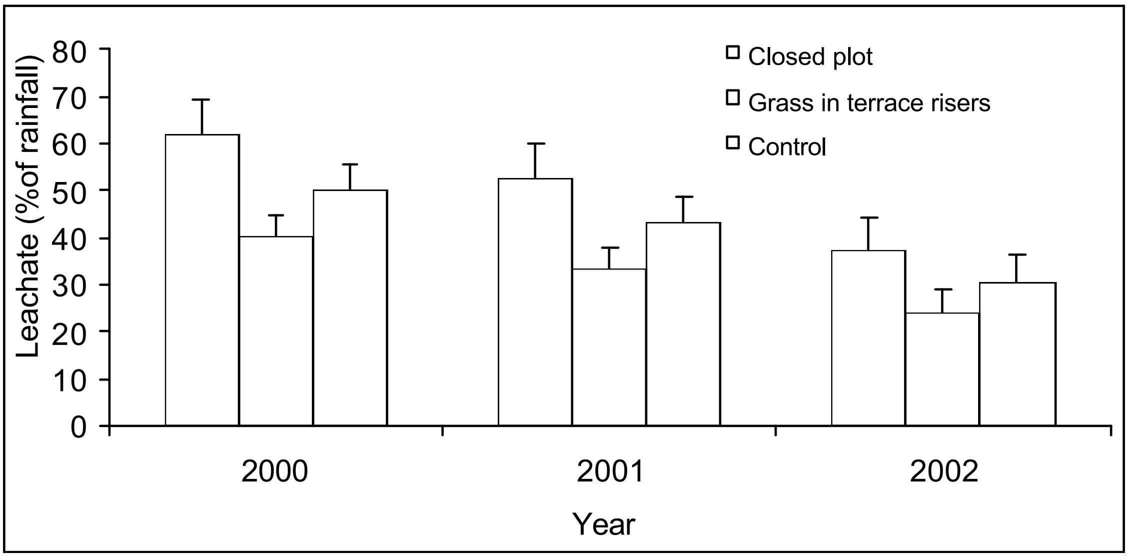

Figure 14.3: **Leachate (percentage of rainfall) at Landruk during 2000-2002**

rainfall water is controlled and infiltration of water takes place in closed plots, which results in more leaching of nutrients in the infiltrated water. The total losses of nitrate-N (97.9 kg/ha) and exchangeable K (99.2 kg/ha) were higher in the closed plots than in the farmers' practice, where nitrate-N and exchangeable K losses were 73.4 kg/ha and 75.7 kg/ha respectively.

During 2001, the leaching of both nitrate-N and exchangeable K was higher in the mid and late seasons than in the early season (Table 14.3). No significant difference in leaching was recorded between treatments with grasses in the risers and the farmers' practice in early, mid, or late seasons. The total loss of exchangeable K was the highest (59.4 kg/ha) in closed plots followed by the farmers' practice and grasses in the risers. Similarly, the total nitrate-N loss was the highest (99.7 kg/ha) in the closed plot and

Table 14.3: **Effect on nutrient loss (kg/ha) in leachate at Landruk during 2000-2002**

Treatment	Early season		Mid season		Late season		Total	
	N	K	N	K	N	K	N	K
2000								
Closed plot	21.2	3.0	61.1	63.0	18.7	33.1	97.9	99.2
Grass in terrace riser	5.7	3.8	73.6	38.4	15.0	20.8	95.4	61.1
Farmers' practice	7.2	3.6	48.0	45.0	17.4	28.9	73.4	75.7
p	0.36	0.87	0.29	0.86	0.84	0.88	0.46	0.87
2001								
Closed plot	4.0	4.0	62.0	27.0	31.0	29.0	99.7	59.0
Grass in terrace riser	3.0	2.0	33.0	22.0	23.0	12.0	61.6	35.0
Farmers' practice	21.0	4.0	24.0	27.0	21.0	19.0	61.3	48.0
p	0.80	0.69	0.45	0.89	0.50	0.74	0.59	0.78
2002								
Closed plot	3.5	3.5	19.9	24.0	6.6	8.8	28.0	35.3
Grass in terrace riser	3.0	2.1	10.8	18.4	6.1	6.6	18.3	26.7
Farmers' practices	4.2	2.6	11.8	20.7	3.5	7.9	17.3	30.7
p	0.89	0.61	0.09	0.89	0.57	0.93	0.45	0.91

N = nitrate-nitrogen; K = exchangeable potassium; *p* = level of significance

more or less similar (61.3-61.6 kg/ha) in the grasses and the farmers' practice treatments. However, these differences were not significant as the grasses in the risers were poorly planted in 2001 and were still becoming established by the end of the monitoring period.

In 2002, intervention plots lost more N (18.3-28.6 kg/ha) than the farmers' practice (17.3 kg/ha) (Table 14.3). More nitrate-N was lost from the closed than the grass planting in terrace riser plots. The loss of nitrate-N was more in the mid season and less in the early season for all treatments except the farmers' practice, which lost slightly more in the early season than the late season. The closed plots lost more K (35.3 kg/ha) than the farmers' practice (30.7 kg/ha) and the plot of grass planting in terrace riser lost least K (26.7 kg/ha). However, the differences among the treatments for the loss of K in leachate were not significant in any period of the season. K loss in leachate was most in the mid season, followed by the late season, and least in the early season for all treatments.

At Nayatola, the total rainfall was 1386, 1123, and 867 mm in 2000, 2001, and 2002 respectively (Figure 14.4). The total leachate in the strip cropped plots was lower in 2000 and higher in 2001 and 2002 than in the farmers' practice but the differences were not significant in any year (Figure 14.5).

Both nitrate-N and exchangeable K leaching losses were slightly higher in the maize and ginger strip than in the farmers' practice in the early season 2000. Losses were reduced in the maize and ginger strip in the mid season because the maize and ginger plants established well and they covered the ground by the mid season. However, it was not so in the farmers' practice. As there was no rainfall in the late season of 2000, no samples of leachate were collected from the lysimeters. The total loss of nitrate-N was less (52.6 kg/ha) in the maize and ginger strip than in the farmers' practice (60.3 kg/ha) (Table 14.4). The total exchangeable K losses in both the interventions (maize and ginger strip as well as farmers' practice) were similar (22.5-23.0 kg/ha). However, leaching losses of both the nutrients were not significantly different between the interventions.

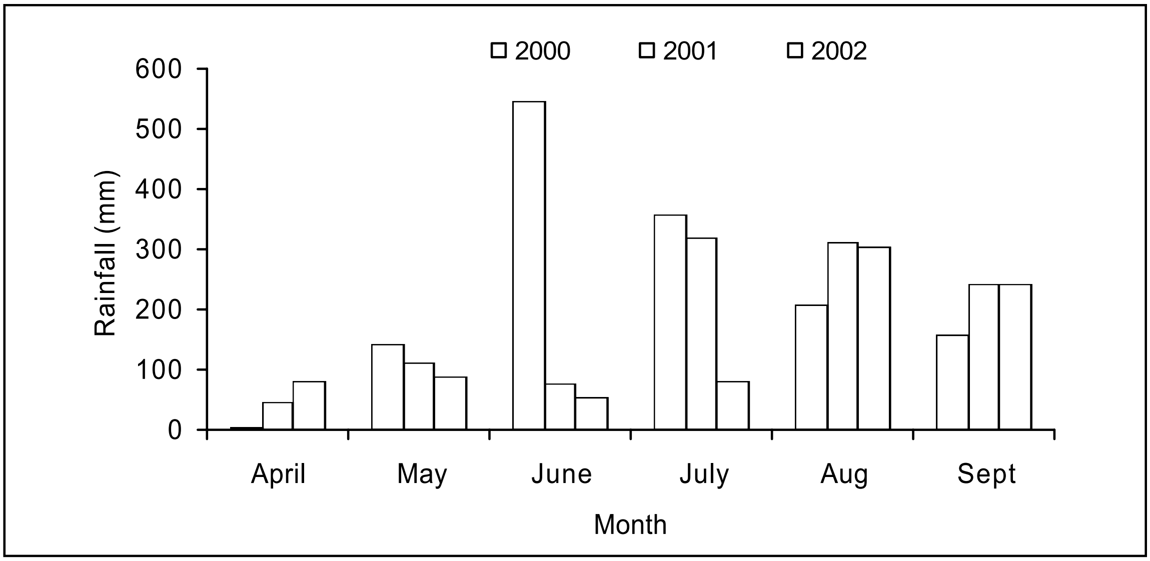

Figure 14.4: **Rainfall amount and pattern at Nayatola during 2000-2002**

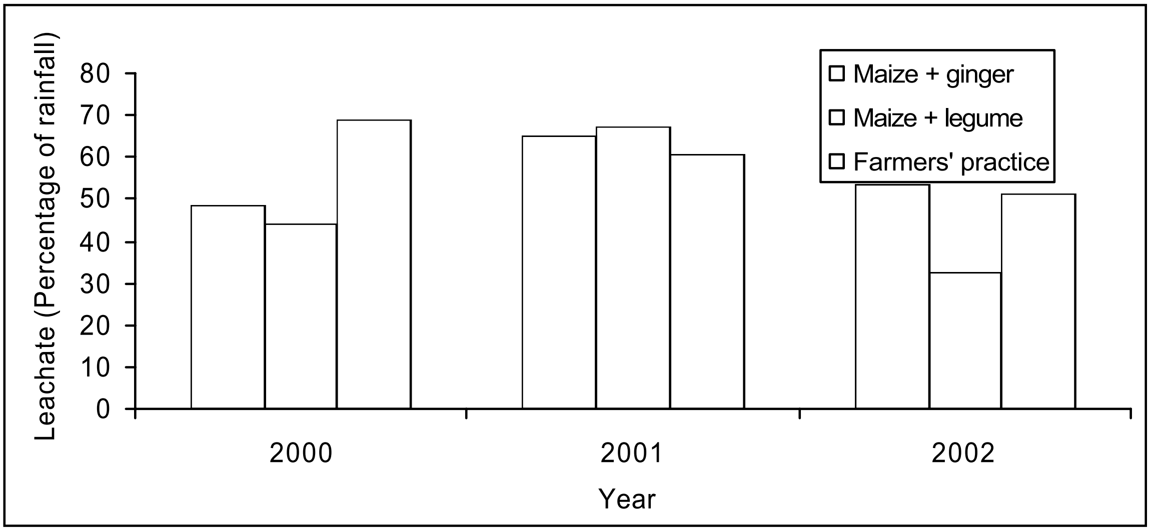

Figure 14.5: **Leachate (percentage of rainfall) at Nayatola during 2000-2002**

Table 14.4: **Effect on nutrient loss (kg/ha) in leachate at Nayatola during 2000-2002**

Treatment	Early season		Mid season		Late season		Total	
	N	K	N	K	N	K	N	K
2000								
Maize + ginger	39.1	7.5	13.5	15.6	-	-	52.6	23.0
Maize + legume	41.5	7.9	23.1	17.3	-	-	64.5	25.1
Farmers' practices	37.3	4.3	23.0	18.2	-	-	60.3	22.5
p	0.94	0.25	0.12	0.94			0.54	0.96
2001								
Maize+ ginger	27.9	5.9	18.9	12.4	17.5	8.3	64.2	26.6
Maize + legume	29.3	6.0	33.9	15.7	20.4	7.8	83.6	29.5
Farmers' practices	32.6	5.0	14.0	9.3	15.5	7.4	62.1	21.7
p	0.84	0.75	0.21	0.36	0.64	0.74	0.35	0.38
2002								
Maize+ ginger	10.9	6.1	10.2	5.7	33.8	4.9	52.9	15.2
Maize + legume	0.4	2.3	3.5	4.0	16.1	4.5	21.7	10.7
Farmers' practices	8.2	2.6	4.4	3.6	23.2	4.2	34.8	10.2
p	0.30	0.20	0.13	0.27	0.63	0.84	0.40	0.35

N = nitrate-nitrogen; K = exchangeable potassium; *p* = level of significance

During 2001, nitrate-N losses in the early, mid, and late seasons were lower in the maize and ginger strip plots than in the farmers' practice and maize and soybean strip. Nitrate-N leaching loss was greatest in maize and soybean most probably due to fewer soybean plants germinating in this treatment. Exchangeable K leaching loss was higher (15.7 kg/ha) in the maize and soybean strip in the mid season than in the maize and ginger and farmers' practice (9.3-12.4 kg/ha) but remained more or less the same in the early and late seasons. The total nitrate-N loss was higher (83.2 kg/ha) in the maize and soybean strip than in the maize and ginger (64.2 kg/ha) and farmers' practice (62.1 kg/ha) (Table 14.4). The same was true in the loss of exchangeable K, where the maize and soybean plot had 29.5 kg/ha and the maize and ginger and farmers' practice had 26.4 and 21.7 kg/ha respectively. However the results were not significantly different.

In 2002, nutrient losses were not significantly affected by the treatments. The loss of total nitrate-N through leachate was the highest (53 kg/ha) in the maize and ginger strip cropping, followed by 35 kg/ha in the control. The lowest loss was 22.0 kg/ha in the plot of maize and legume strip cropping. The seasonal distribution of N loss through leaching was the highest in the late monsoon period. Likewise, the total K loss through leachate was the highest (15 kg/ha) in the plot of maize and ginger strip cropping and its loss was 10.7 kg/ha from the maize and legume strip cropping and 10.2 kg/ha from the control plot (Table 14.4). The seasonal distribution of K loss through leaching was slightly higher in the early period followed by the mid and late periods.

At Bandipur, annual rainfall was 1250, 2043, and 1681 mm in 2000, 2001, and 2002 respectively (Figure 14.6). Leaching of nutrients was the highest in the old citrus orchard (36.4 kg of N and 32.0 kg of K per ha) and the lowest in the young citrus orchard (8.2 kg of N and 11.7 kg of K per ha) in 2000 (Table 14.5). The old citrus orchard lost more nutrients throughout all the years. The lowest loss of nutrients was 25.9 kg N per ha in

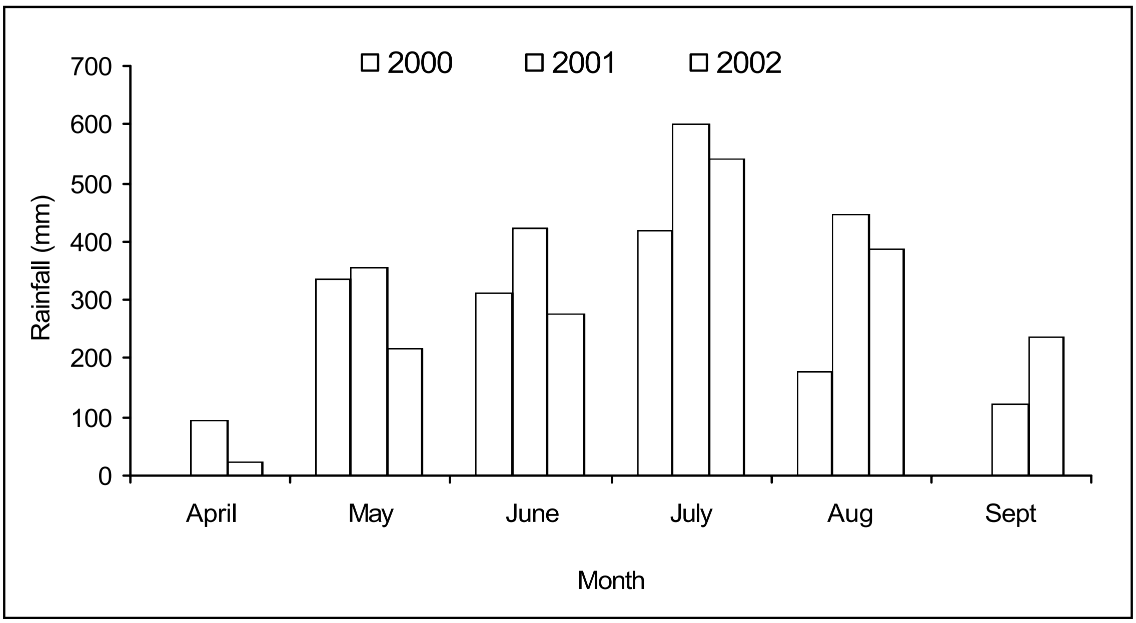

Figure 14.6: **Rainfall amount and pattern at Bandipur during 2000-2002**

Table 14.5: **Effect on nutrient loss (kg/ha) in leachate at Bandipur during 2000-2002**								
Cropping system	**Early season**		**Mid season**		**Late season**		**Total**	
	N	**K**	**N**	**K**	**N**	**K**	**N**	**K**
2000								
Wide terrace and M-F-F	0.9	9.8	8.4	4.8	6.5	6.1	15.8	20.7
Young citrus orchard and intercropping	0.2	1.1	5.6	7.2	2.4	3.3	8.2	11.7
Narrow terrace and M-F-F	2.8	1.8	3.2	4.2	8.1	5.6	14.2	11.5
Old citrus orchard	9.0	3.6	14.5	13.1	12.9	15.2	36.4	32.0
2001								
Wide terrace and M-F-F	2.5	0.8	12.1	6.7	11.4	4.4	25.9	11.9
Young citrus orchard and intercropping	15.9	3.4	17.5	5.7	17.1	3.6	50.4	12.7
Narrow terrace and M-F-F	10.5	3.7	9.6	8.7	25.5	6.0	45.6	18.4
Narrow terrace and M-F-F + grass planting in terrace riser	10.0	3.4	2.5	3.0	14.1	4.2	26.6	10.5
Old citrus orchard	24.2	102	16.5	202	24.8	95	65.5	399
2002								
Wide terrace and M-F-F	15.9	4.9	12.5	11.5	4.2	7.2	32.6	23.6
Young citrus orchard and intercropping	19.1	26.6	23.0	5.8	6.8	1.7	48.9	34.1
Narrow terrace and M-F-F	12.9	3.7	8.9	9.5	7.6	4.3	29.4	17.5
Narrow terrace and M-F-F + grass planting in terrace riser	19.5	3.6	8.4	8.1	11.9	6.5	39.8	18.3
Old citrus orchard	38.7	8.5	12.8	6.9	3.3	1.3	54.9	167
N = nitrate-nitrogen; K = exchangeable potassium M-F-F = maize - fallow - follow								

the leachate of the wide terrace maize-fallow-fallow system and 10.5 kg K per ha in the leachate of the narrow terrace maize-fallow-fallow system with grass planting in terrace riser in 2001 (Table 14.5). In 2002, the lowest losses of both N and K were in the leachate of the narrow terrace maize-fallow-fallow (Table 14.5). The loss of total phosphorous (P) in the leachate was less than 1 kg/ha. This indicates that the loss of soluble P is negligible in leachate.

Runoff and eroded sediments

Sediment loss at the high rainfall site of Landruk in 2000, 2001, and 2002 and average runoff from the different types of plot over the same period are shown in Figures 14.7 to 14.10. The total runoff from closed plots was significantly lower than from open plots during 2000 but it was similar during 2001 and 2002. However, the amount of runoff was very low in all years as compared to rainfall.

Sediment loss (Figures 14.7 - 14.9) was higher in farmers' practice (2229 kg/ha) than in closed plots (994 kg/ha) during 2000. Similarly, during 2001, the total loss of the sediment was the highest in the plots with grasses grown in the riser (1293 kg/ha) followed by the farmers' practice (886 kg/ha) and closed plots (478 kg/ha). In both years, low sediment loss in the closed plots was due to the limited area in which runoff water could not flow freely from the terraces above, and because runoff velocities were reduced, hence reducing erosion. The higher loss of the sediment from grasses grown in the riser than in the farmers' practice during 2001 was most probably due to first-year planting of grasses in the riser, where roots were not sufficiently well established

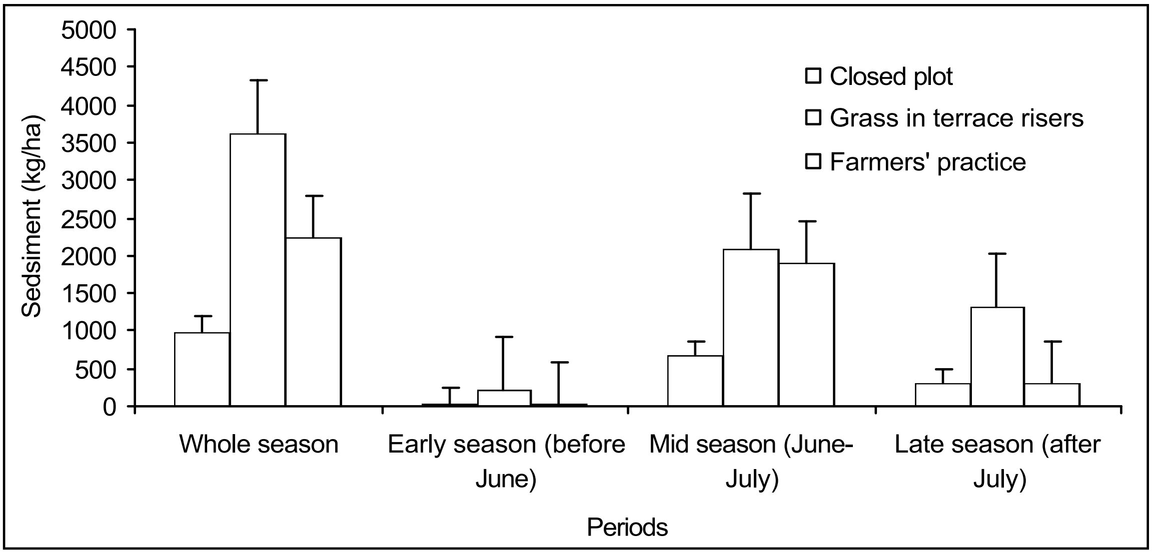

Figure 14.7: **Soil losses at Landruk during 2000**

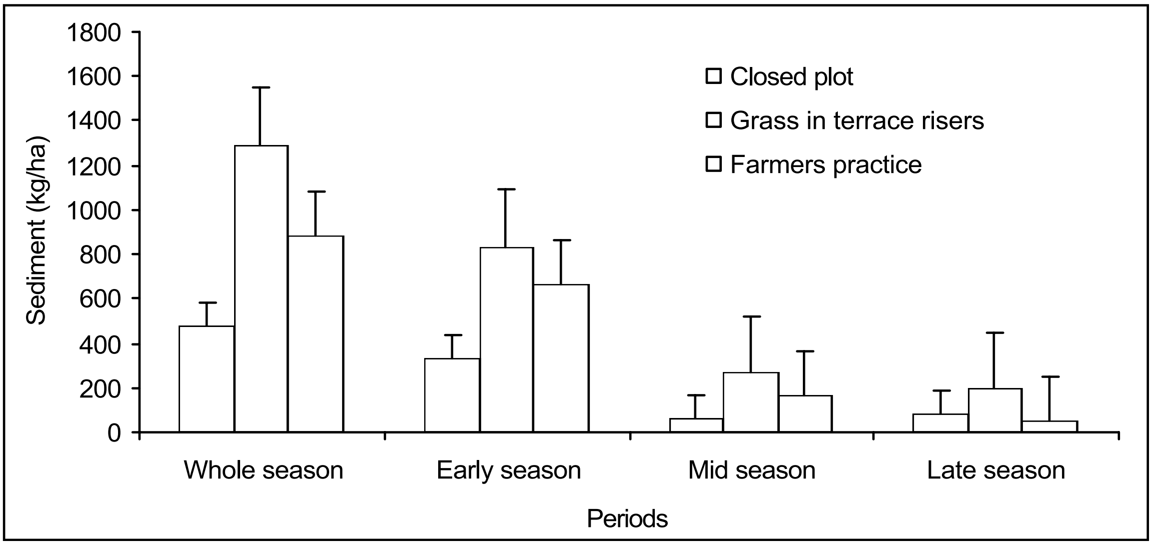

Figure 14.8: **Soil losses at Landruk during 2001**

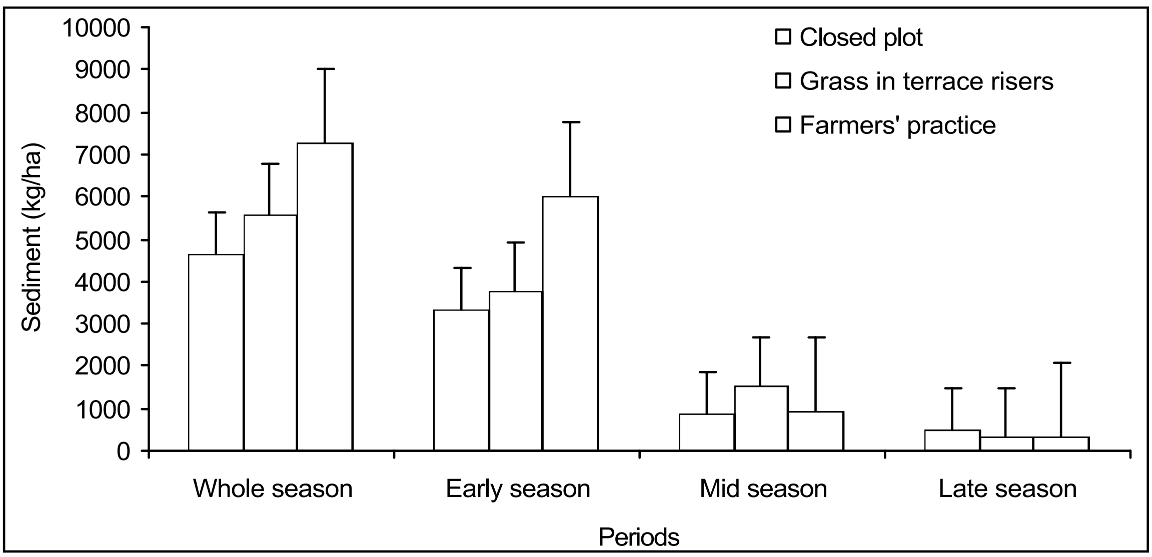

Figure 14.9: **Soil losses at Landruk during 2002**

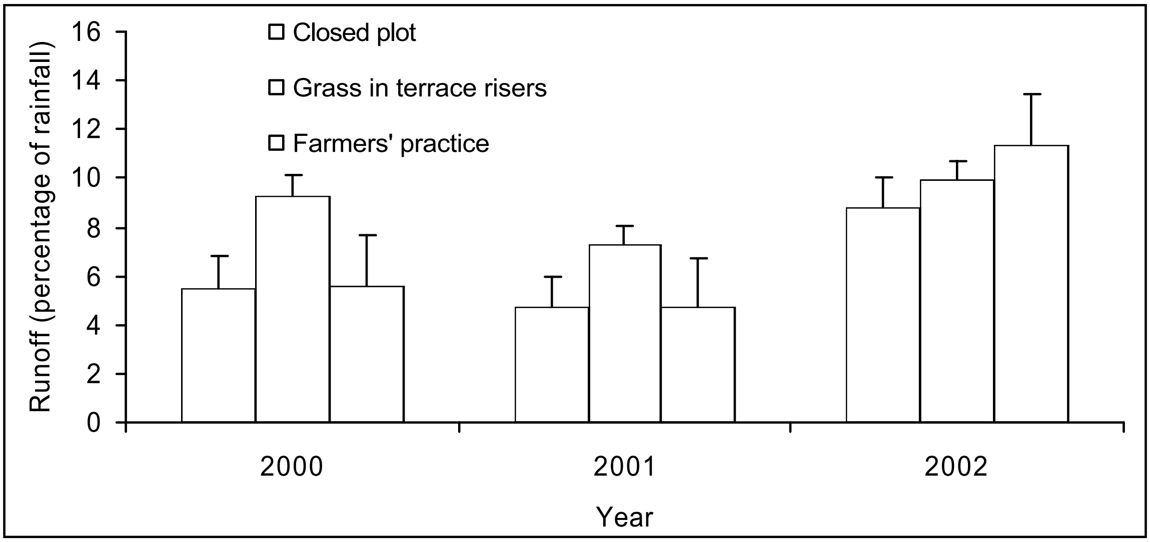

Figure 14.10: **Runoff (percentage of rainfall) at Landruk during 2000-2002**

to conserve soil. In 2002, the soil loss from the closed plots was the lowest (4653 kg/ha) and it was the highest (7256 kg/ha) in the farmers' practice. The soil loss from the plot with grass planting in terrace risers was also less than the loss from the farmers' practice.

Sediment loss at Nayatola in 2000, 2001, and 2002 and average runoff from the different types of plot over the same period are shown in Figures 14.11 to 14.14. The total runoff from the strip cropped plots was less than for the farmers' practice (Figure 14.14); however differences were only significant in 2001. The total sediment loss (Figures 14.11 - 14.13) was higher in the farmers' practice (144 kg/ha) than the maize and ginger strip (58 kg/ha) in 2000. In 2001, the total loss of sediment was highest in the farmers' practice (867 kg/ha) followed by the maize and soybean strip (472 kg/ha) and maize and ginger strip (231 kg/ha). The maize and ginger strip was more effective than the maize and soybean as well as the farmers' practice for minimising sediment loss by runoff because in the maize and ginger strip the ginger was mulched with locally available materials at planting time, which acted as a cover to the soil as well as minimising the soil runoff. In 2002, 280.7 kg/ha of sediments were lost from the maize and ginger strip crop plots compared to 865 kg/ha from the maize and legume strip cropped plots and 1756 kg/ha from the control plots. Sediment losses were greatest in the early season irrespective of treatment. The losses of soil in the early season were 269.5, 843.0, and 1730.6 kg/ha from the maize and ginger strip plots, maize and bean strip plots, and control plots respectively. Insignificant amounts of soil were lost in the mid and late seasons, however the trend among the treatments was the same as for soil loss in the early season.

The total loss of soluble nutrients in runoff was not significantly affected by interventions at any of the sites. However, eroded sediments contain a high content of organic matter and P (Acharya et al. 2001). The results showed that a large amount of organic carbon was lost with sediment rather than other nutrients (Tables 14.12 and 14.13) in both Landruk and Nayatola. Organic matter is one of the most important

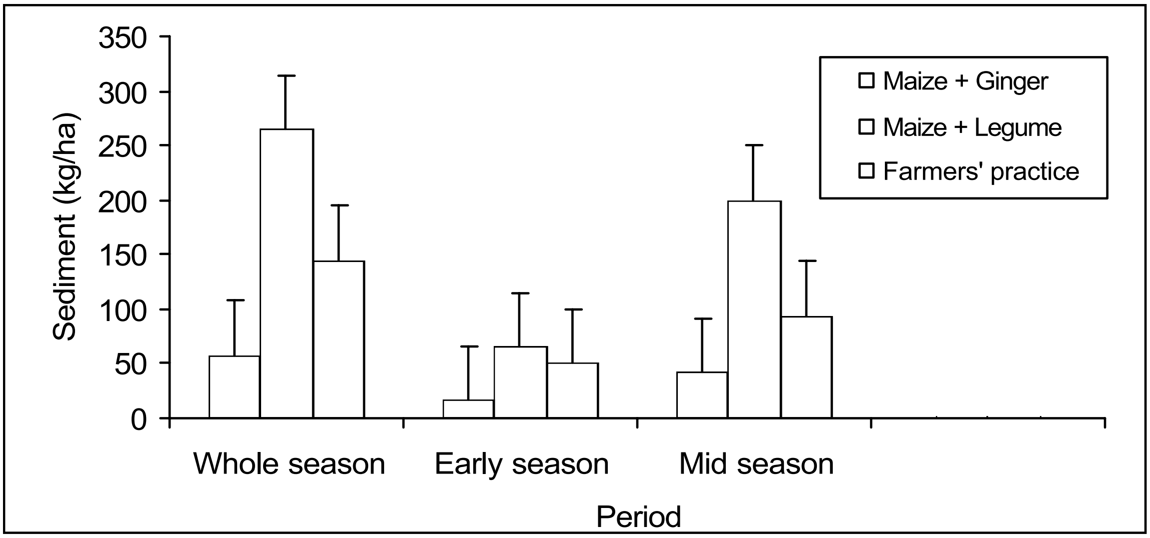

Figure 14.11: **Soil loss at Nayatola during 2000**

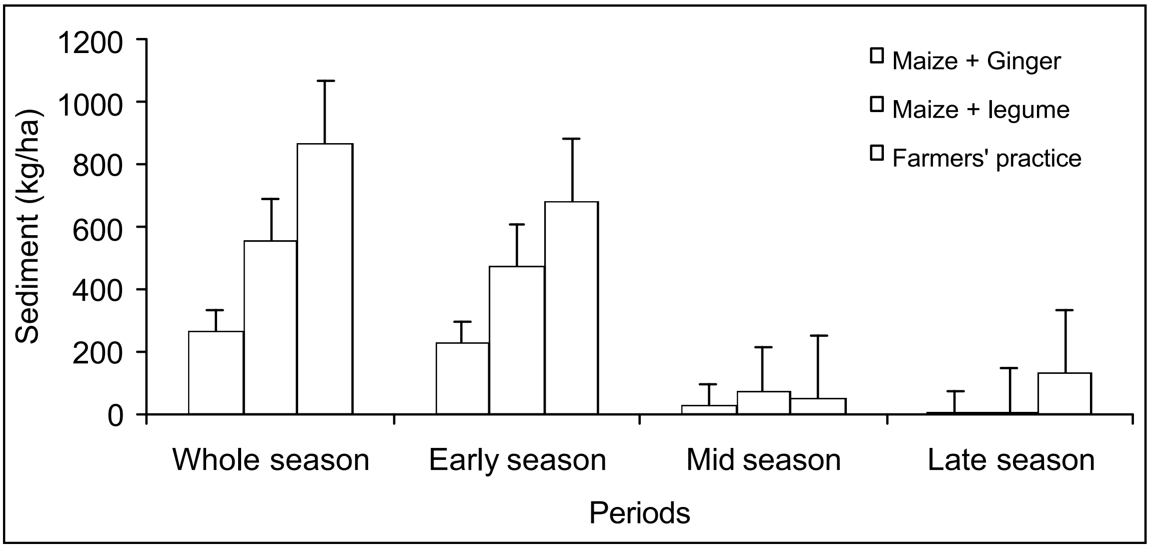

Figure 14.12: **Soil loss at Nayatola during 2001**

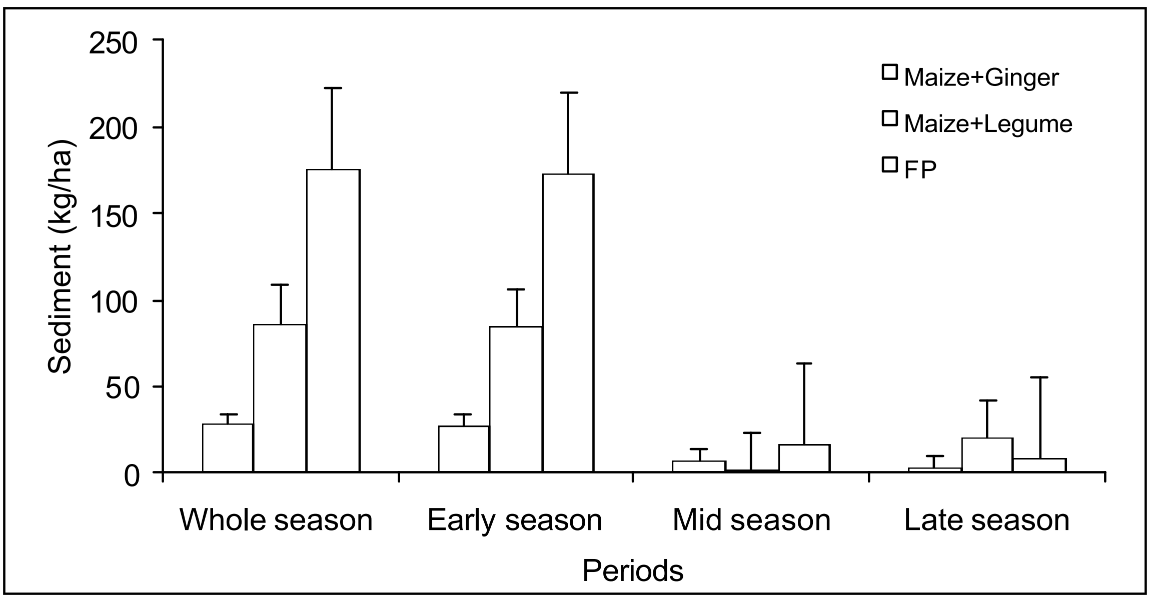

Figure 14.13: **Soil loss at Nayatola during 2002**

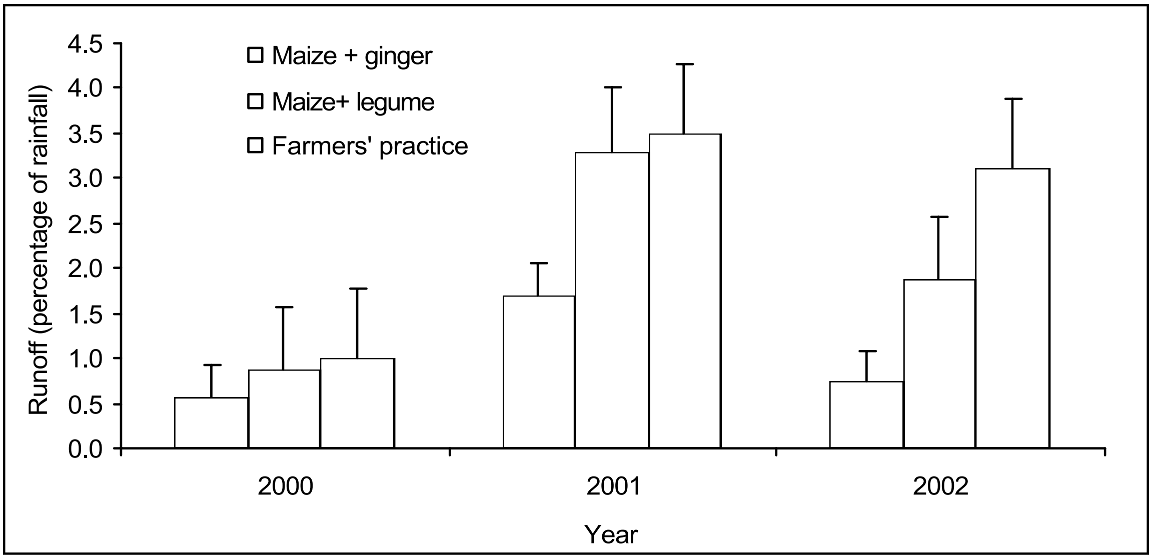

Figure 14.14: **Runoff (percentage of rainfall) at Nayatola during 2000-2002**

Table 14.12: **Nutrient loss in eroded sediment at Landruk (3 years' average)**

Treatment	Organic C (kg/ha)	Total N (kg/ha)	Available P (kg/ha)	Exchangeable K (kg/ha)
Closed plot	55.1	4.7	0.14	0.30
Grass in terrace riser	108.3	8.0	0.26	0.44
Farmers' practice	114.2	8.4	0.20	0.47

Table 14.13: **Nutrient loss in eroded sediment at Nayatola (3 years' average)**

Treatment	Organic C	Total N (kg/ha)	Available P (kg/ha)	Exchangeable K (kg/ha)
Maize+ginger strip cropping	6.7	0.2	0.01	0.05
Maize+legume strip cropping	17.2	0.4	0.02	0.10
Farmers' practice	22.4	0.5	0.04	0.15

sources of nitrogen and plays a major role in the improvement of the physical properties of soil.

Sediment loss at Bandipur in 2000, 2001, and 2002 is shown in Figures 14.15 to 14.17. At Bandipur, the highest sediment loss in 2000 was 1316.3 kg/ha from old citrus orchard and the lowest was 201.8 kg/ha from young citrus orchard, in 2001 the loss was the highest from the narrow terrace maize-fallow-fallow cropping system. Grass planting in the terrace riser had reduced soil loss from the narrow terrace maize-fallow-fallow cropping system indicating the riser planting could help to minimise soil movement along with runoff. In 2002, again the narrow terrace maize-fallow-fallow system yielded more sediment loss and the riser planting with grass did not show any reduction in soil loss.

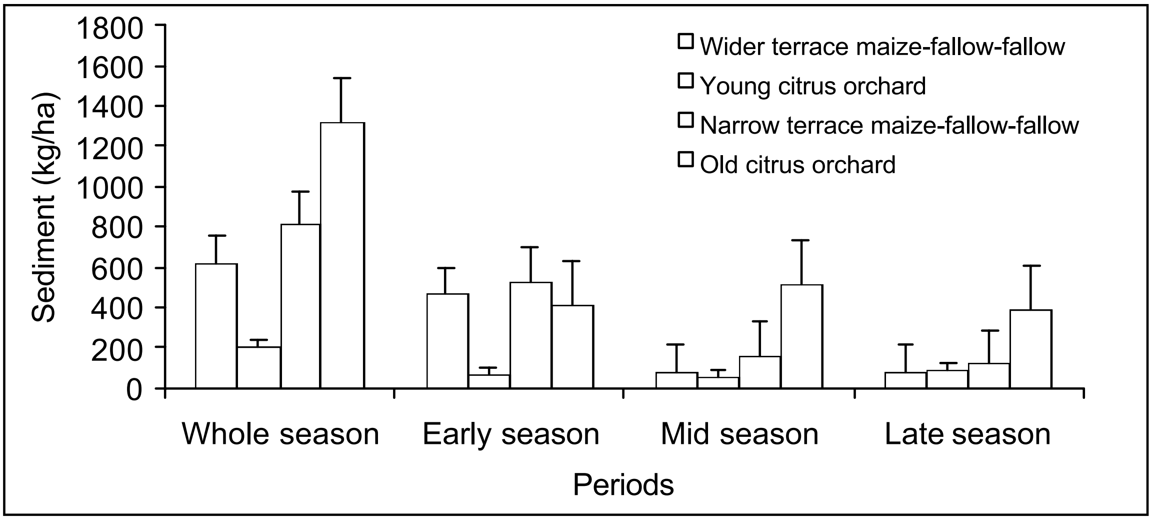

Figure 14.15: **Soil loss at Bandipur during 2000**

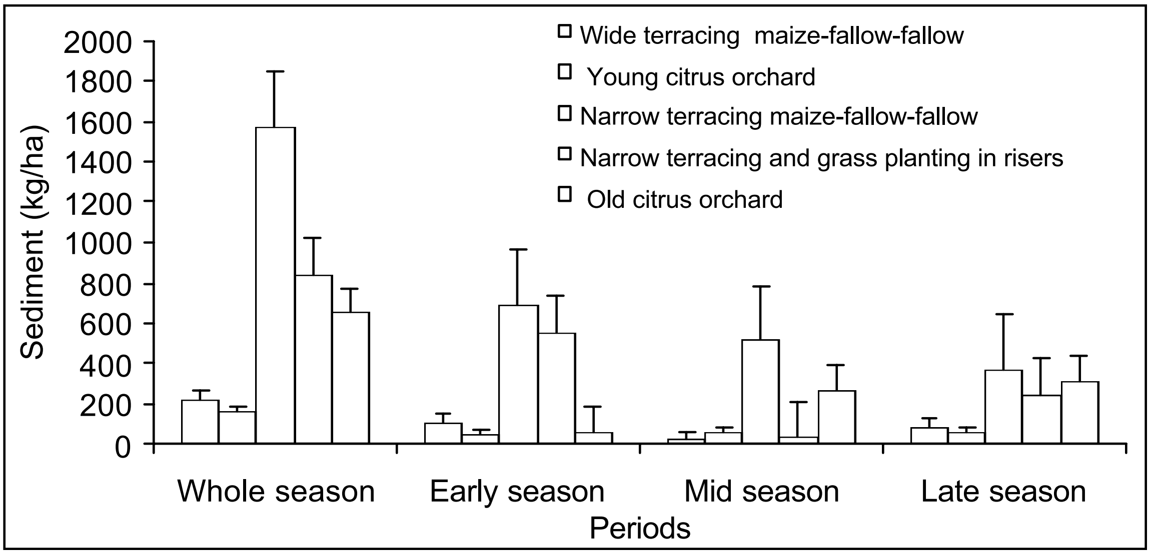

Figure 14.16: **Soil loss at Bandipur during 2001**

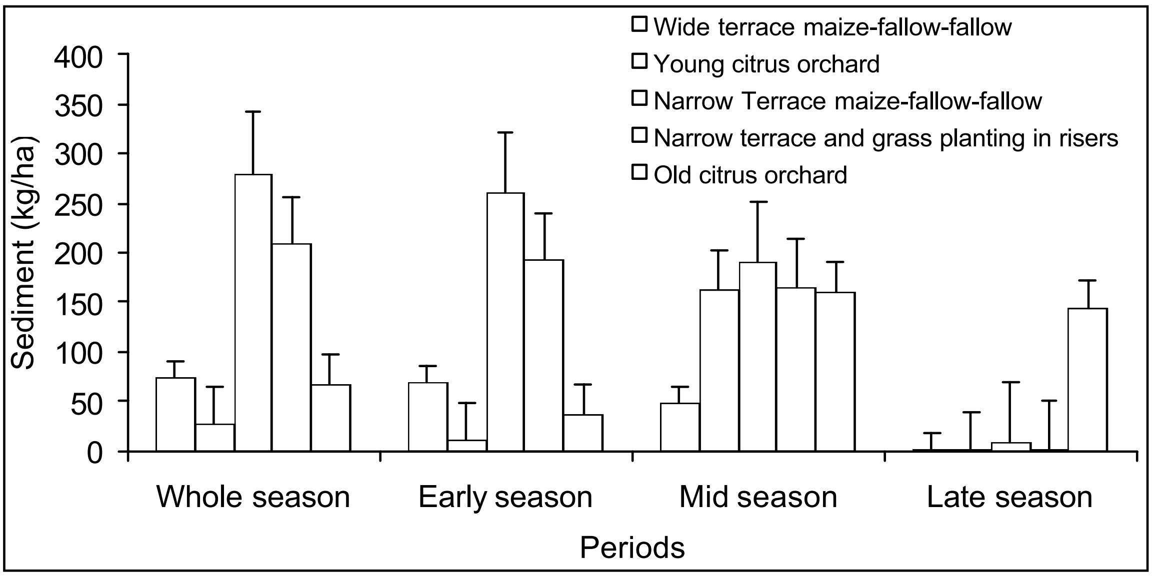

Figure 14.17: **Soil loss at Bandipur during 2002**

Yield and economy

Total productivity of the interventions was compared with the farmers' practice. The interventions did not reduce crop productivity at Landruk (Table 14.14); maize and ginger strip cropping gave a higher income than farmers' practice at Nayatola (Table 14.15), mainly because of the high value of the ginger crop.

Table 14.14: **Effect on crop grain yields (kg/ha) at Landruk**

Treatment	2000	2001	2002
Closed plot	3929	3381	4778
Plot of grass planting in terrace risers	3715	3866	5248
Control (farmers' practice)	3160	3650	4516
P	0.18	0.76	0.76

Table 14.15: **Income (NRs*/ha) from strip cropping at Nayatola**

Treatment	2000	2001	2002
Maize+ginger strip	18,110	31,868	33,647
Maize+legume strip	9,236	18,820	6,420
Control (farmers' practice)	15,332	21,089	9,398
P	0.02	0.04	<0.01
US $1 = NRs 69, 76, 78 in 2000, 2001, and 2002, respectively			

Discussion

The diversion of runon reduced soil erosion in the high rainfall area (Landruk, Kaski) without a significant effect on the loss of nutrients. However, diversion of runon enhanced water infiltration in which a great loss of nitrogen and potassium occurs. Grass planting in terrace risers showed a trend of reducing potassium loss in leachate. Landruk appears to be highly susceptible to runoff and erosion, which relates to its high rainfall and runon and red/brown type of soil (Tripathi et al. 1999; Gardner et al. 2000). The intensity of rain just after field ploughing (for crop planting and fertiliser incorporation) as well as intercultural operations accelerate the soil runoff causing about 50% of the total sediment loss in early June (Mawdesley et al. 1998) when the soil is bare. Gardner et al. (2000) further reported that the timing of heavy rain vis-a-vis the land management activities of ploughing, weeding, and mounding, all of which affect the percentage of ground cover (predominantly weeds) during the May/June/early July period, is an important, albeit random, determinant of the extent of soil loss in a particular year. Soil losses by surface erosion, where run-on is controlled, were low (2.5-5.0 t/ha per year) in all the terraces studied, even where rainfall totals and erosivity were high. However, uncontrolled surface (runon) or sub-surface (piping) water input may result in higher volumes of soil movement on the hillsides and potentially to severe net losses (Gardner et al. 2000).

At Nayatola, the strips of maize and ginger reduced both runoff and leachate volumes under low rainfall and sloping field conditions as compared to the farmers' practice. However, the losses of soluble nutrients in runoff or leachate were not affected, only those adhered to eroded sediments. The ginger strips were mulched with plant materials, which effectively functions as a filter, slows runoff, and prevents the movement of soil particles with runoff water so that the loss of the soil was observed to be low in the maize and ginger strip-planting plot. Montoro et al. (2000) observed a marked reduction of runoff and sediment yields with light mulching of straw to the soil surface at 50% slope in a semiarid region (Smoliowski et al. 1998). Mulching is being used in the area on a small scale for a limited number of crops such as dasheen (*Colocasia esculenta* [L.]) and ginger. It can be extended to other crops provided the mulching material is available or the area under the farmers' traditionally mulched crops can be extended if markets are assured. The existing cultivation practice for the maize crop is the main reason for soil and plant nutrient losses from bari. The sloping nature of the terrace also contributes to increased runoff and soil loss (Vaidya et al. 1995). McDonald et al. (2002) reported that contour-tree-hedgerows are effective for soil and water conservation through the sieve-barrier effect and increased water infiltration and have the potential to enhance the sustainability of the land-use system at a plot scale. The improvement of the terraces is the best technology to reduce runoff from the fields, but it could result in increased leaching unless an appropriate combination of crops is used. Intercropping of legumes with maize is the traditional practice, but tending the maize accelerates soil movement. The modifications to traditional practice as tested in this study, such as inclusion of bushy types of legume crops (for example, cowpea) with maize as strips, reduce operation and control soil nutrient loss from the cropped fields particularly through runoff. Similarly, the use of mulch in ginger production is the usual practice of farmers in this area and the introduced modification of strip cropping of maize and ginger was shown to significantly reduce rates of soil loss through runoff and improve the fertility status of the eroded bari for sustainable crop yields. A maize-soybean rotation may reduce nitrate-N leaching loss as compared to continuous corn planting practices (Owens et al. 1995). Other potential interventions could be extended to include cover crops to protect the soil from erosion and to improve soil fertility through reducing the potential of nutrient leaching (Changkija and Yonghua 1997).

In the citrus-growing area of Bandipur, old citrus orchard showed higher nutrient losses in leachate than young citrus orchard. Intercropping in young citrus orchard reduced nutrient losses. Potassium leaching losses were much higher from old citrus orchard. This result differs from the findings of Ongprasert (2002) who observed that compaction of topsoils in mature litchi orchards results in lower infiltration of water and enhanced runoff.

Soil loss is high during early monsoon. The rainy season was divided into three parts to understand the factors that increase or decrease the erosion rate. In the early rainy season soil remains mostly susceptible to erosion (before June). In the mid rainy season the soil remains resistant to erosion (late June to early August). After that erosion depends on the time of the monsoon and soil cultivation for the next crop cycle.

The amount and nutrient content of runoff were very low compared to leachate but the associated sediment movements carry significant amounts of organic matter and available P. Therefore, further developments should maintain the focus of decreasing leaching and controlling sediment losses in runoff.

Besides N and K leaching, strip cropping at Nayatola and runon diversion and grass planting in terrace risers at Landruk increased productivity by reducing the losses of organic matter in the sediment.

Conclusions

From these findings the following can be concluded.

- The amount of nutrient loss through runoff is very low, but significant amounts of N and P were lost through leaching. Significant amounts of organic matter and available P were washed out along with sediment movements.
- Strips of ginger and maize minimised soil loss and maximised net income from the sloping bari land. This practice can be recommended to the farmers of other areas to minimise soil erosion.
- Young citrus orchard followed by leguminous crop intercropping is beneficial in reducing soil loss as well as nutrient loss in predominantly citrus-growing areas.
- Wide terraces are better for management of soil fertility as they have less runoff and nutrient leaching.

Therefore, technical efforts should focus on trapping nutrients that are lost in solution through leaching and the use of barriers to reduce soil movement and nutrient losses in eroded sediments.

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15 Enhancing the Impacts of Research in Soil Management – Development of Practical Tools in the Hillsides of Eastern Uganda[1]

Yuelai Lu[2], John McDonagh[2], Onesmus Semalulu[3], Michael Stocking[2], and Charles Owuor [3]

Abstract

The dearth of practical tools for local professionals (LPs) for use in identifying and targeting appropriate technologies for client farmers has limited the impact of soil management research. This chapter presents research aimed at bridging the research and development gap in soil management through the development of tools with which the LPs can work better with farmers. The scope of the tools was defined through household surveys, group discussions, and stakeholder workshops. With a strong emphasis on visualisation and the use of local indicators, the developed tools are practical and resource light, so that they are able to address the diversity and complexity of local circumstances as well as the resource constraints to the LPs. On-farm experiments by farmers were encouraged and facilitated by LPs and different adaptation strategies were observed. An active partnership between farmers, LPs, researchers, and local officials proved to be an important factor for the successful application of the tools developed in the research. Further research challenges are the development of approaches for exploring more technical options for soil management and strengthening and mobilising elements of local social capital important for soil management at the community level.

Introduction

The goal of soil management research is to make positive impacts on rural livelihoods through sustainable utilisation of soil and other natural resources. Soil degradation is recognised as a major threat to rural livelihoods in sub-Saharan Africa and is ranked high on regional and national agendas (Dejene et al. 1997; Casey and Donovan 1998; MFPED 2000; Sanchez 2002). However, research and technical progress in soil management have made less impact than they should in tackling the problems and many comment on the poor uptake by farmers of promoted soil management practices (SMPs) (Bunch 1999).

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al. 2001; Scoones 2001; Lu et al. 2002). However, tools and approaches for describing and analysing this complexity and then incorporating this into development practice are resource demanding (Baltissen et al. 2000; Bunch 2000). Acknowledging the resource constraints under which LPs operate in eastern Uganda it would seem appropriate to focus on 'resource-light' (that is, simple, fast, and easy to access and use) options more realistic for LPs working today and to avoid 'resource-heavy' approaches wherever possible.

One way to reduce the resource demands of the tools and approaches is to make them more locally relevant, which includes the localisation of content as well as format. This was achieved by means of a livelihood survey and a series of workshops that assessed the local demand for soil management services, thereby defining the required scope of the interaction between LPs and farmers.

A household survey in the project areas showed farmers to be different in many ways – in their access to resources, in their perceptions of soil degradation, and in the constraints they experienced in crop production (Lu et al. 2002). These differences are apparent at the levels of household, community, village, and district. Farmers living on steep slopes, having experienced rapid soil fertility decline due mainly to erosion, view the worsening soil condition as their greatest constraint. In less steeply sloping areas where decline in soil fertility has occurred over a long period of cultivation, farmers are more concerned by the lack of inputs for crop production. The constraints to crop production were ranked differently by farmers with different wealth status (Table 15.1). Farmers' wealth status was classified based on criteria identified by farmers during a participatory wealth-ranking exercise. These included land area, types of crops and management levels, age and composition of family members, off-farm activities, and education levels. Rich farmers were more concerned about the physical constraints and shortages of labour while poor farmers were more concerned with financial constraints relating to input shortages and limited access to land. These and other differences explain why farmers manage their land differently and this complexity has to be catered

Table 15.1: **Constraints to crop production ranked by different groups of farmers**

Site	Wealth status	1st	2nd	3rd	4th	5th
Kapchorwa	R	Poor soil conditions	Pests and diseases	Lack of labour	Lack of input	Poor marketing facilities
	M	Poor soil conditions	Pests and diseases	Lack of inputs	Lack of labour	Lack of land
	P	Poor soil conditions	Pests and diseases	Lack of inputs	Lack of land	Lack of labour
Mbale	R	Lack of labour	Poor soil conditions	Pests and diseases	Lack of input	Theft
	M	Pests and diseases	Lack of inputs	Poor soil conditions	Lack of labour	Unfavourable weather
	P	Lack of inputs	Poor soil conditions	Lack of land	Pests and diseases	Unfavourable weather

Note: *R – rich, M – medium, P - poor

Table 15.3: **Knowledge and tools required by LPs working in the field**

Objectives	Knowledge and tools required by LPs
Problem identification	**Knowledge** • signs and symptoms of erosion and soil fertility decline • livelihood characteristics of the community **Tools** • field methods for identifying problems (nutrient deficiency and land degradation guides) • protocols for holding group meetings, area walks, identifying and prioritising soil problems in the community • deciding what sort of activities are required (primarily teaching or farmer-led experimentation) • economic analysis tools
Participatory learning	**Knowledge** • soil structure, function, and processes, roles of main nutrients, causes and effects of common soil problems **Tools** • aids for teaching farmers in signs and causes of soil problems – posters and other visual aids, resource flow mapping techniques • protocols for holding structured group meetings and prioritising soil-related problems
Solutions identification	**Knowledge** for different problems to understand the • extent to which they can be resolved • current approaches to resolving them • most appropriate generic solutions and a number of adaptations farmers may like to experiment with • costs of adopting the solutions (land, labour, cash, knowledge) **Tools** • decision support tools
Fine tuning	**Knowledge** • guiding principles for on-farm experimentation, simplicity, small size, reducing variation, isolating variable of interest. **Tools** • framework and protocol for facilitating, monitoring, and evaluating farmers experiments • inputs (seeds, seedlings, contour measuring instruments, fertilisers) in small quantities to give to farmers for experimentation

The use of localised visual indicators improves the communication between LPs and farmers. When LPs use the visual field assessment tools in their work, farmers can easily identify particular soil-related problems and management options. Furthermore, local indicators help farmers link soil fertility status to other crop production constraints that are important in formulating intervention measures. This, in turn, improves the participation of farmers in problem assessment and identification of the solutions. Furthermore, this encourages the mutual learning through sharing of knowledge between farmers and LPs. For example, when discussing the symptom of nitrogen deficiency, farmers listed a number of factors which they thought were connected to the problem, including weed invasion, drought, and dense planting; indeed all these related factors not only explained why nitrogen deficiency occurred, but also indicated some of the possible measures for alleviating the problem.

Table 15.4: **The reasons for farmers' adoption of SMPs (%) in Mbale and Kapchorwa districts, Uganda**

	Napier grass strips	Mulching	Planting trees	Contour bunds	Cover crops (*Mucuna*)	Compost/ farmyard manure	Crop rotation	*Sesbania* hedges	Trenches/ ditches	Fertiliser application	Contour planting
Maintain and improve fertility	9	46	26	10	79	74	74	58	24	71	
Erosion control	37	19	7	76		8		8	44		100
Increase yield	4	6		5	4	15	19	17		29	
Produce fodder	33		7	1	4			17	32		
Conserve moisture	5	10		8		2	3				
Fire and construction wood			52								
Weed control		12			8						
Increase income	3	8	4								
Mulching material	5										
Reinforce bunds	3										
Improve soil structure					5	1					
Retain sediment	1										
Pest control							4				
Shade			4								

Table 15.5: **Fine tuning the SMPs to fit the specific situation**		
Recommended method of implementation	**Actual method of implementation**	**Reasons for modification**
Bunds Mark out and leave the bunds when ploughing	After ploughing, plant napier grass and sunflower along the contour to form bunds; construct bunds after weeding and planting; reinforce and maintain the bunds that were already established	Easy to make when labour is available.
Compost making Apply after ploughing; apply during dry season when fields are being prepared; spread in the field during ploughing	Apply around plants; around the banana stool or in hole during planting; apply whenever compost has accumulated	To reduce labour for carrying to the field; compost is in short supply; expected benefit to the crop will be more rapid; apply whenever it is available to avoid being washed away by rain.
Fertiliser application Diammonium phosphate (DAP) at planting, urea at the knee height for top dressing	Did not apply DAP at planting, only applied urea for top dressing; planted with DAP but no top dressing	Lack of money for both DAP and urea; dry spells interfere with top dressing timing; field was still fertile and there was no need for two applications
Mulching Apply mulch across the banana plantation, not touching the stool; use any available vegetation materials	Using dried banana leaves and pseudo stems; mulching is done after harvesting maize; arranged mulch during weeding	When mulching material is in good supply; simplify the procedure
Residue incorporation Plough back residue during ploughing	Arrange residues in a line before ploughing; residues from beans taken to the banana plantation	Maize stover makes ploughing difficult; A lot of residues from beans are available after threshing beans.

interpreted, farmers' priorities can be addressed at the same time as improvements in soil management are made.

Good Partnership

A good partnership between researchers, LPs, and farmers is regarded as an effective way to understand and handle the complexity and diversity of local conditions. One of the important components of this research is the fostering of partnerships.

The partnership in this project is built up at two levels. First the project team is a partnership, which includes researchers, extension officers, and farmers as active team members. The second-level partnership is the professional linkage between the research team and other stakeholders. Table 15.6 lists the partners and the nature of the partnership established by the project. Farmers are the key informants in identifying and assessing soil fertility-related problems; farmers make the final decisions on which type of soil management should be undertaken; farmers lead the fine tuning of the on-farm research process; LPs are the facilitators supporting farmers' soil management decisions and the partnership they have with formal researchers (NARO) allows them to

In order to enhance the application of the tools and approaches developed in this project and overcome the constraints as identified above, stakeholders (LPs in particular) have made a number of recommendations:

- generating more technical options to fit with the different situations (social, economic) of farmers;
- concentrating on identifying and developing multi-purpose options;
- establishing small demonstration plots at district farm institutes (these centres are increasing in importance with the decentralisation of the agricultural support and research services);
- mobilising local politicians' support, with village, parish, and sub-county councillors involved in the process;
- strengthening existing community bye-laws promoting better land management and formulating new bye-laws, for example for controlling grazing on farm land;
- mobilising grass roots level community groups where resolutions can be made and implemented effectively;
- adopting a catchment approach, particularly for soil conservation;
- blending new management recommendations with what farmers are currently doing, for example, it is easier for farmers to adopt compost making if they are already applying animal manure in their field;
- encouraging those techniques for which the necessary materials are locally available.

These and more challenges could be addressed during the scaling-up phase of this work.

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16 SCALING UP SUCCESSFUL PILOT EXPERIENCES IN NATURAL RESOURCE MANAGEMENT – Lessons from Bolivia

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Abstract

The limited impact of natural resource management technologies and practices, successful at a pilot level, is a cause of concern. In order to promote 'scaling up', the experiences of organisations attempting to increase the impact of successful pilot work of projects in Bolivia, Nepal, and Uganda were documented. Important factors that limit and facilitate scaling up were analysed providing increased understanding of the ways that institutional, socioeconomic, and technological issues affect scaling up. Some of the lessons learnt from the case studies were incorporated and implemented within institutional workplans of development projects in Bolivia. Despite a short time horizon the main requirements for scaling up were identified. These include planning for scaling up at project outset, understanding the wider environment, developing funding mechanisms that go beyond the time horizon of traditional projects, improving collaboration, building institutional capacity, improving community approaches, ensuring the poorest are not excluded from the process, ensuring sustainability after project completion, and improving monitoring and evaluating systems.

Introduction

In recent years there has been growing concern amongst donors and development agencies about the limited impact that natural resource management (NRM) technologies and practices have had on the lives of poor people and their environment. Interventions have often failed to reach the poor at a scale beyond the target research sites (for example, Briggs et al. 1998; Ashby et al. 1999; Bunch 1999). Acknowledgment of this fact has resulted in a recent surge of interest in the concept and practicalities of 'scaling up'.

In 1999 and 2000, pioneering international workshops in Washington and the Philippines (IIRR 2000), discussed concepts and principles for scaling up in the context of agriculture and NRM. These workshops developed the currently accepted definition of scaling up:

More quality benefits to more people over a wider geographical area, more quickly, more equitably, and more lastingly.

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Central to understanding this definition are the terms horizontal and vertical scaling up (Figure 16.1).

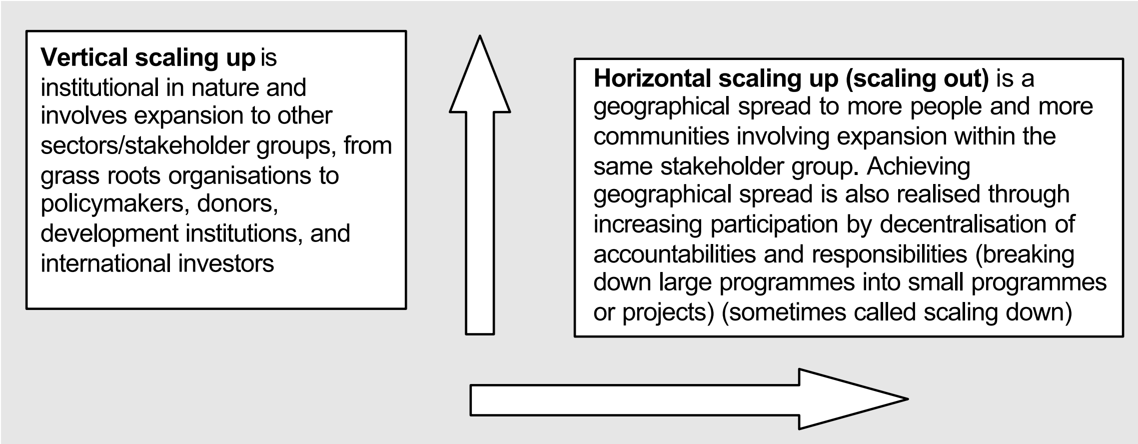

Figure 16.1: **Definitions of vertical and horizontal scaling up**
Source: IIRR (2000)

The approach implied by this definition contrasts with the traditional linear technology transfer model, in which creating impact at a wider level largely resided with the development of traditional documentary uptake material aimed at a very limited homogenised audience at the end of the project. Moreover, research within this linear approach tended to be supply led, with those who conducted the research aiming to transfer their knowledge and sensitise stakeholders to the products that they had developed. Generally scaling up was not considered at the beginning of a project and did not take into account the dimensions of quality, quantity, time, equity, and sustainability (Gündel et al. 2001).

Despite the innovative approach implied by the definition of scaling up, relatively little information has been available on practical strategies to facilitate this process. In order to fill this knowledge gap, the Natural Resources Systems Programme (NRSP) of the Department for International Development (UK) (DFID) commissioned a two-year research project (R7866) to identify strategies for the scaling up of promising pilot experiences in soil, water, and land resource management to the wider community.

The three planned outputs of the project were:

- processes for scaling up successful pilot NRM practices and technologies at community and individual level analysed and understood with key constraint and success factors identified;
- 'best option strategies' for scaling up developed and tested through participatory action research;
- strengthened capability of local professionals in collaborating institutions to promote scaling up.

The research was based on the following set of assumptions.

- There exists a range of NRM practices and technologies, which, if implemented at the landscape level, would contribute to poverty alleviation and improved livelihoods (but there has been limited impact).
- The reasons for this limited impact and potential solutions to the problem can be identified through the study of real experiences of institutions attempting to 'scale up' a range of technologies and practices. Strengths can be built upon and weaknesses overcome through better understanding and through learning from the experiences and perceptions both of other institutions and other stakeholder groups.
- A scaling-up strategy can be drawn up based on the research findings that can be incorporated within the different stakeholders' agendas.

This chapter aims to discuss the experience and findings of the research and to communicate the key lessons that have been learnt in Bolivia on the scaling-up process.

Research Activities

The research reported in this chapter had two distinct phases.

Phase One ('the case study phase')

This phase focused on using case studies to identify important factors that influence the scaling-up process, learning from the positive and negative experiences of a range of institutions in the process of scaling up the impact of the technologies/practices that they had developed or piloted. Five studies were undertaken in Bolivia, one in Nepal, and one in Uganda.

For the purpose of case study analysis the key research questions addressed were:

- What were the positive aspects of the process and how can these be built upon?
- What problems were experienced and how could these be overcome?
- What is the influence of people's livelihood strategies on the process?

Each study consisted of a multiple-stakeholder analysis, comprising primary institutional analysis, community level analysis, individual farmer analysis, and secondary institutional analysis. The intention was to gain a holistic view of the process by taking into account the different experiences and perceptions of all the relevant stakeholder groups. The learning process was iterative, with the knowledge provided by each stakeholder group influencing the analysis of the perceptions of the other groups.

The case studies were analysed to draw out key lessons. In preparation for the second phase of the project, these were presented to stakeholders at a workshop in Cochabamba. During the workshop, working groups considered key topics including a theoretical framework for approaching the scaling-up concept (Gündel et al. 2001), the relevance and practical implications of the case study lessons, and approaches for the monitoring and evaluation (M&E) of scaling up.

Phase Two ('the action research phase')

This phase focused on working with collaborating organisations in Bolivia to develop existing dissemination strategies[2] into scaling-up strategies through implementing selected key lessons identified in the case studies. The intention was to simultaneously validate the lessons learnt from the case studies and build scaling-up capacity with local institutions. In order to achieve this, a range of action research activities were undertaken.

- The key factors that were pivotal for scaling were identified by collaborating institutions up to a landscape level and were incorporated into their institutional work plans, elements of which were then implemented and monitored.
- A local NRM 'platform' was established amongst collaborating organisations to strengthen local capacity, share experiences, influence policy relevant to the management of natural resources, and strengthen the capability of local professionals to promote scaling up.
- A series of capacity-building workshops were held for various stakeholder groups. These focused on selected practical aspects of scaling up, namely functional linkages with municipal governments and grassroots' organisations; effective inter-institutional experience sharing; involvement in national networks, and seeking/introducing innovative funding mechanisms.
- Three workshops were undertaken to communicate the main findings of the project. Each workshop was tailored to the needs of the different target groups, namely farmer and community leaders; extension workers and non-government organisation (NGO) staff; and directors or senior staff from funding bodies and development organisations.

A range of promotion materials were produced and distributed to relevant actors. These materials included a manual containing practical advice on the main issues, a 'scaling-up kit' for the development of a practical work plan, and a video on farmers' perceptions of the requirements for scaling up.

The whole research process was iterative with lessons learnt from monitoring activities influencing both the development and analysis of subsequent activities.

Results and Discussion

This section presents and discusses the lessons learnt on scaling up. Each sub-section discusses one of the broad lessons identified from the case studies. For the sake of brevity, individual case studies are not referred to specifically. More detailed information on the specific lessons of the individual cases is available (Middleton et al. 2002). Where appropriate, experiences and insights from the action research phase are provided (Table 16.1). However, the reader should be aware of the short duration of the

[2] The difference between dissemination and scaling-up strategies in this context is as follows. Scaling-up strategies imply a multi-dimensional approach, simultaneously taking into account political, social, and economic factors in order to ensure a wide impact that is sustainable and equitable. It requires an iterative approach to learning and implementation, constantly responding to the ever-changing environment. Dissemination, although an integral part of scaling up, usually focuses on promoting specific practices and technologies to pre-determined groups.

Table 16.1: **Lessons learnt from case studies and action research**	
Lessons from case studies (Phase I)	**Insights from the action research (Phase II)**
Planning for scaling up Ensure that concept of scaling up in all its dimensions is fully understood Develop plans for scaling up early in the project cycle	Use appropriate communication approaches to ensure understanding • Institutions should define their role in the scaling-up process and develop a relevant scaling-up goal, objectives, activities, and indicators • Build on the strengths and weaknesses of existing institutional plans • Budget for scaling-up activities • Identify key support, supply and demand actors • Link with local government planning activities
Understanding the wider environment Undertake timely situational analysis that includes political, institutional, social, cultural, and biophysical analysis Undertake a livelihoods assessment	Do not limit this to community-level PRAs focusing on NRM • Encourage stakeholders to build on each other's work and not to compete (for example, NRM fairs)
Increase time horizons Ensure long-term technical/ organisational support at the community level Build long-term community capacity to manage new technologies/practices	Ensure a critical mass of awareness, interest, and expertise within local stakeholders • Involve the municipal government in this process. • Identify capacity-building needs • Work through government organisation/NGOs with a long-term local presence
Developing effective funding mechanisms and making the most of those in place Ensure closer integration of funding between research and development activities Consider cost sharing within strategic alliances and seek existing government funding to promote local sustainability Promote and lobby for higher political priority for NRM with decision makers Ensure institutional sustainability through commercialisation of activities does not compromise the pro-poor focus of activities Donors need to consider longer-term flexible funding approaches tied to intermediate milestones and linking research and development activities	Ensure local stakeholders are aware of changing donor funding arrangements and if possible contribute to new policy • Assist local communities to voice their needs and priorities for improving NRM to local government (for example, NRM technology fairs) • Review relevant policies and policy-making processes (use appropriate media) Raise institutional understanding and use of existing funding mechanisms and sources • Build an easily accessible database of funding sources and their requirements
Improving collaboration, networking, and strategic alliances Form strategic alliances with stakeholders to increase widespread impact Ensure the 'primary' institution identifies, consults, and plans for collaboration with stakeholders Primary' institutions should work with existing community groups	Develop a forum for institutional knowledge sharing and collaboration • Ensure that institutional roles are well defined and collaborative activities agreed and funded • Strengthen local capacity to organise and manage relevant activities

Table 16.1: **Lessons learnt from case studies and action research (cont…)**	
Building institutional and community capacity Target capacity-building activities at institutional and community-level stakeholders funded as part of the scaling up process, including both organisational and technical training	• Prioritise capacity-building training to the needs of stakeholders. For example, workshops on funding strategies and developing linkages with local government and local communities at three levels (farmer, field, and management staff) with appropriate dissemination material
Improving community approaches to technology development Undertake awareness raising prior to technology development including exposure to new options Use participatory technology development approaches bringing together local and scientific knowledge and joint planning Avoid the use of incentives unless there is evidence that they are not the over-riding factor influencing adoption	Arrange practical field demonstrations, exchange visits, and technical support • Focus on genuine participatory techniques responding to farmers' needs and not donors' requirements. (Farmers complain that approaches are often not genuine.)
Improving accountability to local communities Ensure project activities address community problems Ensure community organisations are accountable to the wider community	
Including the poorest and marginalised Develop a strategy taking into account the situation analysis and livelihoods assessment Ensure technology options are available within the resource levels of the poorest	
Ensuring sustainability after project completion Base new practices on locally available materials, low investment, and tangible short-term or multiple benefits Ensure that farmers are aware, from the beginning of the project, of the timeframe and interventions Ensure that farmers have ready access to the necessary input supplies through local suppliers Ensure local organisational capacity before project completion Ensure access to technical support after project completion	Ensure scaling-up objectives are being met through the technology that is being promoted
Monitoring, evaluation, and impact assessment Implement M&E systems as early as possible • at institutional level to assess effectiveness and measure impact • at community level to strengthen community control • undertake impact assessment	Ensure that the requirements of M&E are fully understood and that indicators are relevant and measurable • Identify those responsible for different aspects of M&E • Ensure that this is adequately budgeted for • Plan for long-term impact assessment • Develop and agree indicators between institutions • Develop and share appropriate indicators with communities • Ensure that impact is assessed in relation to a baseline of information provided by the situational analysis and livelihoods assessment • Remain focused on impact indicators

action research phase, which limited the potential for validating the impact of implementing scaling-up lessons with collaborating organisations. Moreover, time constraints meant that collaborating institutions focused their efforts on a selection of the key issues that they considered of priority in their particular circumstances, rather than on the whole range of lessons from the case studies. As a result, the exploration of institutional issues is more developed than that of community-level issues. This reflects the institutional priorities of the project's collaborators but does not imply that such issues are more significant for successful scaling up. Because scaling up is such a complex multi-dimensional concept there is necessarily much overlap between the issues discussed in the different sections. It is recognised that no single factor alone will ensure successful scaling up. Success will require a range of complementary activities combined with a sufficiently enabling environment.

Planning for scaling up

The concept of scaling up is relatively new. In most of the case studies, failure to fully understand the implications of the concept in institutional strategies and activities limited the success of the process. When organisations did not understand the concept they often failed to plan scaling-up activities into their projects and programmes. For example, only three of the seven case studies had a deliberate scaling-up strategy. The other organisations considered scaling up to be synonymous with dissemination (horizontal spread), which they only considered towards the end of the project cycle. Those case studies with a deliberate scaling-up strategy demonstrated the importance of considering the vertical aspect of the concept. They showed that activities such as forming inter-institutional alliances, increasing the priority of NRM issues in government agendas, and benefiting from existing legislation and policy, require deliberate action and long-term planning early in the project cycle.

In order to communicate the concept of scaling-up, three dissemination workshops were undertaken. Each workshop was tailored to the needs of a different target group, namely farmers and community leaders; extension workers and NGO staff; and directors or senior staff from funding bodies and development organisations. These workshops proved vital for the successful development of 'scaling-up plans' with collaborating institutions, because they enabled them to gain a clear understanding of the implications of the concept.

Prior to these workshops collaborating organisations experienced difficulties in planning for scaling up because they were unsure of the relevance of the concept to their specific situation. In this context it proved useful to develop a plan that allowed them to define their role in scaling up and to develop a relevant 'scaling-up goal' for their organisation. Once the scaling-up goal had been identified, a logical planning sequence was followed, developing appropriate objectives, outputs, activities, and indicators for achieving this. So as to remain relevant and realistic, the scaling-up plans built upon the strengths of existing institutional plans.

Generally, the collaborating institutions found the experience of developing scaling-up plans to be very useful. They felt that the plans broadened their horizons and helped them to consider important factors that had been overlooked in their existing institutional working plans. Developing the plans proved to be particularly useful for analysing the effectiveness of their existing approaches in fulfilling their primary scaling-up goal. Often institutions realised that they had assumed their existing activities would result in scaling up impact without really considering how this would occur. Research institutions in particular realised that they had focused too heavily on technical issues without considering necessary social and organisational issues.

One factor proved significant in increasing institutional motivation to develop scaling-up plans. This factor was that funding policy changes within the Bolivian research sector now create a major incentive for NRM institutions to direct some of their resources towards an effective scaling-up strategy. Within the new funding framework, institutions must be competitive in undertaking research that is holistic and interdisciplinary, involving partnerships with development organisations and demonstrating impact.

The main impediment to the implementation of the policy changes was the question of responsibility and funding for those scaling-up activities that did not lie within existing institutional remits. This highlighted the importance of long-term strategic planning rather than considering such activities as 'add-ons' to individual projects.

Understanding the opportunities and threats of the wider environment

In order to plan for scaling up an understanding is needed of the opportunities and threats provided by the political, institutional, cultural, social, and biophysical environment. Focused and timely situational analysis should enhance the impact of scaling-up activities by ensuring that they are appropriate to the specific situation, that opportunities are exploited, and that over-riding limitations are understood. However, most of the case studies focused their situational analysis on community participatory rural appraisal (PRA) activities with an NRM bias with little consideration of the wider environment. Only one of the five case studies had deliberately and systematically considered the implications of the political and institutional environment. This meant that most institutions had missed opportunities for building on existing good development work and for benefiting from available municipal funding and support required by the new laws of decentralisation and popular participation.

During the action research phase of the project it became clear that many institutions in Bolivia were aware of the potentially positive implications of the new laws but that they were unaware of which steps to take in order to benefit from them. However, those institutions that had developed strategies for channelling their NRM projects through local government planning activities felt that the potential for achieving widespread impact was limited by the fact that NRM issues had a very low priority in municipal government agendas.

In response to these problems, an 'NRM fair' was held. The 'fair' had several inter-related objectives, all aimed at increasing stakeholder awareness of how to benefit from political and institutional opportunities. The day included workshops on how to develop community demands into projects and how to incorporate these into the legally binding municipal plans. Stalls and practical demonstrations by NRM organisations were also used with the intention of increasing community and municipal awareness of the significance of NRM issues and the range of technologies and practices available for tackling them.

An evaluation of the fair and its impact demonstrated the effectiveness of such an event in raising awareness, capacity building, and promoting interaction between different stakeholders. However, limited farmer attendance highlighted the importance of making such events more accessible to community members by holding them in rural areas. Consequently, some of the participating organisations obtained European Union funding to hold similar fairs in rural areas.

Another example of the importance of understanding the situation was the failure of certain institutions to take into account the significance of religious division in some rural areas. This division, when ignored, seriously limited the uptake and spread of NRM methodologies and practices promoted by these institutions. However, development institutions that had analysed the situation demonstrated that the sectarian problem was not insurmountable. Understanding the situation enabled them to develop interesting strategies jointly with the target communities, allowing for a better integration of methodologies within the cultural context. This also highlighted the potential for both research and development institutions to be aware of and build on each other's existing work, rather than each individually undertaking their own situational analyses, which are often costly and time consuming.

Increasing time horizons

In the case studies, the timeframe of project intervention was shown to affect impact and sustainability because it influenced the nature and quality of activities undertaken at the institutional and community level. Long-term commitment proved to be a facilitating factor both at the community and institutional level. Long-term projects were able to take a more strategic view of scaling up and to plan for it early in the project cycle. Those projects with short, medium, and long-term plans were better able to plan for and undertake scaling-up activities. At the community level, long-term institutional support was a key factor facilitating technology uptake because it provided farmers with a point of reference when they had difficulties or queries. Because even long-term projects tended only to have a short-term presence at the community level, strategies for providing on-going support need to be developed. Successful approaches included building community capacity to manage new technologies, working through NGOs with a long-term local presence, and involving the municipal government in the process.

The case studies demonstrated that achieving impact at a landscape level is a slow process, even when all the necessary inputs are available. Only one case study demonstrated environmental benefits at a watershed level. This had taken 10 years with high levels of control and support. Institutions wishing to promote changes at a landscape level will benefit from a realistic view of the time scale involved.

Collaborating institutions felt that they needed longer-term support for scaling up, particularly with regard to building a critical mass of awareness and interest and monitoring the impact of their plans. They felt that the existence of a body to provide motivation, guidance, and training during the action research phase had been effective but that the expectation that they could effectively continue the process alone after only a matter of months was perhaps unrealistic. Although the pitfalls of dependence were understood by these organisations, they felt that the process of developing independence and confidence with new concepts and practices required more than a few months.

Developing effective funding mechanisms and making the most of those in place

Insufficient capital proved to be a factor limiting scaling up at all levels (institutional, communal, and individual). The way in which funding is planned and managed was shown to influence the success of the scaling-up process. The case studies suggested that the scaling-up process is most successful where there is a long-term financial commitment. This is because longer-term funding provides the level of institutional security/continuity required for developing short, medium, and long-term plans which include key scaling-up activities such as capacity building and the formation of networks for inter-institutional collaboration. The failure to plan and budget for scaling up activities, particularly those which span beyond the project implementation phase such as M&E, situational analysis, networking, and capacity building, was shown to limit the scaling-up process.

The experiences of the research organisations involved in the case studies showed that short-term funding and poor integration between research and development were limiting planning horizons and reducing the opportunities to plan or budget for key scaling-up activities. Projects that had integrated research and development into one process demonstrated the benefits of an integrated approach. This approach should also include the development of an appropriate infrastructure to support the scaling-up process. Of the various funding strategies followed by the case studies, tapping into government funding programmes and cost sharing appeared to enhance the sustainability of the process. In the case of government funding, opportunities needed to be enhanced by stimulating demand for technologies at the community level whilst simultaneously raising awareness of NRM issues within the municipal governments. In one case, the provision of a competitive fund for scaling-up activities such as raising awareness, capacity building, and institutional networking was shown to facilitate secondary organisations in undertaking positive scaling-up activities. Whilst commercialisation of activities was shown to have ensured institutional sustainability, this had occurred at the expense of a pro-poor focus.

In order to respond to these issues, the action research phase of the project identified the need for a two-pronged approach. On the one hand there was a need to increase NRM institutions' knowledge and understanding of existing funding opportunities in Bolivia and to develop practical methodologies for 'making the best' of these. On the other hand there was a need to lobby funding bodies to increase their recognition of the importance of NRM in poverty alleviation and to encourage them to respond to the opportunities and constraints identified by NRM institutions.

Due to the project's time constraint, a workshop on funding, bringing together donors and NRM institutions, was considered to be the most effective approach for dealing with these issues. The extent to which the workshop objectives were met was limited by the absence of key donors, who failed to attend at the last moment. This absence reinforced the sentiment amongst NRM institutions that most development interventions were still top-down and donor driven and that the donors were uninterested in hearing or responding to the viewpoints of the organisations that they funded. This highlighted the need for a lobbying body, capable of dialogue and influence at the policy and decision-making level.

Improving collaboration, networking, and strategic alliances

Inter-institutional collaboration (from grass-roots to local government level) is the backbone to successful, sustainable scaling up. In Bolivia it facilitated the scaling-up process by ensuring that the responsibility for reaching more people was not only in the hands of the 'primary institution' (i.e., the one promoting the practice or technology developed). Although many organisations showed evidence of working with different partners, achieving effective inter-institutional collaboration was shown to be a complex and problematic activity. Opportunities for effective collaboration were often limited by the lack of space for inter-institutional communication and planning, lack of funds, and the fact that institutions were too busy with their own projects and agendas. Such limitations were only overcome in the cases where all the collaborators were committed to achieving the same goal or where there was a capable key institution facilitating the process by providing capacity building and supporting network formation. These positive cases highlighted the importance of motivation for successful collaboration.

The case studies demonstrated that scaling-up approaches were strongly influenced by the orientation of the 'primary institution'. This highlighted the importance of improved linkages between research and development organisations. Development organisations with a more process-based approach to scaling up were more successful than the technology-focused research projects. One of the key factors that limited the development of scaling-up strategies in these research projects was the fact that they did not consider themselves to be responsible for scaling up. Their goal was to develop and disseminate appropriate technologies at a pilot level. Although low-budget research projects cannot be expected to achieve the same level of networking and capacity building as large development projects, they can improve their chances of impact by collaborating with these organisations. By incorporating scaling up into their institutional goals, research institutions will become increasingly aware of their need to link with development and government organisations with their increased capacity for networking and achieving wider impact. There is clearly a need for technically orientated organisations to become more process orientated in their work.

The development institutions in the case studies also demonstrated the importance of developing networks of stakeholders with well-defined roles and responsibilities and legally binding agreements. Development of such networks was enhanced through the early identification of and consultation with demand, supply and support actors. Regular meetings to discuss issues arising and to share experiences also improved the effectiveness of these networks.

At the community level the achievement of sustainable impact was greatly facilitated by working through existing community groups and organisational structures. For example, working through the Bolivian farming syndicates ensured that most farmers were aware of new project activities and felt more confident about getting involved. In the context of the laws of popular participation and decentralisation the formation of a strategic alliance with the municipal government was vital for achieving widespread impact at the community level.

Understanding how best to manage alliances and partnerships between actors proved to be one of the greatest challenges facing organisations committed to scaling up in the field of NRM. It was within this context that the action research phase of the project placed much emphasis on helping participating organisations to plan and manage effective collaboration between actors. One of the main approaches taken was the development of an NRM platform. This platform was developed by the participating organisations and had four main aims, which were in keeping with the lessons learnt from the case studies: providing relevant capacity building; lobbying to move NRM up the political agenda; coordinating more effective inter-institutional collaboration; and providing a database of relevant information on topics such as funding, existing NRM research, and current development projects. A key advantage envisaged in the development of this centralised forum was that it would allow different stakeholders to share comparative advantages and provide a single accessible location for accessing relevant information. An evaluation with participants attending the NRM fair showed that 90% of them believed that the NRM platform was an appropriate body for tackling some of the key problems related to scaling up.

One of the main lessons learnt from developing the NRM platform was the importance of a key person or organisation to drive the process, motivating and coordinating participants until a solid base had been established and benefits were evident. Building a critical mass of motivation amongst the platform members was vital for its survival. The involvement of the State University of San Simon proved beneficial as its reputation gave the platform credibility and it was able to provide a stable base, funding, and good potential for institutional linkages at a national level.

Building institutional and community capacity

The case studies demonstrated that adequate stakeholder capacity in technical, social and organisational areas is essential for scaling up. Organisations with a deliberate policy of capacity building from the grass roots to local government level achieved greater impacts. Where lack of capacity is limiting scaling up, weaknesses need to be identified and appropriate training provided. Capacity building at community level in organisational and technical issues is vital for the on-going implementation and management of NRM practices at local level. It is vital because it provides members of the community, whether they are farmers or local organisations, with the confidence and ability to make decisions and to manage their own NRM projects.

Following from the case study findings, the action research phase of the project placed most of its emphasis on capacity building at different levels. Given the project's time constraint, the focus was on short-term training, mainly delivered through workshops. Those areas recognised by the institutions as pivotal for scaling up and in need of further consideration were identified and appropriate training workshops delivered. The main issues tackled were innovative funding strategies, functional linkages with the municipal government and grass roots organisations, strategies for effective inter-institutional experience sharing, and involvement in national networks.

The participating institutions found the workshops to be a useful approach to capacity building because they provided an interactive environment in which they could raise questions and also share their experiences. They all agreed that the availability of on-going opportunities for relevant capacity building would greatly facilitate the scaling-up process. However, they considered that in practice necessary programmes of capacity building were likely to be limited by the need for a sponsoring body to cover the costs and assume organisational responsibility. It was also noted that there was a lack of readily available expertise for building capacity on certain key organisational issues.

The planning and implementation of the capacity building workshops brought to light certain organisational factors important for achieving a successful outcome. To ensure that workshops are relevant, appropriate, and well targeted, it is vital to think very clearly and logically about what the workshops are trying to achieve and how this will be done. The main questions to consider are, Who are we working with? What is the base upon which their capacity will be built? How can we develop an approach that will be relevant and appropriate to their existing knowledge and skills? Although this point may seem obvious to the point of banality, such an approach was not common in Bolivia.

The community-level workshops on the concept of scaling up reinforced the importance of using communication techniques and tools adapted to the target group's vision of reality. They also highlighted the importance of carefully considering the mix of workshop participants from within the overall target group. Although contrary to the notion of inclusion, it proved more constructive to work with a small selection of open-minded people with good social skills who were better equipped to fully participate in activities. Such participants were then able to communicate appropriately the key messages to others within the community who found the workshop environment difficult. In the case of farmers, the youngest leaders seemed the most appropriate ones for the promotion of a scaling-up strategy. A memorable message from the farmers was that they needed organisational training more than technical training, particularly in the areas of local government proceedings and laws, project evaluation, articulation of their demands, decision-making capacities, and conflict-resolution methodologies.

Institutional workshops also demonstrated the importance of selecting an appropriate range of participants for achieving the workshop's outcomes. However, a workshop on funding strategies proved that when certain key invitees do not participate, the outcome of a well-designed workshop could be compromised. In this case, many of the donor organisations failed to attend, at the last minute, what had been designed as a forum for sharing and debate between themselves and interested NRM institutions. The resulting unbalanced group of participants limited useful debate and learning.

Improving community level approaches to technology development

Community-level analysis in the case studies demonstrated that the nature of the technology promoted was a key factor influencing adoption and hence scaling up. Technologies based on adding value to existing practices were popular because farmers could more easily understand the ideas and processes behind the technology. In some cases, use of locally available resources facilitated adoption and maintenance of technologies. Poor availability of key materials was shown to limit adoption of otherwise popular technologies. Technologies requiring a relatively high investment of cash, labour, or time, were less easily adopted by farmers with limited resources. In all cases the key factor limiting adoption of NRM practices was the lack of short-term benefits. In some cases this was overcome to a certain extent by developing technologies with multiple benefits.

The development of appropriate technologies and practices was shown to be highly dependent on the technology development process. As a result the strategies used by institutions to develop and disseminate NRM technologies or practices at the community level played a key role in uptake. Consultation with farmers in all the case studies identified those strategies that were most effective at stimulating uptake at the community level. Awareness raising activities were shown to be key in stimulating farmer demand for NRM practices because they allowed the farmers to gain a greater understanding of the negative impact that natural resource degradation was having on their livelihoods. Involving the farmers in planning research and development activities was important in ensuring that the projects responded to their needs and fitted in with their daily realities. Failure to take these realities into account reduced farmer participation. Participatory technology development and the farmer innovator approach were both popular with farmers because they widened their horizons by bringing together local and scientific knowledge and ensured a sense of ownership of the practices promoted. Practical field demonstrations and inter-community visits were also shown to be vital components of a successful promotion strategy because they enabled farmers to understand how the technology or practice worked and to see its benefits in their own environment. Incentives were shown to mask the true cost of a practice and also to motivate the involvement of farmers who are not really interested. In some cases this resulted in high short-term adoption levels, which were not maintained.

Because in Bolivia almost all institutions claim to use participatory approaches, their scaling-up plans tended to focus more on issues relating to vertical scaling up, where they felt that their weaknesses lay. However farmer feedback at the scaling-up workshop contradicted this vision. At least half of the workshop's 40 participants felt that many so-called 'participatory' approaches were merely cosmetic. They felt that most approaches were still top-down, with institutions being more concerned about farmer participation in their project activities rather than considering how their institution could participate in the community development processes. In particular, research institutions were considered to be overly focused on spreading their particular technologies or practices without considering whether these were really appropriate for improving livelihoods in a given area or community.

Improving accountability to local communities

The case studies showed that local development activities are often dictated by the agendas of external development institutions, namely researchers, NGOs, and donors. NGOs and researchers tended to be primarily accountable to donors with little accountability to their target beneficiaries. Many NRM interventions were sector specific, based on the institutional perception of community needs with little consideration of other community priorities. Most of the communities in the case studies had had little or no control over the development projects that they were offered or over their relationships with the intervening institutions. This sometimes resulted in piecemeal project interventions and duplication of work by various institutions. Certain case studies demonstrated that duplication could be reduced and the relevance of interventions increased by working through existing broad-based community groups. Where one development institution had developed mechanisms to give the community greater control over interventions and to consider NRM issues within the context of broader community needs, they had been enthusiastically received at the community level. Clearly local democratic processes are important in ensuring local leaders remain accountable to local communities.

The farmer evaluation mentioned in the previous section reinforces the importance of the call to improve organisational accountability to local communities. Although this issue was not specifically tackled in the action research phase of this project, there is much scope for interesting future action research in this area.

Including the poorest and marginalised

The case studies demonstrated that despite wide variations in livelihood strategies, the farmers who adopt or innovate technologies are nearly always the better resourced. Key factors influencing adoption identified in the case studies included the nature of the technology, access to resources, migration, education, and levels of non-agricultural income. The poorest resourced farmers had less risk-bearing capacity, less access to productive resources, less education, and less exposure to information. The main limiting resources were credit, land, irrigation, and time/labour. Education levels were important because educated people had better access to written information and wider exposure to activities beyond the community. Isolated families and those who migrated tended to be excluded as they often could not attend community meetings and missed out on important information and activities. Migrants to the city and those less dependent on agriculture for their income were less motivated to improve NRM practices. If the technologies developed are to benefit the poorest of the poor, then NRM organisations need to understand the livelihood factors that are leading to their exclusion and develop strategies that will counter these factors. This reinforces the message that timely situational analysis is important if the equity aspect of the scaling-up concept is to be fulfilled.

Ensuring sustainability after project completion

The case studies demonstrated that farmers were often dependent on institutional presence for continued implementation and dissemination of NRM practices. Lack of on-going institutional support was a widespread complaint made by farmers interviewed in all the cases. Institutional dependency needs to be overcome if scaling up is to be sustainable. The more successful cases showed that in order to overcome this problem, farmers need ready access to all the necessary elements that enable them to adopt, adapt, and disseminate technologies and practices that they have found attractive. These elements include increased organisational capacity, access to appropriate materials for implementation and maintenance, and technical support for when problems arise.

Monitoring, evaluation, and assessing impact

None of the case study institutions had functioning systems for assessing the impact of their activities. This lack of effective systems for measuring impact made it difficult to ascertain the extent to which promoted technologies were spreading and whether they were providing the desired benefits to smallholder farmers. Where M&E had occurred it had been limited to measuring outputs within the project lifetime. The main factors limiting the development and implementation of M&E strategies identified by the institutions were confusion over who should be responsible for M&E and how it should be undertaken, uncertainty over the definition of useful and accessible indicators, and lack of funds earmarked for M&E activities.

The experience of developing scaling-up plans with the collaborating institutions reinforced the fact that there was an urgent need to build capacity in this area. There was particular confusion over how to develop effective indicators for monitoring progress and measuring impact. Often, it was thought that proving a planned activity had been undertaken was sufficient for demonstrating impact. Moreover, where there was no necessity to demonstrate impact, institutions did not feel motivated to invest time and money in the process. This highlighted the importance of the increased donor emphasis on impact. Where measuring impact beyond the project lifetime is a requirement for funding, institutions will be more motivated to plan and implement effective M&E strategies.

In response to some of these problems, one of the collaborating institutions planned an interesting approach for building capacity in the development and use of indicators. Through discussion they had identified the importance of two main types of indicators: those to ascertain the extent to which scaling up was taking place and those to allow targeted groups to ensure that institutions were being accountable to their needs. To build on this, they aimed to hold a series of events bringing together a range of stakeholders in order to develop harmonised indicator types, which would then be incorporated into an indicator guide for measuring impacts. After the completion of this guide, they planned to offer training in its use at different levels, including municipal authorities. Unfortunately it was not possible to monitor the success of these activities within the project lifetime.

Conclusions

Although processes for scaling up successful pilot NRM practices and technologies were analysed through case studies, with key constraints and success factors identified, the short time frame of the action research phase significantly limited the extent to which these factors could be put into practice and tested. Within the short time available, the project focused on strengthening the capability of local professionals to promote scaling up, with a strong emphasis on building their motivation to continue with planned scaling-up activities after project completion. However, many of these activities remained within the institutional rather than the community domain.

Despite project limitations, the case studies combined with a short period of action research did demonstrate that the main requirements for scaling up include:

- planning for scaling up at project outset;
- understanding the wider environment beyond the project boundaries;
- increasing time horizons with a greater commitment to building long-term capacity;
- developing funding mechanisms that go beyond the time horizon of traditional projects with closer institutional integration and cost-sharing agreements;
- improving collaboration, networking, and forming alliances between the main stakeholders;
- building institutional capacity at both institutional and community level;
- improving community approaches to technology development and not just paying lip service to farmer participation;
- ensuring the poorest and marginalised are not excluded from the process;
- ensuring sustainability after project completion;
- carefully monitoring and evaluating progress at both institutional and community levels and assessing impact some time after project completion.

However, because scaling up is such a broad concept encompassing many important areas, each with its own microcosm of issues, the lessons gained from this research project are still relatively general. In order to develop an improved understanding of the practical approaches required for successful scaling up, longer-term action research is indicated in some of the key areas identified during this project. In particular it would be interesting to explore in greater depth the questions of community empowerment and organisation for scaling up NRM, which were not sufficiently tackled in this project's action research phase.

Moreover, although scaling up applies a non-linear approach to the spread of NRM practices, by starting with successful pilot technologies, we remained caught in a linear technology transfer approach from which it was hard to escape. The collaborating NRM institutions remained the key actors and the key issue remained how to get 'proven' NRM technologies to benefit more people. Perhaps it would have been interesting to focus more on how to ensure that the poor are able to articulate their NRM demands and how to respond to these demands.

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17 LINKING FIELD-LEVEL FINDINGS TO POLICY AND DECISION-MAKING IN NEPAL

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Abstract

Decisions by policy makers and implementers affect the uptake of innovative land management technologies and the strategies through which farmers put them into practice. Field research in Nepal has identified drivers to adoption related to awareness, support from external agencies, risk aversion, uncertainty over costs and returns, labour requirements, and effectiveness of farmer groups, while a lack of inter-agency and inter-ministry sharing of information constitute barriers to successful policy formulation and implementation. The 'Theory of reasoned action' is being used alongside qualitative research to identify those barriers that may be most amenable to policy intervention. The research so far has highlighted the need to move from a linear to an iterative and interpretive approach to analysing policy processes. Future steps in the research will use actor-network analysis to explore how information from field-level research and experience can help to inform the policy-making agenda and contribute to effective implementation. Lessons learned in the process of carrying out the research have had an impact on the design, conceptual framework, and methods.

Introduction

This chapter reports on ongoing research funded by the Natural Resources Systems Programme (NRSP) of the Department of International Development (UK) (DFID) under the title 'Developing supportive policy environments for improved land management strategies – Nepal'. It recognises that the policy environment creates incentives and disincentives for individuals, households, and other local decision-makers to adopt more sustainable strategies for managing their land resources. It is premised on the twin assumptions that (1) there are land management strategies (LMSs), developed and verified through field level research, that are appropriate for uptake on a wide scale beyond the area where the research was conducted; and (2) there are constraints to their uptake, at both farm and landscape levels, which can be eased through policy decisions in the political and administrative arenas.

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Effective management of land resources is an important element in improving the sustainability of local farming systems in the hills of Nepal and enabling them to contribute to poverty alleviation among food-deficit households that have little access to non-farm livelihoods. Many improved land management practices and strategies have been developed and validated at field, community, and landscape levels through on-farm, participatory research. But innovations often do not spread beyond the locality in which they were developed. This is partly a question of access to information about such innovations, pointing to the need for development of agricultural and knowledge information systems (AKIS), which can empower households and communities to pursue improved strategies. But constraints on the process of wider uptake and further adaptation occur in central and local government policy-making frameworks and in the operational policies of development organisations, government departments, non-government organisation (NGOs), donors, and private sector bodies.

Efforts to reverse land degradation processes require appropriate incentives for land users, principally farmers, both individually and collectively to change their behaviour. Government policies and the means through which they are implemented are major instruments to influence the behaviour of land users at local and national levels through incentives and sanctions. Without a clear understanding of how policies are made, who is involved in policy formation, how policies are implemented, and the potential impacts of proposed policies on the improvement of land productivity, effective engagement with policy processes to promote LMSs cannot be achieved.

The aim of the project is to identify constraints to the widespread adoption of farmer-validated LMSs that are amenable to policy intervention and reform, and to find effective ways of getting these constraints onto the agenda of policy-making bodies and processes. The project began formally in March 2001, though implementation in the early stages was delayed through factors largely beyond the control of the project team and NRSP, and is currently due to end in February 2004. The three planned outputs of the project are:

1. information and knowledge from recent and current land management research which can be applied on a wide scale identified;
2. constraints to uptake and adaptation of LMSs, which are amenable to policy intervention, identified and promoted;
3. sustainable processes for informing policy discussions at national level, within government policy-making structures, and within organisations that provide support services to rural land users, identified, validated, and promoted.

Activities and Findings to Date

Output 1: Identifying information and knowledge for wider application

Identifying relevant information and knowledge was addressed initially through a review of published and grey literature and discussions with research teams working on soil fertility, land management, and scaling-up, including other NRSP projects. This was followed by field validation in 10 village development councils areas (VDCs) in Parbat, Palpa, Myagdi, Tanahun, and Chitawan Districts (Regmi et al. 2002). The rationale for the field validation was to understand farmers' and other local stakeholders' perceptions of the strategies identified from the literature and in particular on their inherent viability. Field work was carried out at six locations where specific technologies or strategies had been developed or promoted with farmers ('intervention sites'), and then in six further locations, which had broadly matching agroecological conditions to the six intervention sites to form an assessment of the potential for widespread uptake (Regmi et al. 2002, Table 1). The strategies identified included fertility enhancement and maintenance through use of farmyard manure (FYM), composts, and/or chemical fertiliser; use of legumes within crop rotations; and modified sloping agricultural land technology (SALT).

Because of the security situation in the country at the time, a more restricted set of methods was used in this field work than originally intended. The main method used was discussions with focus groups established on the basis of gender and livelihood categories, backed up with transect walks or village tours and discussions with key informants including officers of the District Agricultural Development Office (DADO). In each intervention site, the focus groups identified factors that had facilitated or constrained the uptake of LMSs, and in each non-intervention site the research team assessed the similarity of socioeconomic and agro-ecological parameters with the intervention sites and explored with farmers the reasons for adoption or non-adoption of improved LMSs. These ranged from lack of awareness of alternatives to current practice and strategy, risk aversion, and perceived lack of support from local government and line agencies.

In the intervention sites, factors which have supported uptake include the high level of interest and resource deployment of government and NGOs, accessibility and exposure to new ideas, the involvement of organised and motivated farmers' groups, and the felt need to respond to negative pressures such as falling numbers of livestock and declining landholding size per household. The main constraints were related to concerns over high costs, low or risky returns, and the perceived (by some farmers) high labour demand of the LMSs. Farmers at these sites generally confirmed the technical success of the LMSs in terms of higher production of food crops and fodder, enhanced fertility, and reduced soil loss.

Output 2: 'The Theory of Reasoned Action' – identifying constraints to wider uptake

As work began on output 2, the research team recognised that it was necessary to clarify the distinction between specific land management technologies and practices and land management strategies. The distinction hinges on the goals that land managers are trying to achieve through a particular combination of practices. While there is a lot of (mainly grey) literature on improved practices (as shown in Regmi et al. 2002)) there is not much discussion in the literature about the strategic thinking that underlies the selection, adaptation, or rejection of these technologies and practices at household level.

Two clear approaches to the definition of an LMS emerged from discussions among team members. The first was to base the definition and selection of LMS for study in the project on existing Ministry of Agriculture land management policies. For example, the policy of encouraging farmers to incorporate both organic and inorganic fertilisers, which was inspired by the agriculture perspective plan (APP) initiative to encourage integrated plant nutrient management systems, could be used as the basis for defining a LMS. Others could be based on strategies promoted by NGOs, such as planting perennial species on terrace risers in order to increase fodder availability. This approach, however, assumes that the farmer or household adopts a particular practice or set of practices with a particular goal in mind. The second approach is to look at principal land management issues articulated by farmers and the combination of practices they employ at the farm level to address these issues. This second approach to defining the LMS was adopted. Two key land management issues were identified based on discussions with farmers during the field validation for output 1: integrated soil fertility management and soil conservation. The practices and techniques that farmers relate to address these issues link soil, livestock, tree, and crop management systems.

Constraints to the improvement of LMSs by farmers are being explored within the conceptual framework offered by the 'theory of reasoned action' (TORA,) (Ajzer) and Fishbein 1980). TORA has been applied extensively in a range of disciplinary fields including public health, nutrition, agriculture, and forestry to explore the cognitive decision-making processes of different social groups. It is acknowledged as one of the most reliable theoretical approaches to understanding the cognitive constructs underpinning individuals' decision-making processes (McKemey and Rehman forthcoming). It hypothesises that the expressed intent to undertake a particular behaviour is the best predictor of actual behaviour; that behavioural intention is dependent on two factors – attitudes and the subjective norm (which is essentially the social pressure felt by the individual to behave or not behave in a particular way); that attitudes depend on a combination of the individual's belief that a particular behaviour will lead to a particular set of outcomes and the values they attribute to those outcomes; and that subjective norms are a function of the individual's normative beliefs regarding how they feel 'important others' would expect them to behave and their motivation to comply with these 'others' (Figure 17.1).

The field work element of the TORA methodology comprises two main steps: qualitative field research based on semi-structured interviews and group discussion to elicit output beliefs and social referents, followed by a sample survey using a formal questionnaire to assign quantitative values to the separate constructs in the model. Correlation analysis shows the strength of relationships between the various constructs. The outputs of the analysis can then be used to plan information, advisory, and policy interventions to address those factors that are most strongly associated with the performance or non-performance of the behaviours – in the present case, LMSs and the specific technologies and practices through which they are expressed. The main

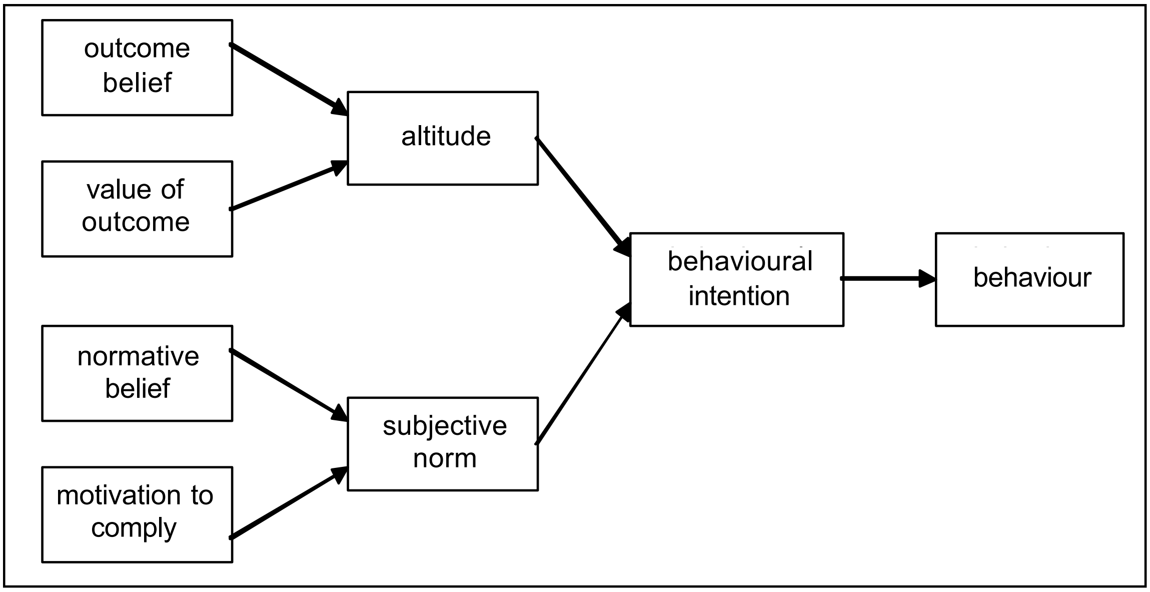

Figure 17.1: **Schematic presentation of the 'Theory of Reasoned Action'**

purpose of using TORA in this project is not, however, to design information and advisory programmes for farmers, but to identify constraints and motivating influences that might be amenable to policy intervention. The outputs of the analysis will be a key input to a workshop with policy makers in July 2003.

The team carried out the qualitative phase of the field work in November 2002 through interviews and discussions with 30 households in 6 villages, some in areas exposed to extension interventions relating to land management and some in areas not exposed, and in a range of altitudes. The outcome beliefs derived from the interviews and discussions give an insight into the strategic thinking behind the use or non-use of particular techniques. The final TORA questionnaire addressed six behavioural decision areas relating to the two strategic issues identified above. Taken together, these six allow land management to be viewed from an integrated perspective of livestock, forestry, and crop management systems:

- increased dependency on FYM;
- increased dependency on chemical fertilisers;
- cutting rather than pulling legumes when harvesting;
- planting hedgerows (live barriers);
- stall feeding;
- planting fodder trees.

With regard to each decision area, specific related management practices were identified, for example, methods adopted in the production and application of FYM. After piloting the questionnaire, the team completed the second phase of the field work in February 2003, through interviews in 8 locations with a total sample of 240 respondents, stratified to ensure adequate representation of men and women and different livelihood categories. Data entry was completed in March and analysis will be carried out in Nepal during May 2003.

Output 3: Exploring the policy-making process

Sutton (1999) suggests that policy decisions in developing countries are often made on the basis of limited knowledge. Policy making frequently depends on generalisations from poorly interpreted statistics or on policy narratives that at once simplify and set an agenda for action. In the agricultural sector, practical knowledge of how sub-sectors function and respond to change is poor and there is a shortage of biophysical and socioeconomic data. Attempts to improve decision support mechanisms incorporate two objectives: the transformation of available data into useful information, and the management of information in order to maximise knowledge potential (Holt et al. 2002).

The team has carried out an initial review of relevant policies and policy-making processes in Nepal. The former was done through a desk study of policy documents (Subedi et al. 2002) and the latter through key informant interviews followed by a one-day consultation meeting in Kathmandu with policy makers (Holt *et al.* 2002). These studies suggest it will be appropriate to abandon a linear model of policy making in favour of a more complex interpretive approach that acknowledges negotiation, iteration, and the importance of actor-networks in establishing knowledge that contributes to the making and implementation of policies (Clay and Schaffer 1984; Keeley and Scoones 1999). In this model, networks of actors engage in the joint production of understanding of a problem. Policy-makers and implementers are both actors. Interaction can be a creative 'forward and backward mapping' between problem definitions and assessments of policy solutions that can produce fresh insight into a problem and new directions for policy. From this perspective, formulation and implementation overlap and interact, and implementation becomes communicative action between policy actors and their target groups. Understanding the process by which issues surface in the policy-making agenda and how shared perceptions emerge among policy makers about the nature of problems and solutions will provide a key to identifying points at which information from field-level research can have an influence.

The consultation highlighted gaps in current policy and unintended negative consequences of policies that have been applied beyond the area to which they are most appropriate, for example, implementing community forestry policy in the high mountains, which has negatively affected migratory livestock farming (Holt et al. 2002). More detailed analysis of the policy-making process is continuing and will culminate in a stakeholder workshop planned for July 2003. In particular further analysis is needed to validate the following preliminary conclusions:

- social, political, and economic circumstances in Nepal critically influence and limit the effectiveness of the policy-making process;
- inter-ministry and inter-agency coordination over policy formulation is lacking and information sharing ineffective;
- participation of relevant actors in policy making from the private and non-governmental sectors and the farming community is lacking;
- plans and project documents are developed mainly from external consultancy for external funding requirements with little local input;
- farmers' interests and indigenous knowledge are seldom reflected or represented in policy.

Learning from the Research Process

The research project was originally conceived within a linear model: identify improved LMSs; identify policy constraints to their wider uptake; and then seek to reduce these constraints through informing the policy-making process. During the research so far, the team has learned lessons that will affect how the remainder of the project is carried out and will lead to a more useful set of eventual findings. These lessons include:

- land management innovations in one village do not necessarily spread to neighbouring communities with apparently similar circumstances, even when the innovation is highly visible: in order to understand this better, we will now look for innovations that have spread autonomously and explore the reasons for this;
- a major cause of non-adoption of innovations seems to be a general lack of confidence among community members: this suggests that community empowerment must be seen as an integral part of any strategy to encourage improved land management. We will incorporate discussions with participating communities about general issues relating to life chances and aspirations into the field work;
- it is too simplistic to separate policy making and policy implementation into two separate activities and processes, involving different sets of actors: our analysis of policy making will be done using an actor-network approach, which explicitly recognises the interaction and mutual learning that goes on between these two interrelated processes;
- the role of change agents (extension workers, adaptive research projects, NGOs, and innovative farmers) is clearly an important factor in the speed of adoption of land management innovations: the policy-making analysis will include exploration of decisions regarding the employment and deployment of public sector and NGO extension staff.

Next Steps

In the light of the lessons learned so far, the immediate next steps are to:

- complete the analysis of the TORA survey data, in a way that builds capacity among the Nepalese researchers in this form of analysis and interpretation;
- explore from literature and from known instances in the field, contributory factors in the spread of land management innovations beyond the boundaries of extension or project intervention or beyond the source of the innovation if it has derived from local knowledge;
- explore ways to empower community members to make a balanced assessment of the risk involved in adopting land management innovations;
- derive an actor-network matrix for extension mechanisms based on an AKIS model through interviews with key informants active in fieldwork areas;
- delineate further the central and local government policy-making frameworks and identify any changes introduced as a result of recent political instability.

The main link between output 2 and output 3 is the stakeholder workshop planned for July 2003, in which the main participants will be policy makers and senior managers of organisations with mandates relating to land management. The purpose of that workshop will be to:

- explore the extent to which the constraints to uptake of LMSs identified through the TORA analysis are amenable to policy intervention;
- further elaborate our analysis of the policy-making process, including the extent to which policy makers use available information to assess the likely consequences of their decisions;
- identify ways in which policy makers become aware of alternative actions and the effects of policy on land management decisions at household and landscape levels;
- explore means of increasing the flow of information between the various actors involved in policy making and implementation;
- develop a detailed plan for the final year of the project – for achieving output 3.

The essence of the final year's activities will be to test ways of introducing lessons from local research into the policy-making and implementation discourse and monitoring the effect of this on policy makers' awareness of the extent to which their decisions can strengthen the motivators and minimise the constraints to the uptake of sustainable LMSs. The research process so far, including the opportunity to present the work in progress and receive feedback from peer review, has highlighted the need for flexibility and learning during the implementation of a programme of research: the team has been able to modify their plans for the final stages of the research in ways that are likely to lead to a more useful set of findings.

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18 BRIDGING RESEARCH AND POLICY FOR IMPROVING NATURAL RESOURCE MANAGEMENT – Lessons and Challenges in the Highlands of South-western Uganda

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Abstract

Natural resource management (NRM) research and development (R&D) is becoming an expanding thrust of policy research on African agriculture because although natural resources constitute the basis of sustainable livelihoods, their degradation has intensified over the years. However, despite this interest in NRM policy research, there is a paucity of empirical studies that link research to policy process in Africa. There is concern that NRM research and technology development has not been reflected in policy change, nor has it affected decision-making processes of rural communities for better management of natural resources. This chapter reports experience with a participatory policy action research process in Kabale, Uganda. It aims at strengthening local-level processes and capacity for developing, implementing, and enforcing local policies or byelaws to improve the adoption of NRM technologies that require collective action and collaboration. The main thrust of this action research process is building and strengthening a tripartite dialogue and interaction between local communities, local government structures, and R&D organisations. This critical triangle is made operational by the policy task forces at the district, sub-county, and village levels. These task forces have proved to be critical in building support for byelaw review and formulation, and in mobilising political, social, human, and technical resources that are needed to sustain the participation of local communities in policy dialogue and action and for the adoption of NRM innovations. Lessons learnt suggest that there is significant opportunity for research to influence and support the process of decentralisation by strengthening the capacity of local governments and local communities to accelerate wider-scale adoption and dissemination of NRM technologies. To be able to influence policy, research needs to provide direct support to the process of policy formulation and implementation. Mechanisms that researchers could use to influence and support

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policy actions to accelerate the adoption of NRM technologies are suggested. Influencing policy in NRM is, however, a long process that needs perseverance and a sustained programme of interventions by different institutions.

Introduction

Natural resources constitute the basis of rural livelihoods systems and hold the key to increased food security and sustainable development in the highlands of east Africa. However, the degradation of natural resources is intensifying and has been described as one of the key constraints to sustainable development. Natural resource management (NRM) is a relatively new and expanding thrust in policy research on African agriculture (Omamo 2003). Several scholars have concluded that if natural resources are to be protected against the risk of destruction, it is essential that governments devise a range of policy instruments that can influence behaviour for the adoption of technology innovations and institutions that promote sustainable management of natural resources to alleviate poverty (Scherr et al. 1996; Egulu and Ebanyat 2000; Shiferwa and Holden 2000; Pender et al. 2001). However, there is concern that NRM research and technology development has not been reflected in policy change, nor has it affected the decision-making processes of wider communities (NRSP 1999).

In Uganda, recent decentralisation efforts have shown promising improvement in the participation of local people and other stakeholders in the policy decision-making process. To be effective, decentralisation must be based on effective and sustainable local institutions, by engaging local communities directly in the articulation of their policy needs and in the analysis, design, and implementation of policies and innovations (Rasmussen and Meinzen-Dick 1995). However, there is concern that decentralisation has not resulted in improvements in the management and use of natural resources, nor has it affected the capacities and decision-making processes of local communities over the management of natural resources. As Thomson (2000) points out, in too many cases, local communities and other stakeholders have a very limited role to play and even when policies advocate participatory processes, they are often used in a more extractive than empowering context. Many problems of NRM require a wider perspective involving community organisations, research and development (R&D) institutions, local government, policy-makers, and multiple stakeholders. The need to broaden NRM research from simple technology solutions to include socioeconomic and policy dimensions is increasingly recognised in the NRM R&D community (Wang'ati 1994; Pretty 1995; Lawrence et al. 1999). Policy support is an essential ingredient for widespread adoption of NRM technologies and for scaling up sustainable management of natural resources. However, despite this interest in NRM policy research, there is a paucity of empirical studies that link research to policy process in Africa.

Recognising that policy support is always needed for the adoption of NRM innovations, the African Highlands Initiative (AHI)[7] established a policy working group to increase the

[7] "AHI was established in 1995 as an eco-regional programme to focus on the issues of land degradation and agricultural productivity in the highlands of East and Central Africa. AHI's guiding philosophy is a client-driven approach using participatory methods and an effective research development continuum where research partners, using collaborative, synergic partnership can bring together diverse contributions to foster farmers' innovation and collective action for design and dissemination of appropriate integrated technologies and methods for improving NRM in the diverse and complex situation." (AHI 1999)

policy relevance of research at the local level and to design alternative policy instruments to facilitate adoption of NRM technologies. The AHI local NRM policy research initiative focuses on assessing the effectiveness of local NRM policy processes and assessing the relationships between policy change, technology adoption, and NRM (Place 2001). This chapter reports experiences with a participatory policy action research project which aimed at strengthening social capital to improve policies and decision-making in NRM in four pilot communities in the highlands of Kabale, south-western Uganda. The purpose of the project is to strengthen local-level processes and capacity for developing, implementing, and enforcing byelaws and other local policies. This will improve NRM by supporting and facilitating the integration of participatory approaches into policy decision-making and implementation to promote the adoption and increase the impact of NRM innovations and byelaws that require collective action and collaboration.

This participatory action research addresses three important aspects of sustainable livelihoods: social and human capital, policies, and institutions to improve natural capital. Its purpose is to strengthen the social capital of pilot communities to improve their participation in local policy formulation, implementation, and decision-making to accelerate the adoption of sustainable NRM practices. The central hypothesis of the project is that the presence of social capital is a necessary pre-condition for the participation of resource-poor farmers in policy formulation and implementation, and in R&D activities and for the adoption of NRM innovations that require collective action and collaboration.

The rest of the chapter is divided into four sections. The next section describes the research setting, its institutional and policy setting, and the operational framework for the study. Based on this framework, we describe the policy action research process, which includes (1) participatory research in NRM; (2) facilitating policy dialogue; (3) participatory policy analysis; and (4) supporting policy action. We also discuss some mechanisms for supporting policy action. The chapter concludes with some key lessons learnt and challenges for policy and R&D.

Research Methodology and Conceptual Framework

The research setting

The highland areas of east Africa cover 23% of the region and house over 50% of the people (over 50 million). Population pressure has continued to increase resulting in high population densities, land shortage, and fragmented small farms (0.25-1.0 ha for a family of 6). In Uganda, the highlands account for 27% of land area and close to 40% of the total population. They are mostly in the south-western and western part of the country as well as in the east. This paper is based on research work conducted in Kabale, a mountainous district in south-western Uganda and a benchmark site of AHI. The benchmark site is also characterised by high population density (exceeding 400 inhabitants/km^2 in some areas), and steep cultivated slopes (1500-2700 masl) but with an adequate bi-modal rainfall (annual average 1000 mm). The majority of the hills have semi-permanent bench terraces up to the hilltops, developed some 50 years ago along the contours of the hills and now a common feature of Kabale district. These soil conservation measures were widely practised prior to the 1970s, promoted by agricultural services and enforced by the local administrators. However, as a result of several years of political turmoil, breakdown in administrative services, population pressure, and poverty, many of these old terraces have seriously deteriorated (Pender et al. 2001). As a result, declining soil fertility and erosion are serious problems in this area. It is estimated that about 90% of the district soil is affected by erosion, due to steep slopes, population pressure, deforestation, poor farming, and vulnerable soil. Results of household interviews showed that indeed most households are affected by soil erosion, gullies, collapsing terraces, and flooding of valley bottom farmlands (Sanginga and Kamugisha 2003). A recent study, which assessed the extent of land degradation and soil losses in the pilot communities, estimated that between 21 and 59 t/ha of soil are lost at slope gradients ranging between 48% and 71%, respectively, through gully and rill erosion in the watershed (Mbabazi et al. 2003). Livelihood options for most people are limited to food crop production (sorghum, beans, potatoes, field peas, sweet potatoes, maize, and banana) and a few livestock. Off-farm employment options are limited, but there is an increase in the number of men seeking employment elsewhere.

The project works directly with its primary stakeholders in the Buramba-Mugandu watershed in Rubaya sub-county – poor male and female smallholder farmers – using community-based participatory action research methods. Rubaya is notable both for its land degradation and the large number of projects that have attempted to address NRM issues. The project facilitates regular interactions and discussions between the primary stakeholders, decentralised policy institutions, and local target institutions. The implementation of the study combines and integrates a range of participatory research approaches and formal survey methods in order to triangulate research findings from different perspectives and to ensure the participation of local stakeholders.

Policy and institutional setting

Decentralisation in Uganda is probably one of the most ambitious and far-reaching reforms of local government reform undertaken in sub-Saharan Africa. The decentralisation process was initiated in 1986 and culminated in the '1997 Local Government Act', which provides the legal framework for the participation of local communities in policy-making and for sustainable NRM. The functions and services regarding land use, management, and administration are the responsibility of local government and local councils (LCs) (Table 18.1). At the base of the local government structure, the LC1 (village council) consists of all adults residing in a particular village. The village community elects a nine-member village LC executive committee. Beyond the village, in ascending geographical size, there are parish (LC2), sub-county or gombolola (LC3), county (LC4), and district (LC5) councils. The district council (LC5) is the highest level of local government and links with central government. The sub-county level (LC3) is the basic unit of local government, both political and administrative. The provision of local government elections guarantees widespread representation at the various councils and includes quotas by gender, people with disabilities, and young people. For example, at least one-third of the council members must be women, an affirmative action to empower women and promote gender equity.

Table 18.1: **Decentralised structures in Uganda: levels and main functions**		
Local Council Level	**Composition**	**Functions**
LC 1: Village (composed of about 50 households)	9 members At least 4 women	• Assist in maintaining law, order, and security • Initiate, support, and participate in self-help projects • Recommend people for local defence units • Serve as a communication channel with government services • Monitor the administration of projects • Impose service fees • Collect taxes • Resolve problems and disputes • Make byelaws
LC 2: Parish (composed of 3-10 villages)	• At least 4 women from each village elected	• Assist in maintaining law, order, and security • Serve as a communication channel with government services • Initiate, support, and participate in self-help projects • Monitor the administration of projects • Resolve problems and disputes
LC 3: Sub-county (composed of 2-10 parishes)	• At least 1/3 women • At least 2 young people • At least 2 people with disabilities • Elected councillors from parishes	• Local government • Enact byelaws • Approve sub-county budget • Levy, charge, and collect fees and taxes • Monitor performance of government employees • Formulate, approve, and execute sub-county budgets • Resolve problems and disputes
LC 4: County (composed of 3-5 sub-counties)	• 5 (chairpersons or vice-chairpersons from each sub-county)	• Advise district officers and area Members of Parliament • Resolve problems and disputes • Monitor delivery of services
LC 5: District (composed of 3-5 counties)	• 36 members • At least 12 women councillors • At least 2 young people • At least 2 people with disabilities • 19 elected councillors	• Exercise all political and executive powers • Provide services • Ensure implementation of and compliance with government policies • Plan for the district • Enact district laws and ordinances • Monitor performance of government policies • Levy, charge, and collect fees and taxes • Formulate, approve, and execute district budgets

The mechanisms of decentralisation are established and functioning, with the structure of a five-tier system of local councils and committees, decentralised staff, a bottom-up planning process, and powers to collect and disburse local revenue (James et al. 2001). These changes have brought some impressive results, creating a fundamentally different environment for open and participatory policy and decision-making at the lower councils. However, there are some problems in the implementation of the decentralisation policy. Inadequate resources, trained personnel and human capital, revenue collection and use, and accountability of funds, and weak institutions and misconception of policy are some of the most common problems (Kabale District Local Government 2002). Decentralisation in Uganda is still a relatively young process and does not yet constitute a genuinely participatory system of local governance (James et al. 2001). The need to strengthen that process and ensure the participation of local communities in the decentralisation process constitutes the thrust of this participatory policy action research conducted in Kabale, Uganda.

Operational framework

Our operational framework (Figure 18.1) is adapted from the policy process framework (Minde 2002) and is based on the following key components: (1) participatory NRM research and development, (2) participatory policy analysis, (3) facilitating policy dialogue, and (4) supporting policy action. The process is facilitated and monitored by policy task forces (PTFs) at different levels (district, sub-county, and village), which ensures the integration of the different elements of the process. For an effective policy dialogue, some conditions are necessary. One is the presence of social capital or efforts to strengthen social capital. The other condition is effective mechanisms for participatory policy analysis. Policy action follows the participatory policy analysis process and needs to be supported by technologies that will improve the natural resource base and increase land and labour productivity and profitability.

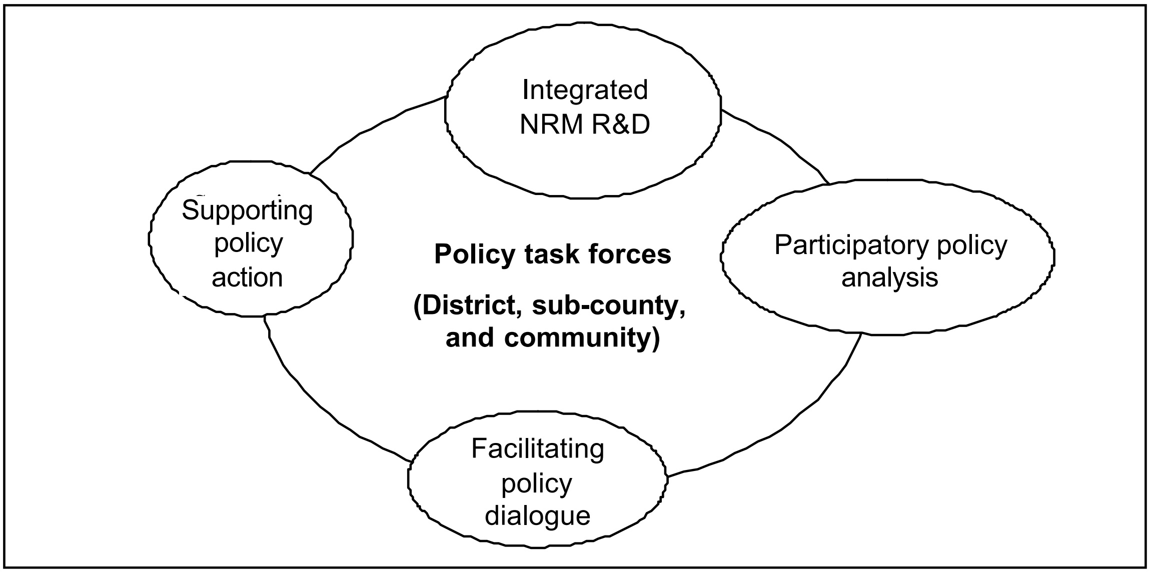

Figure 18.1: **Operational framework for the participatory policy process**

Results and Discussion

In this section, we present and discuss the experiences and lessons learnt in the implementation of this participatory policy action research. First we summarise the participatory research process in NRM promoted by AHI and other development partners. Second, we describe our efforts in promoting and facilitating policy dialogue through the use of stakeholder forums and PTFs at the different levels.

Participatory NRM R&D

The decrease in soil fertility and high rates of land degradation and erosion are some of the common concerns of farmers and R&D workers as well as government leaders in Kabale. Several NRM technologies are available locally and are being promoted by R&D organisations such as Agroforestry Research Network for East and Central Africa (AFRENA), AFRICARE, the National Agricultural Research Organization (Uganda)

(NARO), AHI, CIAT, and Africa 2000 Network. A recent survey (Raussen et al. 2002) compiled an inventory of existing technologies to solve NRM issues in Kabale. Despite these considerable efforts, widespread adoption of NRM technologies is still a challenge (Table 18.2).

Table 18.2: **Use of soil conservation measures by farm households**

Soil Conservation Measure	(Percentage of farmers, n=146)		
	Female	Male	All households
Construction of new terraces	38.6	45.3	42.1
Digging of trenches	32.9	38.7	35.9
Mulching	14.3	21.3	17.9
Use of trash lines	5.7	6.7	6.2
Planting grass strips	8.6	9.3	9.0
Use of agroforestry	25.7	30.7	28.3
Fallowing with trees	20.0	32.0	26.2
Natural Fallow	31.4	34.7	33.1

Source: Sanginga and Kamugisha (2003)

It has been argued that the dearth of participatory approaches for technology development and dissemination is one of the key factors that limits the adoption of NRM technologies. There is a general dissatisfaction with the agricultural research and extension system (Röling and de Jong 1998), which has not been particularly successful in supporting positive technological change for small-scale farmers. Over the years, it has been widely suggested that a new type of approach for agricultural R&D is called for. There is considerable evidence to show that new R&D approaches allowing farmers to participate fully in developing, demanding, and accessing information will improve farmers' capacity to select and adopt appropriate technologies and will improve the capacity of scientists and partners to respond to research needs (Chambers and Jiggins1986). In other words, the participation of potential users increases the efficiency and effectiveness of the processes of technological change in agriculture.

Over the years, the AHI has made substantial efforts to catalyse and promote participatory research in NRM. AHI's approaches emphasise the use and formation of farmer research groups as a central strategy for participatory research. The participatory agroecosystem management (PAM) approach has eight distinct stages, from rapid rural appraisals to technology dissemination. In general, participatory rural appraisal exercises provide the starting point for identifying problems by developing problem trees with farmers that can then be used as a basis for identifying and selecting solutions and best-bet technologies.

Once the entry points were established, PAM planning workshops were organised to develop participatory research action plans. The next phase was the design of adaptive research experiments, which were established on farmers' fields, managed by farmers, and evaluated to select best-bet options. Successful options could then be disseminated through farmer-to-farmer dissemination channels or other alternative dissemination channels, such as the telecentre or rural community information centres. Greater participation, of farmers in all the research processes, moving from the consultative to collegial type of participation, is a major thrust of AHI.

Given the wide range of NRM issues and approaches for addressing them, AHI has adopted the term 'integrated natural resource management' (INRM). This novel approach needs to balance and integrate different disciplines, embrace focused systems thinking, have multiple scales of intervention and analysis, focus on creating adaptive capacity of farmers, and give considerable attention to policy and strengthening social capital or organisational development (Sayer and Campbell 2001). The INRM paradigm would engender a focus on participatory approaches that redefine the role of scientists, farmers, and other stakeholders (Opondo et al. 2002), in a resource-to-policy system. The resource-to-policy system links farmers resources and capital assets, their management and production constraints and opportunities for marketing, and policy to provide incentives for the adoption and use of NRM technologies. It examines policy options that provide incentives to adopt NRM technologies that increase productivity and profitability of land and labour and facilitate collective action and collaboration.

Participatory policy analysis

Policy analysis is another important aspect of the research contribution to policy. As Thomson (2000) points out, the contents of policy, the process of policy formulation, and the way policy is implemented, need to be fully understood by those responsible for policy implementation. In this chapter, we use the term policy in its broad sense, to refer to programmes, strategies, plans, rules, and regulations and their implementation resulting from public (state) or collective decision-making (Thomson 2000; Means et al. 2002). Policy can be generated at different levels: international, national, regional, district, and local levels and can operate at all levels, and in both public and private spheres or in community organisations. They can be formal (for example, laws that govern land tenure) and informal (for example, social customs and conventions), created (for example, as a result of deliberate political or policy decisions), or evolved over time. In this study, we are particularly concerned with those local-level policies and local authority and community regulations usually referred to as byelaws. Byelaws are rules made by lower LCs under the 1997 Local Government Act and provide the local policy guidelines to be followed in sectoral developments such as agriculture and NRM.

Under decentralisation, many local governments are involved in reviewing existing byelaws and formulating new ones. However, there is no systematic information that provides policy-makers and other stakeholders with much guidance on people's awareness, implementation and assessment of the effectiveness of existing byelaws, constraints in their implementation and their outcomes, and strategies for making existing byelaws more effective. In too many cases, byelaws and policies are designed on the basis of inadequate empirical understanding or weak empirical evidence. The need for more empirical information about the awareness and effectiveness of current byelaws and other local policies and the problems or constraints in their implementation was evident in the various policy stakeholder workshops. The first policy stakeholder workshop in 1999 recommended that a study should be conducted to improve the understanding and awareness of byelaws, to assess their effectiveness, and to suggest mechanisms and processes for improving the formulation and implementation of byelaws and other local policies.

Byelaws (or local arrangements and institutions) for NRM now receive greater attention as a viable alternative for enforcing government policies and rectifying their inefficiencies in agriculture. There are six general byelaws in agriculture and NRM in the areas of soil and water conservation, food security, tree planting, bush burning, controlled grazing, and swamp reclamation. Each of these byelaws has specific regulations and enforcement mechanisms (Box 18.1).

Box 18.1: **Examples of byelaw regulations and enforcement mechanisms**

The soil and water conservation byelaw

1: Any person who clears land for cultivation on a slope shall:

- construct bunds /barriers across the slope parallel to the contour;
- plant appropriate grasses or agroforestry trees on the bunds;
- construct barriers as determined by technical agricultural extension officer;
- not plant annual crops on a steep slope, but plant trees.

2: Planting of crops shall be done along the contour.

3: Any person demarcating two plots shall not use farrows nor gullies, but mark stones, live hedges or shrubs.

4: (a) All paths, cattle tracks, and access roads shall be protected against erosion by runoff channels and soak-away pits and;

(b) Paths or tracks may be closed by community leaders to prevent erosion and alternative routes provided.

Any person disobeying the provisions of this law shall be guilty of an offence and shall on first conviction be liable to a fine not exceeding UG SHS 3,000/= or imprisonment for 15 days or both and shall on any subsequent conviction be liable to a fine not exceeding Shs. 5,000/= or to imprisonment as may be effective.

The tree planting byelaw

- Any person who cuts a live tree shall (a) plant two (b) ensure the planted ones are protected and well looked after
- All persons who own private woodlots on hills and want to clear fell must first seek advice from forest department, local council and local chiefs
- Appropriate tree species shall be planted not less than 3m on both sides of feeder roads
- Only agroforestry trees shall be planted on the boundary, terraces of neighbouring plots. Other tree species should be planted at a distance not less than 3m away on any other boundary
- The local committees with help of chiefs will make sure all road reserves are planted with rows of trees on both sides

Whoever contravenes the conditions of this byelaw should be guilty of an offence and shall on the first conviction be liable to a fine of UG SHS 3,000/= and planting the number of trees felled; on second conviction will be liable to both imprisonment of 21 days and planting the number of trees felled.

To make the byelaw review process more systematic, we adapted the sustainable development framework of the International Institute for Sustainable Development (IISD) (Hardi and Zdan 1997), which has the following steps.

1. Bring together all stakeholders and begin to analyse the issues; to begin the analyses of the policies, byelaws, and related issues, adopt an appropriate scope and focus
2. Prioritise policies and byelaws for analysis
3. Analyse whether the policies and byelaws are consistent with sustainable NRM in the broader rural livelihoods context
4. Assess the capacity for implementing policies and byelaws to identify potential problems
5. Develop action plans to revise byelaws and to build capacity for policy formulation and implementation; this step involves full stakeholder participation in developing policy reform options, allocating responsibilities and resources, and undertaking additional activities to build the necessary local capacity for successful policy formulation and implementation
6. Develop criteria and indicators by which progress will be assessed and measured
7. Review and monitor the implementation of policies and byelaws on a regular basis

We conducted a survey of 146 male and female farmers in the pilot communities to assess their awareness and perception of the effectiveness of these byelaws in agricultural and natural resource management (Sanginga and Muhanguzi 2003). Among other results, it is interesting to note that there is a byelaw that recommends that the construction of barriers and planting of vegetation on the bunds should be guided by technical agricultural extension workers. This regulation was not known by the majority of farmers and its enforcement was therefore not effective. The enforcement of the soil and water conservation byelaws was very effective in the colonial times, because then there was strict and regular monitoring of byelaws by extension workers, local chiefs, and government administrators. Most soil conservation measures, especially the terrace bunds, were established during that period. This strict administration faded in the 1980s, with civil unrest and the degradation of administrative and extension services. The inefficiency of government extension services has partly led to the increasing number of non-government organisations (NGOs) that are actively working with farmers to combat soil erosion and land degradation. But given their nature and modalities of work, they do not have capacity to enforce the implementation of byelaws. With the recent initiatives of the National Agricultural Advisory Development Services (NAADS) in privatising agricultural extension services in Uganda, there are concerns that public authority for enforcing such byelaws will be further lost.

Results show further that about half of the farmers were not aware of the tree planting byelaw, recommending that "only agroforestry trees shall be planted at boundary or terraces of neighbouring plots". The regulation that "all persons who own private woodlots on hills and want to clear fell must first seek advice from forest department, local councils and local chiefs", was the least effective. This has caused the dramatic destruction of woodlots for poles and timber production, leaving many hills with very little, if any, tree cover. Figure 18.2 shows that the main reasons for the ineffectiveness of the byelaws include weak enforcement mechanisms, outdated regulations, no sensitisation of farmers, and conflicts between different policies and administrative structures (agriculture, forest, and wetlands departments), as well as lack of effective extension services. With the decentralisation process, the local chiefs are not sufficiently empowered to reinforce strict implementation of byelaws and the dual nature of decentralisation has created some confusion about the roles of different power structures. In many cases byelaws are outdated and their prescribed sanctions can be easily abused.

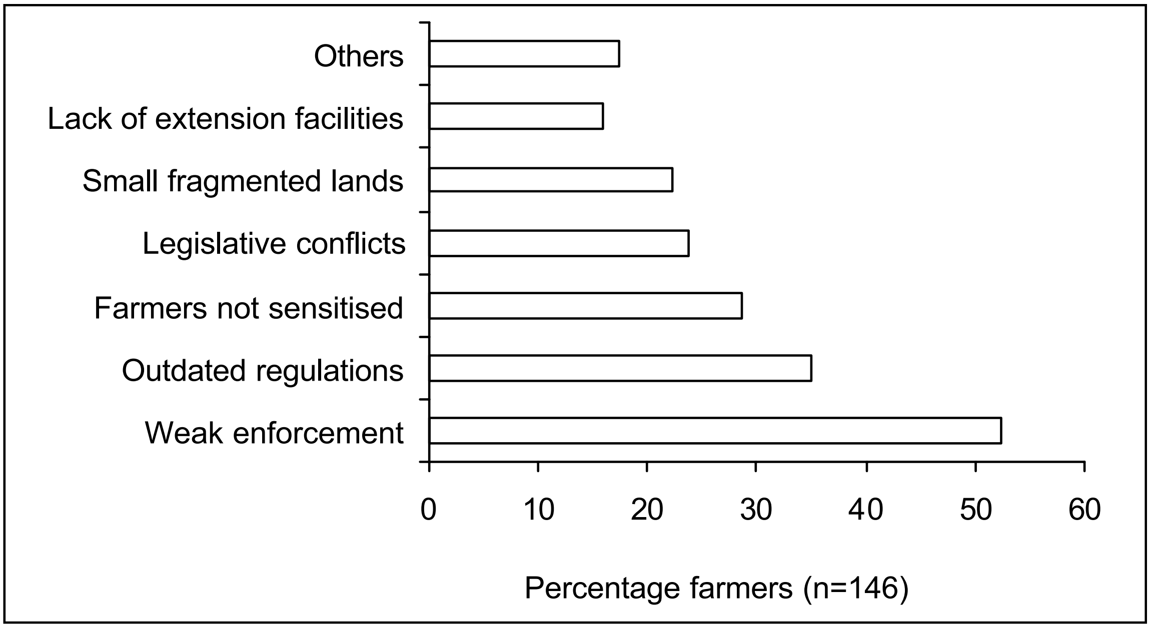

Figure 18.2: **Farmers' assessment of the reasons for weak and ineffective byelaws**

Byelaws that are thought to be more effective are associated with strong enforcement mechanisms, participation and sensitisation of local communities in their formulation and enforcement, and technologies and practices that increase productivity. It was evident that byelaws need to be supported by appropriate technologies that can increase agricultural productivity for resource-poor farmers with diminishing land resources. Many of the recommendations to make byelaws more effective require capacity building of different stakeholders, both local communities and decentralised structures, which R&D organisations are better placed to facilitate. This is a significant role that R&D institutions can play, but it requires initiatives to facilitate and promote policy dialogue between the different stakeholders and to support policy action for improving decision-making and the adoption of improved NRM practices.

Promoting and facilitating policy dialogue

It is evident from the results of the participatory analysis of byelaws that it is important to develop capacity for implementing byelaws and enhancing community level participation in formulating and monitoring byelaws. For more than two decades, participatory methodologies have proved effective in enabling people to take greater control of the development process. However, with few exceptions, efforts have not focused on increasing local participation in policy review and formulation. Participation can be promoted by facilitating dialogue where community members or community representatives can engage in dialogue with local leaders, government officials, and other stakeholders. The project used two mechanisms: policy stakeholder workshops and PTFs.

NRM policy stakeholder workshops
The first district-level policy stakeholder workshop was held in November 1999. The workshop was organised by AHI in collaboration with the district council and was attended by district leaders and councillors, members of parliament, sub-county councillors, local government technical services, R&D organisations, and farmers' representatives. The theme of the workshop was: "Improving the policy relevance of NRM research and development" (AHI 1999). The workshop identified a number of priority issues for research and policy intervention.

Policy stakeholder workshops are held twice a year to bring together a large number of participants (80-100), including representatives of neighbouring districts. The themes of these workshops vary according to the needs expressed during previous workshops and results from R&D to share with a wider policy audience. The workshops are organised into three sessions: (1) presentations by farmers, R&D organisations, and government technical services; (2) plenary discussions to identify and debate key issues from the different presentations; and (3) multi-stakeholders' working groups to discuss specific issues in detail and to develop policy recommendations.

As noted earlier, even such participatory processes may actually be extractive rather then genuinely participatory; local farmers may have little role to play and their presence may be more symbolic (Thomson 2000). To make this dialogue more effective and participatory, some specific efforts are necessary to strengthen the weakest stakeholders, the farmers, and other local stakeholders. To prepare farmers to be effective partners in the district-level stakeholder workshop, we facilitated a number of meetings and consultations in the villages. Using a range of participatory techniques (mapping, diagramming, role plays, group discussions, and visioning techniques) farmers are facilitated to develop their community action plans, indicating NRM issues that need policy and R&D interventions. The village policy task forces (VPTFs) are further facilitated and mentored to a articulate their presentations better with confidence. It has been particularly useful to organise farmers' exposure visits to areas with some successful experience in collective action, effective byelaws, and adoption of NRM technologies. After such visits, the VPTFs of the different villages meet together to reflect on their observations and impressions and on opportunities for their integration in their community plans. They also use the opportunity to rehearse their presentations while other farmers ask questions and suggest improvements. Some farmers are elected to chair and facilitate the meetings and discussions, while the research team play a low profile role. We found that this process has been very useful not only for exposing farmers to innovative NRM technologies, but also for building their confidence and capacity to engage in policy dialogue with other stakeholders. This confidence grows with the number of meetings and events that farmers attend. In his mid-term review report, Stocking (2002) observed that the most interesting highlights of the stakeholder meetings were farmers' presentations and subsequent working group discussions. Indeed in several cases, farmers' presentations were more articulate than those of researchers and development workers.

Policy task forces (PTFs)

The first stakeholder workshop recommended the formation of a PTF, with the principal responsibilities of identifying and undertaking joint priority activities and providing a forum for institutional linkages between the different stakeholder groups. The members of the task force were nominated by the stakeholder workshop to represent their stakeholder groups. It was initially composed of eight members, representing different stakeholder groups (district council, local government technical services, R&D organisations, sub-county council, and farmers' representatives), but has been extended recently to 12 members to enable a broader representation. The district policy task force (DPTF) was coordinated by the district council speaker, a 'champion' in NRM R&D and policy, who was later elected as the district chairman.

It was further resolved to facilitate the formation of PTFs at the sub-county level and in the four pilot learning communities. The sub-county is a critical aspect of the decentralisation system, as it has important political and administrative powers to develop byelaws, development plans, and budgets, and to allocate resources. It is ultimately the unit where policy reform can be initiated more effectively. The VPTFs are modelled on the 'Landcare triangle' (Figure 18.3) of the tripartite relationships of key actors in NRM: farmers, local government, and R&D technical facilitators (Garrity et al. 2000; Catacutan et al. 2001). The criteria for electing or selecting members, and the number of members of the VPTF, were determined during community meetings. In general, a VPTF has between 6-8 elected members with a representation of women of at least 40%.

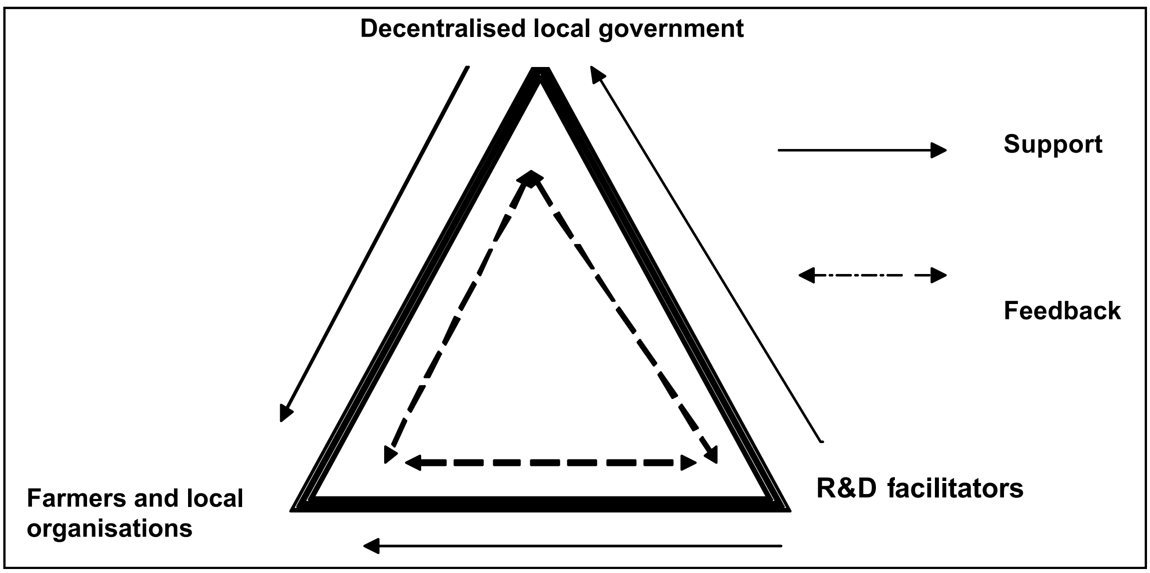

Figure 18.3: Policy Task Force (critical triangle)
source: adapted from Catacutan et al. (2001)

Besides the elected farmers, at least four local councillors and government officials are appointed to the VPTF. The VPTFs also nominate their representatives to the sub-county PTF that meets regularly. The formation of the PTFs is based on the 'synergy approach' of social capital (Woolock and Narayan 2000). This approach contends that the synergy between local policies and social capital is based on the complementarity and mutually supportive relationship between local government and community actors. At the village level, because local government councillors or government officials are from local communities, they are embedded in local social relations and hence can be under pressure from the community to perform and be responsive to them.

The VPTFs are meant to (1) create a platform for dialogue between communities, local government councils, and R&D organisations on the analysis of NRM issues and local byelaws, (2) to initiate and monitor the review, formulation, and implementation of byelaws, and (3) disseminate NRM technologies. This requires strengthening the social capital of local communities to improve their decision-making powers and collective analysis. The steps include the following among others.

- Identifying and supporting farmers' organisations and institutions in relation to NRM
- Motivating and facilitating people and communities to be involved in the process of action learning, and stimulating reflection on policies, byelaws and their NRM practices
- Use of group dynamic methods to facilitate and support actions, initiatives, and interventions that catalyse the development and strengthening of community organisations and sustainable management of natural resources
- Stimulating joint analysis through visualisation, diagramming, and other relevant participatory tools
- Creating opportunities and space for collective action, and common platforms and forums for negotiation of NRM issues and providing links between research, extension and policy, and local communities – these include community meetings, village-level meetings, multi-village meetings for making connections and exchange between representatives of different villages, and stakeholders' meetings for negotiations between local communities and policy-makers

Supporting policy action

The aim of the participatory policy analysis and facilitating and promoting policy dialogue is to provide necessary information and space for influencing policy decision-making and implementation processes. In his recent compelling critique of policy research on African agriculture, Omamo (2003) argues that policy researchers must get closer to the reality and become more concerned with practical issues of implementation, for example, how to promote the feasibility of the alternative policy options and recommendations. As Tyler (1999) also observed, for the findings of the participatory policy analysis and policy dialogue to be reflected in policy use and systematic practice, initiatives for supporting policy action are required rather than only "abstracting data, analysing and generating expert-driven technical solutions". To be able to influence policy, R&D needs to provide direct support to the process of policy implementation. The way in which policy is implemented can change the effective content of policy. In the various policy stakeholder workshops and DPTF meetings, we aimed to identify mechanisms researchers could use to influence and support policy actions. Some of these mechanisms are consistent with and exemplify some important elements of the sustainable livelihoods policy guidance sheets (DFID not dated). They include the following.

Coordination and networking
Constraints on influencing policy include lack of coordination and duplication and fragmentation of R&D efforts. It was pointed out that in many cases, R&D players convey different and at times conflicting messages to policy-makers as well as to farmers. Reaching and influencing policy-makers depends on R&D, and building effective networks of influence and communication. Networking between local NGOs, and other national and international organisations and civil society engaged in agriculture and NRM may be an effective strategy in getting research results into the policy-making process.

Communication and information
It was observed that research results are like any other products that need to be marketed to be used. However, the language of academic researchers is frequently inappropriate to a policy and development audience. Effective communication skills are essential for influencing policy. Well-documented evidence, quantitative economic analysis, scenario building with practical examples using simple graphical analytical tools and information representation (for example, mapping and geographical information systems) can be powerful ways of presenting results to policy-makers. Researchers need to develop alternative innovative communication and information strategies and processes for targeting people who make, influence, or implement policy. Some powerful means are tailor-made policy-learning events' (workshops, seminars, videos, exposure visits, and field visits) that aim to disseminate NRM best practices or technologies, share lessons of experiences, and expose policy-makers and other stakeholders to existing practices and knowledge that improve natural resources. Researchers should market their own products or build strategic alliances with NGOs and government institutions who can market these products.

Opportunistic timing
If researchers wish to influence policy, they must be able to diagnose the relevant policy environment to identify key points of leverage and recognise short-term opportunities associated with related legislative calendars, planning and budgeting activities, changes in key leaderships, political appointments, and government personnel. R&D needs to pay attention to two important aspects in order to influence policies.

– Identifying and capitalising on crisis situations. Windows of opportunity for change can present themselves at times of crisis, such as floods, land slides, drought, fires, and other natural disasters. The successful example of Kyantombi watershed (Raussen et al. 2001) was a response to flooding during the El Nino rains.
– Leadership consistently plays an important role in any policy initiative. It is generally

leaders who put reform on political agendas, who provide a vision, who are actively involved in shaping the content of proposals for change, and who spearhead the process of generating support for policy change. The emergence of strong NRM champions in the district councils provides an opportunity for advancing policies that promote NRM.

Capacity building

In a decentralised system, the most effective voices in reaching policy makers are those of the elected local councillors. However, the inadequacy of human capital at the different levels of local government is a key constraint to policy formulation and implementation. Researchers can have an important influence on policy by helping to build the capacity of local councillors, helping their understanding of the situation, giving them credible data and evidence, and strengthening their confidence. Appropriate capacity-building events on NRM technologies and policy process and content are critical for any sustainable policy change.

Strengthening social capital

Social capital is one of the specific factors that point to successful and effective implementation and sustainability of agricultural policies and innovations. Effective policy action must be based on effective local institutions and community organisations that engage local communities and farmers in the formulation and implementation of policies. It was recognised that even in a decentralised system or a participatory process, local communities and farmers' representatives often have a very limited role to play and are limited simply to representation. As argued by Thomson (2000), a sustainable livelihood-friendly policy process would require a much more active role for farmers and local communities, community-based organisations, and civil organisations. The greatest potential for achieving participatory policy action lies in an emphasis on strengthening and sustaining the capacity of local communities to carry out policy dialogue and action. The success of any policy dialogue and policy action will depend on the presence of mature social capital and efforts towards strengthening synergies between social capital and policy or political capital. Recent research has also shown the importance of social capital foundations for successful policy interventions and community development (Uphoff and Mijayaratna 2000; Woolock and Narayan 2000; World Bank 2000; Grootaert 2001). Its reinforcement and continued deployment in a society is what maintains both the existence of particular institutions and the process of institutional innovations within society. The challenge is to maintain and enhance social capital so that all forms of capital, including natural capital, can be enhanced.

Finding and promoting policy incentives

Research needs to identify and document successful cases of good NRM policies and explore and recommend policy incentives for better NRM, taking into consideration the institutional framework and socioeconomic conditions. For example, research can explore what incentive systems and mechanisms might work for land consolidation in the context of small fragmented agricultural lands in Kabale. What strategies can national policies, such as the plan for modernisation of agriculture, with its related programmes, such as NAADS, put in place to provide incentives for investment in soil conservation and sustainable land management? Could a land management fund to reward farmers who are found to comply with given byelaws (Akelo 2002) provide incentives for sustainable management of natural resources? Should the district provide subsidies for improved varieties of seeds linked to soil conservation measures, such as hedgerow planting and trench making? Should there be a policy on 'minimum input strategies' (Raussen et al. 2001) to facilitate widespread adoption of agroforestry technologies in Kabale? Results of empirical studies in Ethiopia (Shiferaw and Holden 2000) showed that policies that link production subsidies with soil conservation could provide opportunities for combating soil erosion. Can this work in Uganda, given the current policies of liberalisation of economy, decentralisation, and modernisation of agriculture?

Conclusions

The main thrust of this action research process was building and strengthening tripartite dialogue and interaction between local communities, local government structures, and R&D organisations. This 'critical triangle' materialises through PTFs at different levels, from the district to the sub-county and local levels. The PTFs have proved to be critical in building support for byelaw review and formulation; in mobilising the political, social, human, and technical resources that are needed to sustain the participation of local communities in policy dialogue and action; and for the adoption of NRM innovations. For instance, through their VPTF, farmers in the small village of Muguri B (about 59 households) have formulated a byelaw on digging trenches to reduce runoff on hillsides. They have so far established 220 trenches in a short time and are now actively engaged in adaptive research to stabilise the bunds with different options of dual purpose barriers using different legumes and shrubs. This byelaw has now been discussed in the sub-county council for its general application in the sub-county. Raussen et al. (2001) have also reported similar successful cases of this tripartite alliance in Kyantombi watershed in Kabale.

Lessons learnt so far suggest that the VPTFs are also supporting mutual beneficial collective action and other important dimensions of social capital such as exchange of information and knowledge, sharing of resources, collective management of resources, community engagement, spirit of voluntary work, charitable involvement, and local community participation in R&D activities. The VPTFs are strengthening their organisational capacity and their group and leadership structure to act collectively, not only on their experimental activities, but also increasingly towards other activities for the common good. We found that the VPTFs are increasingly becoming vehicles through which farmers are pursuing wider concerns, initiating new activities, organising collective action among members, and extending relationships and linkages with external organisations. These VPTFs are taking the lead in catalysing the development process within their communities and are increasingly making demands to AHI and other R&D organisations. With regular exposure and farmers' exchange visits, the VPTFs are also helping to create 'bridging' social capital by linking VPTFs amongst themselves and to other formal and informal R&D organisations.

However, despite considerable progress at the local and district levels, effective links with national institutions and higher-level policy makers are still problematic. This is partly due to the nature of decentralisation where decisions are taken at lower levels. There are, however, some opportunities that can be realised, such as interactions with the Ugandan parliamentarian group on food security and land degradation and leaders of neighbouring districts, and linking up with national level institutions such as Uganda National Agricultural Advisory Services (NAADS) and the National Environment Management Authority (NEMA), and with nationwide NGOs and civil society organisations within and outside Uganda. There is good potential for scaling up as Stocking (2002) observed in his mid-term review of the project. He notes "... although it is difficult to estimate, about 5 million poor rural people in Uganda live in similar physical environments (taken as the nearby districts of Kabale, Kisoro, Bushenyi, Rukungiri, and Ntungamo), at high population densities, relying on rain fed arable cultivation on steep slopes and valley-bottom wetlands. If the adjacent areas in Rwanda, eastern Congo and Burundi are included, then the project is representing the conditions of at least 30 million people. 'Social capital' has been eroded significantly in the region by migrations, conflicts and ethnic tensions."

We argue that with the current decentralisation in Uganda, there are significant opportunities that R&D can utilise to influence policies, and to translate research results into policy and decision-making in wider communities. The chapter has highlighted such opportunities and strategies that can improve the policy relevance of NRM R&D, and strengthen the capacity of local governments and local communities to accelerate wider-scale adoption and dissemination of NRM technologies. We need to note however, that influencing policy is a long process that needs perseverance and a sustained programme of interventions implemented by different institutions.

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19 CHALLENGES TO INCREASING THE OPPORTUNITIES FOR THE POOR TO ACCESS BENEFITS OF COMMON POOL RESOURCES – The Case of Community Forestry in the Terai of Nepal

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Abstract

The growth of forest user groups (FUGs) in Nepal over the last 10 years could be taken as an example of the effective scaling up of community-based organisations. However this growth has taken place mainly in the hills and not in the Terai (plains) and we have little evidence of the effect of community forestry on the livelihoods of the poor. This chapter reports on research on FUGs in two districts of the Terai of Nepal. Information was collected on the use of common property resources, the processes of community group formation, and the outcomes of these processes. The evidence indicates that while the effect of community-based forest groups has led to improved tree cover within the community forests, for a variety of reasons to do with access, these have not necessarily translated into pro-poor livelihood benefits. A generalised framework is presented that distils some of the key underlying issues in relation to analysing the linkages between new forest management institutions, social and economic processes, and natural resource access and use. While there is room for manoeuvre in creating a more enabling environment for community forestry and promoting pro-poor livelihood benefits, greater recognition needs to be given to the diverse use of forests and the role of these uses in poor household livelihood diversification strategies.

Introduction

The basis for community forestry in Nepal was laid with the 1978 Forest Act that established the principle of participatory forest management. However it was not until the early 1990s when a combination of pressure for democratic reforms and frustration with the failure of community forestry to develop that the legal basis for forest user groups (FUGs) was established through the 1993 Forest Act and the 1995 Forest Regulations. In 1991 the number of FUGs was a few hundred; this grew to 2,756 by 1994, and 8,559 by 1999 (Britt 2002).In September 2002 the Community Forest Division of the Department of Forest recorded a total of 11,586 FUGs in its database, made up of 1,276,433 households managing just under one million hectares of forest. With the growth in numbers of FUGs, an FUG members association, the Federation of Community Forest Users, Nepal (FECOFUN), has established itself to become a

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significant lobbying force for FUG interests. Growing out of a forest user network, FECOFUN was formally established in 1996 and now has a membership of over 7,500 FUGs. It has played a key role in representing user group interests and pressing for legislative and institutional reform in relation to the management of forest resources (Britt 2002).

The growth in number of FUGs over the last 10 years in Nepal could be read as an example of the effective scaling up of community-based organisations. There is a widespread opinion that the community forestry programme of Nepal has been an effective example of community-based resource management (see Arnold 1998; Baland and Platteau 1996) and could come to be a model of community-driven development. The environmental outcomes have been positive with a demonstrable increase in tree and vegetation cover. Organisations have been established that are rule bound, as evidenced by constitutions, operational plans, and committee structures.

One should not underestimate the significant shift in the balance of power between forest users and the Department of Forest in the very specific circumstances of Nepal, a shift that is in progress and under continuing negotiation. However a closer reading of the evidence (and what is missing from the evidence) at the very least raises important questions over the public story of success and it is significant that community forestry remains an important arena of contest between non-government organisations (NGOs), FUGs, and the Department of Forest. Three issues are raised here, which set the background to the rationale for the research study reported on in this chapter.

The first issue is that the growth of FUGs is location specific rather than general. A closer look at the location of FUGs shows that the majority (98%) are to be found in the hills of Nepal (Table 19.1) although the Forest Act does not discriminate between the hills and the Terai. A look at some key summary statistics indicates why this might have happened.

Table 19.1: **Contrasts between FUGs in the hills and the Terai of Nepal**

Key descriptors	Hills	Terai	Total
Number of FUGs	11,341	245	11,586
Total area (ha)	871,845	38,525	910,370
Total number of households	1,184,497	91,936	1,276,433
Average number of households /FUG	104	375	110
Average area/FUG (ha)	76.9	157.2	
Average area/household	0.74	0.42	
Total income (NRs)	4,115,171 (n = 7676)	5,602,140 (n = 196)	9,717,311
Total expenditure (NRs)	733,879	2,687,289	3,421,168
Average income/FUG	536	28,582	
Average expenditure/FUG	95	13,710	
Average income/household	5.2 (n = 793,439)	68.3 (n = 82,066)	
Average expenditure / household	0.92	32.75	

Source: FUG database of the Community Forest Division, Department of Forest, Kathmandu, 11 Sept. 2002.
In 2002, US$ 1 = NRs 78

Although they are fewer in number, the average area and membership of Terai-based FUGs are at least twice that of hill-based FUGs. Further, the average income of Terai-based FUGs is over 50 times that of hill-based FUGs. These differences are carried through to contrasts in income and expenditure levels per FUG household. In summary the Terai forestry resources are extremely valuable and the Department of Forest has been reluctant to allow community forestry in the Terai and lose, as it sees it, a valuable revenue source. For this reason the process of establishing FUGs in the Terai has been hard and contentious (Britt 2002).

The second issue is that the story of social forestry success has focused on the bureaucratic processes (constitutions, membership, plans) and has assumed that positive environmental outcomes are evidence of livelihood benefits for the community. However there is little understanding of the livelihood outcomes of social forestry or any attempt to detail the ways in which households of different caste and socioeconomic status have benefited. It does not necessarily follow that because there has been biomass increase as a result of community action that pro-livelihood benefits are gained from this, either by individual households or communities.

The third issue, which is related to the second, is that there has been a strong tendency to treat 'communities' as socially homogeneous and undifferentiated. There has been little attention paid to the way in which different social groups actually use forest resources and how this varies between social groups. An understanding therefore of if and how the poor access common property resources under existing arrangements is an essential first step in asking how this can be improved and built upon.

The research that is reported on here was initially planned for the hills but a variety of circumstances including insecurity and a shift of interest led to a repositioning in the Terai. The research set out to investigate the linkages between current and proposed new systems of management of common pool resources and prevailing social and political relations around natural resource use. It was based on an understanding that even new systems of resource management are embedded within existing social and political relations and the knowledge of such relations is essential for successful design and implementation of new institutional arrangements. The research focused on collecting information on the livelihoods of different social groups and their access to forests and forest products and sought to detail the way in which these different groups access the resources they need to build and sustain their livelihoods.

After an outline of the methods and location of the research, this chapter presents a summary of the main research conclusions using selected evidence from the site-based studies. It uses these to explore a range of issues that determine the extent to which the poor at present gain livelihood benefits from common property resources before examining the implication of these for 'scaling-up' processes.

Methods and Study Sites

As originally planned the research would have been jointly implemented between NORMS, (a Nepalese NGO established in 2000 by a group of professionals with long-term experience of social forestry in Nepal, and the Overseas Development Group (ODG) of the School of Development Studies of the University of East Anglia, UK. Due to the political instability in Nepal and security issues associated with the ODG team doing fieldwork over extended periods, the onus of doing the fieldwork shifted to NORMS and what evolved was a relationship in which the ODG team provided advisory and capacity support to NORMS through briefing and design sessions, field visits, and debriefing discussions with the research teams. This chapter does not discuss this research process or the lessons learnt by both organisations further, but it should be recognised that such institutional capacity development can also contribute to the scaling up of benefits to the poor.

A range of field sites were selected in the Terai within two districts, Rupandehi and Nawalparasi (see Table 19.2). Sites were selected for contrast, to capture differences in quality of forest resources (for example, Rajahar with high-quality forest against Devdaha's lower-quality forest), differences in location of forest resources between the north of the Terai where most forest is to be found and the south where there is little remaining (for example, Rajahar in the north and Harpur in the south of the Terai), and differences in the nature of the common property resources (for example, forest against wetlands, as in Suryapura).

On the basis of a structured checklist that was developed as the research evolved, discussions and interviews were held at village development committee (VDC), village, user group committee, and social group level in order to investigate the use of common property resources, the processes of community group formation, and the outcomes of these processes.

These group interviews were supplemented with specific household interviews based on a purposive sample to capture the range of users. In addition community group constitutions, committee minutes, and operational plans for community forestry were consulted and analysed. Detailed inventories of forest resources were compiled from operational plans (where they existed) supplemented with records of the Department of Forest and field-level observation.

The research was carried out in three major rounds, with debriefing, review, and drafting of site reports at the end of each round. The identification of missing information and gaps at each stage, supplemented by comparative data coming from new site studies, led to a number of revisits to sites to obtain deeper information on particular issues. NORMS held debriefing sessions with both communities and other interested parties (for example, the Livelihood Forest Project, funded by the Department of International Development (UK)(DFID)) on the basis of the draft reports.

Table 19.2: **Location of research study sites**					
District	**VDC**	**Site**	**Situation**	**Key community resources examined**	**Issues**
N-p	Makar, Jahada	Parijat CF	Main road, market town	Unregistered community forest (CF)	CF boundaries, ward and ethnic inclusiveness
N-p	Harpur	Dalit Mahila	Southern Terai, no forest	Wetlands	Resource taken by VDC
		Harpur Jain Amanigunj Bhaksipur	Southern Terai, no forest	Canal-side tree planting	Political conflict in committee
N-p	Rajahar	Dhuserir – CF	High value forests	Community forests	Diversity; high complexity in high value forest management;
		Chautari – CF	High value forests	Grass and thatch	institutional instability, rent seeking
		Jharahi – CF	Plantation for the control of river cutting		Dispute over land use for settlement
		Kalika – BCF Sishuwar – BCF Bhusamrachhyan – BCF Gaurav – BCF	Buffer zone for conservation area	Grass and thatch	Community definitions based on residence versus community definitions based on use
R-d	Suryapura	Karmahaw	Southern Terai, interior	Wetlands	Community-contractor conflict
		Deurali – CF		Handed over forest; 'under process' forest; good regeneration of natural sal	Potential conflicts as forests start to give good income from sale of timber
R-d	Devdaha	Srijana – CF	Main road, market town	Handed over CF	High value forest but heavily cleared, involvement of NGOs
		Budhhamawali – CF			Participatory processes

VDC = Village Development Committee; N-p = Nawalparasi; R-d = Rupandehi; CF = community forest group; BCF = buffer zone community

Emerging Conclusions

We summarise first our major conclusions with respect to our understanding of the way in which new institutional arrangements around common pool resources have had livelihood effects at the specific sites where the study was done. We limit the discussion here to summary conclusions drawing on selected issues; further details are to be found in the project reports under preparation. We focus for the purposes of this chapter mainly on community forestry.

Resource supply

Information both from data on standing volume of timber, history of specific community forest action, group discussions, specific household interviews, and field observations all support a picture of improved environmental outcomes as a result of the formation of FUGs. Most FUGs have been involved in tree planting activities and the combination of this and protection of their forests has contributed greatly to improved forest cover. For many FUGs (for example, Srijana in Devdaha) the availability of grass for livestock feed has been reported to have increased significantly and internal markets for the sale of grass have emerged. However attention must be drawn to two details that qualify this picture of improved environmental outcomes.

First, the measured data on vegetation that is available refer only to standing timber volumes. They do not include the amount of grass produced (which we do know has increased), non-timber forest products (for example, medicinal plants), or information on the range of other products (such as, charcoal, soil, and leaves for plates) that many households identified as important forest resources.

Second, the data only refer to the community forest area and one cannot assume that forest products are only collected from community forest areas. Indeed it is clear from many household interviews, particularly in Devdaha FUG that the major source of forest products comes from outside the community forest area, for example, in the state forest area, partly because the FUG area is so small. Evidence for the availability of forest resources from these areas is not available. Thus processes of protection that have come with community forests have in some cases simply led to a displacement of extraction by both non-members and members of FUGs into areas that are not effectively protected.

Access

Increased standing volumes of timber do not necessarily mean that there is increased access (officially) to either timber or fuel. Although preparation of the operational plans requires that a complex exercise of calculating the standing volume of timber, annual increment, and annual allowable cut should be gone through, standing forestry rules do not permit the cutting of trees (in 1999 a forest order banned the cutting of green wood). Even under community forestry, the only timber and fuel that can be harvested is from trees that have fallen down from natural causes or from allowable forest practices, including thinning. Although shallow soils, shallow rooting, and intense seasonal storms do yield a crop of trees that have fallen down through natural causes, as might be expected there is ample opportunity and evidence of the falling of trees being an 'assisted' process – trees are 'fallen' down in order to increase supply.

A second consideration of access relates to where you are settled and the available extent and quality of the forest. If the discrepancies between the hills and Terai are striking (see Table 19.1), even more so is the variability in household access to timber resources between FUGs within the Terai. As Table 19.3 makes clear, there is enormous variability between the study sites in terms of both the volume of standing timber, its value, and the amount that is available per household. In Dhuseri, the community forestry area and its value per household is at least five times more than in Srijana in Devadaha, reflecting both the community forest area per household and the nature of the forest resources.

Table 19.3: **Comparison of sample FUGs by area, area per household, resource value and resource value per household**								
Community Forest	**Area and rank (ha)**		**No of households**	**Area per household & rank (ha)**		**Resource value (mill. NRs)**	**Resource value per household and rank (mill NRs/hh)**	
Chautari CF	355	2	665	0.54	1	1084	1.63	1
Dhuseri	205	3	613	0.33	4	880	1.44	3
Parijat	600	1	1324	0.45	3	493	0.37	4
Bartandi	46.3	6	101	0.46	2	152	1.50	2
Kalika (BZ)	22.5	10	207	0.11	8	74	0.36	5
HJAB	14.42	11	460	0.03	14	70	0.15	7
Aichawal Thakurpur	54	5	336	0.16	6	59	0.17	6
Deurali	67.12	4	1221	0.06	12	53	0.04	10
Jharahi	30	8	241	0.12	7	32	0.13	8
Buddha Mawali	40.5	7	600	0.06	12	15	0.03	11
Sisuwar (BZ)	24.3	9	135	0.18	5	14	0.10	9
Srijana	11.3	13	158	0.07	11	3.5	0.02	12
Bhu – Smarakshan (BZ)	14	12	150	0.09	9	1.8	0.01	13
Gaurab (BZ)	3.5	14	41	0.09	9	0.17	0.004	14

Source: Compiled from various sources including operational plans, field measurements, and market prices
In 2002, US$ 1 = NRs 78

This is not just a feature of the study sites. Figures drawn from the Department of Forest for FUGs in Rupandehi and Nawalparasi (Department of Forest 2002) districts show a wide range of forest area per household. For Rupandehi, for the 25 FUGs on the database, the FUG area (ha) per household ranges from a maximum of 0.84 ha to a minimum of 0.01 (an 84-fold difference) with a modal value of 0.16 ha per household. For the 13 FUGs in Nawalparasi, there is a 46-fold difference between the maximum value of 1.21 ha and the minimum value of 0.026 ha per household; the modal value is 0.103 ha. In part these summary statistics reflect a lack of policy focus on issues of spatial equity but they also have a story to tell in terms of how FUGs came to be established within the Terai. This includes pre-emptive action by some communities to which the Department of Forest has had to respond and fight (and sometimes lose) a rearguard action to retain control. Discrepancies on area under community forestry between what the community claims that it controls, what the FUG constitutions state, the details of the operational plans, and the official database have a rich story to tell and are returned to later.

Third, access depends on how 'community' is defined. There are various dimensions to this. One aspect to this is how the Department of Forest defines community and this is largely in terms of 'users'. As the regulations put it (Ministry of Forest and Soil Conservation 1995) "the district forest officer shall have to take into account the distance between the Forest and the village and the wishes as well as the management capacity of local users." How 'account' is to be taken is of course not specified, but by raising the issue of 'distance' it is clear that more distant 'users' are at a disadvantage with respect to potential membership than those who are close. This has meant that, for example, the Tharu (the original inhabitants of the Terai), who tend to live further south from the FUGs and who have historically made seasonal rather than regular use of forest products, have effectively been disenfranchised from access although informal arrangements with some FUG committees have been established.

The buffer zone management around Royal Chitwan National Park under the Parks Department is clear – community is defined in terms of residence. This has had the effect of disbarring households from wards in Rajahar VDC outside the buffer zone, who have traditionally used products within the park boundaries, from any access to the products of the buffer zone. However, Department of Forest regulations allow households from within the park buffer zone to use the community forests of Dhuseri, Chautari, and Bartandi. This asymmetry in rights of access appears to be leading to restrictions on residents from the buffer zone having access to the community forest outside the park boundaries.

The story is however even more complicated. Many households appear to hold multiple membership of FUGs, for example, many of the Buddha Mawali FUG members also have membership in another FUG. It was not possible to assess which households these were but analysis of the households that were not members of FUGs, and most FUGs have households living around the forest who are not members (in Srijana over 40% of households are not FUG members), tended to show that these were the poorer households, often the original residents of the Terai. There are at least two reasons why such households are not members.

The first hinges around the definition of what constitutes a legitimate 'use' of the forest. This has been largely determined by forestry regulations and adopted by most of the FUG constitutions, which refer almost exclusively to a restricted list of timber products. This does not include for example the right to make charcoal or graze goats in the forest. Thus the Lodh (an occupational caste group), who have traditionally been ironworkers and dependent on charcoal from the forest, have officially lost access to this resource although whether this consistently happens in practice is less clear. Those households in Bartandi who had established an important income source through goat rearing had been using the forest area of Chautari and Bartandi before the FUGs were established. Once the FUGs were established they lost their grazing rights and had to dispose of part of their herds. They have shifted into boulder collection from the nearby river.
The establishment of community forests has also had effects on those who in the past have depended on the collection of fuelwood for a major source of income. As one woman in Buddha Mawali FUG in Devdaha put it "before the management of the forest as Community Forest I used to sell fuelwood at NRs 70/basket but I could not do this after the formation of the community forest." She switched her occupation to agricultural labour, but this was seasonal work and she could only earn during the agricultural period.

Differing membership categories established by the committees in some of the FUGs have also acted to restrict access in a number of direct as well as indirect ways. In Parijat, Hjab, and Dhuseri FUGs there are categories of membership, based on contributions, that give rise to differential rights. Dhuseri FUG has, according to the constitution established three categories of users based on the fee they should pay and the respective benefits derived from this. High entry fees (in a number of cases over NRs 1,000 as in Buddha Mawali FUG) make it difficult for late settlers or those who had reservations about joining at the start, to join at a later date.

The final dimension that we will consider here is that of the pricing mechanisms and we draw here from an investigation of the hidden economy operating in Dhuseri FUG, which as Table 19.3 shows has command of valuable resources. The official indicators for the FUG present a model of success. Detailed accounts (annual budgets, audits), plans (operational plans), and reports (minutes of assemblies) are kept and annual income and expenses are around NRs 1.7 million. Regular forest management activities according to the operational plan are implemented including establishing and tending nurseries, forest maintenance, and thinning. However a detailed examination of key policies and practices indicates that there is much that is inequitable and that the distributional outcomes disadvantage the poor. A detailed study of the hidden timber economy of Dhuseri shows that as a result of pricing policies (most notably a difference in internal and market prices of some NRs 150-300 per cubic foot) and timber allocation procedures (which make it difficult for the poor to access their quota, and encourage corrupt practices by members of the committee), windfall profits are available for those with access to capital and the means of circumventing ineffective and often corrupt bureaucratic controls. Out of the NRs 1.5 million FUG budget only 7.2% has been allocated for social development (health, poverty, and basic education). The poor lose out both through lack of effective access to timber and through the way in which FUG revenues are deployed.

Livelihood outcomes

It is generally argued that common property resources are of greater importance and relevance to the livelihoods of the poor than the non-poor and access to them has a potentially redistributive role to play (Beck and Nesmith 2001). We have already noted above the case of individual households that had collected and sold fuel for income or had grazed goats in the forest before FUGs were established.

Evidence from one FUG site (Buddha Mawali in Devdaha VDC), presented in Table 19.4, is revealing about the livelihoods of the poor. The table summarises the key assets of each household, their degree of self-sufficiency from farm production, and their income sources. The three poor households (HH1, HH2, and HH6) are either landless (HH6) or have less than 2 kathas (0.1 ha) of land. They vary in grain self-sufficiency from 1 to 6 months, with wage labour, the sale of goats, and in the case of HH6, some possible remittance income, supporting household needs. The three medium-wealth status households (HH3, HH4 and HH5) all have cattle as well as goats, and larger land holdings (1-9 katha), although HH4 with only 1 katha of share crops has an additional bigha (0.7 ha) of paddy land. Food production provides 6-10 months food requirements with milk sales, livestock sales, skilled labour (carpentry) and contract ploughing

Table 19.4: **Household assets and income sources for eight households in Buddha Mawali FUG**					
HH number	**Year settled***	**Land area**	**Livestock**	**Months self-sufficient**	**Income sources**
HH1	2046 (1988/89)	1 katha	1 goat	1	Wage labour
HH2	2042 (1984/85)	2 katha	2 goats	4	Goat sales, wage labour, sewing
HH3	2026 (1968/69)	12 katha	5 bovine 5 goats	10	Carpentry, milk, sale of buffalo calves, goat sales
HH4	2054 (1996/97)	katha; 1 bigha (sc)	3 bovine 3 Goats	6?	Contract ploughing, milk, goat sales
HH5	2024 (1966/67)	9 katha	4 bovine 3 goats	9	Milk, remittance
HH6	2042 (1984/85)	2.5 bigha (sc)	3 bovine 2 goats	6?	Milk, ploughing, goat sales, son in garment factory
HH7	2029 (1971/72)	10 katha; 2 bigha pasture	1 bovine	10	Grass sales, milk, chickens, alcohol sales, remittance
HH8	2057 (2001/02)	5 katha	0	9	Drives own bus
HH = Household; 20 katha = 1 bigha; 1 bigha = 0.7 ha; sc = share-cropped					

providing income. The two richest households (HH7 and HH8) are grain self-sufficient for 10 and 9 months respectively with off-farm income sources from either remittance or from transport services. HH7 also sells grass and gains a regular income from alcohol sales.

The key conclusions are that the livelihoods of the poor are based on diverse sources, are not directly production based because the poor have few land assets, and depend on employment. They are though largely rural based and do not generally have, for example, remittance income. Given the evidence of how new FUGs have disbarred traditional income sources that the poor gained from the forest and the emphasis on products and biomass development in FUG operational plans, with no specific emphasis on employment creation, it suggests that at best the poor have not gained from FUGs and at worst as in the case of Dhuseri, have probably lost out.

The evidence with respect to livelihood benefits accruing to the poor from the establishment of community forestry institutions is therefore equivocal. Forest rules and regulations, processes of FUG formation, and FUG constitutions and operational plans have all conspired to, if anything, reduce the potential benefits to poor households, but it all depends on circumstances and context, a finding which corroborates the conclusions reached by Springate-Baginski et al. (2001) for the mid-hills. However, Springate-Baginski et al. (2001) go on to suggest that 'tole-based' (hamlet-level) micro-action planning provides a means to involve the poorest marginalised groups in decision making. We would argue that for the Terai, given the socioeconomic and ethnic diversity of the population and the size of the area covered by FUGs, this 'tole-level' decision making would not guarantee that benefits for the poorest would increase.

Key contextual factors include the ecology and the north-south distinction in the Terai. In the north (which also shows considerable internal heterogeneity with respect to forest composition close to the hills and further from it) there has been a declining forest area, but increasing control by communities with FUGs regulating and restricting access. In the south of the Terai dung and agricultural residues have replaced fuelwood and private farm forestry is of growing importance.

The northern areas have also experienced high levels of in-migration leading to some marked spatial patterns of settlement by caste or social origin. A combination of settlement history confounded by political allegiances and contest over resources between the forest office and the community, committee, and FUG members, between members and non-members, and between caste groups all determine who benefits and how benefits are derived from community forest.

Challenges to Increasing the Opportunities for the Poor to Access Benefits from Common Pool Resources

This chapter has so far focused on specific evidence in relation to resource changes, access to resources and livelihood outcomes. We have argued that the site-based evidence indicates that while the effect of community-based forest groups has certainly led to improved tree cover within the community forests, for a variety of reasons to do with access this has not necessarily translated into pro-poor livelihood outcomes.

We develop here a more generalised framework to distil some of the key underlying issues in relation to analysing the linkages between social and economic processes and natural resource access and use. The framework is schematic but it serves to identify some of the key ways in which livelihood opportunities from common properties for the poor are effectively limited by institutional and community processes and it is these that must be addressed if opportunities for the poor are to be increased. One of the key lessons from the research, and this stands in contrast to the emphasis that has been given in much of the research on community forestry so far that has focused more on the rules and practice of governance within FUGs (see Dahal 1994; Blair 1996; Pokharel 1997), is that attention must be given to institutional processes external to the FUG. These can restrict the extent to which FUGs are able to become community-based organisations and deliver benefits for all their members while at the same time offering opportunities, as can be seen from the Dhuseri case, that can be readily captured by the community elite. This analysis indicates an agenda in relation to increasing opportunities and this will be returned to.

Figure 19.1 summarises the framework. It is structured around what are seen to be key questions or 'drivers' (at the institutional and community level) that to some extent, depending on the answers or configuration, may predetermine choices further down the line. For this reason the institutional drivers are positioned above what are seen to be the community drivers, and the combination of the two serves to determine the likely outcomes. The framework should not be read in an entirely deterministic manner. The institutional environment is not omnipotent and communities are far from helpless

Figure 19.1: Framework for the analysis of linkages between social and economic processes and natural resource access and use

Institutional drivers	More control		Less control
What is the resource market value?	High	↔	Low
↓↑			
Where may communities participate?	Restricted	↔	Unrestricted
↓↑			
Legal or encroachment rights?	Encroachment	↔	Legal
↓↑			
Who participates and how?	Consultation	↔	Community-based forest
↓↑			
Product and protection or livelihood oriented?	Protection → Product	↔	Livelihood
↓↑			
'Community' drivers	**Exclusive**		**Inclusive**
↓↑			
Established or dynamic immigrant?	Established	↔	Dynamic immigrant
↓↑			
Differentiated or undifferentiated communities?	Differentiated	↔	Undifferentiated
↓↑			
Price of membership	High	↔	Low
↓↑			
Distributional policies	Hidden	↔	Open
↓↑			
Outcomes			
↓↑			
Livelihood benefits	Selective, less equal benefits	↔	Less-selective, more diverse benefits
↓↑			
Equity	Limited	↔	Expanded
↓↑			
Gender	Limited	↔	Expanded
↓↑			
Institutional	Non-transparent, unstable, exclusive	↔	Transparent, participatory, stable
↓↑			
Environment	Negative → Positive ?	↔	Positive → Negative?

within this context. But it is argued that looking from the perspective of the institutional context there are a number of factors that make it extremely challenging for community forest to generate significant pro-poor benefits.

Each of the institutional drivers can be considered with respect to the way in which they contribute to reinforcing objectives within community forestry that tend to emphasise more control or less control. With more control community forestry in practice is limited to the sharing of a restricted number of benefits and products, shared access, and limited roles for the communities in decision-making; technical objectives (protection, production, and control) set the scene. In contrast, and following the distinction made by Alden Wily (2002), less control implies reduced concern with the details of technical management, a much greater emphasis on the sharing of authority, giving communities a greater role as forest managers, less concern with 'user' definitions, and an overall focus on governance objectives. Reading Figure 19.1, the argument is that high resource values are more likely to contribute to greater control rather than less control and a community forestry strategy that favours technical rather than governance issues. Greater and lesser control lie at the opposite ends of a spectrum and as we shall see the balance between giving communities a licence to use the forest and share access and allowing communities jurisdiction over areas that they manage is closely fought-over territory in which the Department of Forest, NGOs, and communities are all heavily engaged.

Institutional Drivers

What is the resource market value?

As Table 19.3 makes clear, there is an enormous variability just within the study sites with respect to the market value of the timber in the community forest.

This reflects a combination of the difference in the area available per household and the quality and age of the standing timber. It should be remembered, as Table 19.1 notes, that the FUGs in the Terai in general are relatively well endowed in contrast to the hill FUGs. It must also be recognised that given the effective conservation measures that have been implemented in many community forests, resource market values are generally set to increase over time.

Why should resource market values matter and be an important determinant? It is not without reason that the growth of FUGs initially developed more within the mid hills than the Terai because the Department of Forest and government knew the importance of revenue from Terai forestry and were reluctant to hand it over to community forestry. We found cases of VDCs that had effectively taken over common pool resources of ponds for fish and auctioned these off to the highest bidder in order to generate revenue for the VDC (at Pipaharwar in Harpur).

As the study in Rajahar made clear, increased resource values make it all the more likely that hidden economies will emerge from which individuals and the elite can profit. With increased value the incentives for trading and rent-seeking increase. Current bureaucratic procedures, rules, and regulations, encourage the emergence of a hidden economy. Policies designed to restrict the use of timber through bureaucratic control (timber may be used only for construction and other domestic purposes, an official forestry policy adopted by many of the user groups) coupled with a difference in the internal community forestry price and the open market price have promoted illegal use of forests. Potential remedies to this lie in a combination of removing prices distortions, giving more authority to community organisations, and placing much more emphasis on monitoring mechanisms in institutional design that look at distributional consequences.

Where may communities participate?

Underlying this question, as the discussion on access made clear, are a range of issues. From the Department of Forest there are clear opinions as to where community forestry may and may not take place. An operational forest management plan developed in 1996 categorised forest land into conservation forest, production forest, and potential community forest land, with much of the poorer or degraded forest land being allocated to community forest. As is clear again from Table 19.3 and the data cited on community forest area per household at the district level, Department of Forest categories rather than concerns over ensuring equity between communities have led to some marked differentials in the areas which different communities have gained some control over.

In some cases community action has challenged official forestry demarcation with respect to both location and area. What the communities claim with respect to community protection forest may be at odds with what the Department of Forest recognises. In the case of Dhuseri the constitution states an area of 532.5 ha under community forestry while the operational plan refers only to 160 ha, reflecting an on-going dispute between the FUG and the District Forest Officer (DFO) over the area to be managed. There are several other cases, for example, Chautari and Parijat, where there are discrepancies in the stated area figures between the original constitution of the FUG, the area demarcated in the operational plan, and the information recorded on the Department of Forest database, indicating at the least a lack of resolution between the Department of Forest and the community.

Area and location are one matter. Another consideration is the way in which 'community' or 'user' is defined. It has already been noted that most areas where FUGs are established have non-members while some members hold multiple membership of FUGs. FUG committees in a number of cases have established categories of users and established entry fees for non-members to join. Certain uses, for example, goat grazing and charcoal collection, are not recognised as legitimate uses. Committees have therefore reinforced the tendency of the Department of Forest to be restrictive in the definition of users, emphasising more a licence to access resources rather than to share authority. While the national parks have chosen a different route in defining a community – an inclusive definition based on residence – neither the Department of Forest nor the national parks have given much recognition to those communities who had traditional rights of use that were seasonal and reflected their non-residence in the immediate vicinity of the new community forest (or buffer zone) areas. The divide in access to forest resources between those who live in the north of the Terai and those who live in the south is likely to become a major distribution and equity issue in the future.

There are therefore a number of complex issues in relation to how communities are defined and the determination of the area in which community forestry may be established. It is unlikely that the inequalities that have now been established can be resolved through reallocation of resources and the only possible route is a fiscal one, whereby communities that have gained control of valuable resources are appropriately taxed and the distribution of VDC expenditure deployed to address the existing inequities between communities with and without community forest resources and between communities that do have community forest. As matters stand in Nepal, this is likely to be a long and difficult route.

Legal or encroachment rights?

This issue clearly matters more in the Terai than in the hills and is closely related to the previous section. One's status as a 'user', at least in the view of the Department of Forest, clearly depends on whether you have legal rights to the land on which you are settled. In one case the reason for resistance by the DFO to the establishment of an FUG was that it could not be done because it would give legal status to illegal encroachment. The committees of FUGs do not appear to have adopted such a restrictive approach, although it must be recognised that encroachers and landless people may well be amongst the poorest of households and the most dependent on forest resources for income, most notably through the collection and sale of firewood.

Who participates and how?

The processes by which FUGs come to be formed and established indicate a wide range in approach and participatory mechanisms; these may have causal effects on the ways in which FUGs operate and deliver benefits although this is difficult to determine. There is a strong contrast in the way in which FUGs were established in Devdaha with heavy involvement of the NGO Woman Acting Together for Change (WATCH) in the process of group formation and consultative processes and that of the Hjab FUG in Harpur, which was essentially set up by the Department of Forest. Whatever the participative processes in bringing a community forest group into being, there are at least two bureaucratic hoops through which all potential community forest groups must go: the preparation and drafting of a constitution and the preparation and approval of an operational plan. The influence of these on the nature of the FUG is unclear, but the requirement that these documentary processes should be gone through put the Department of Forest in a strong position to regulate or control if and how the group is established.

There is not space here for a detailed textual analysis of the constitutions of the registered FUGs but a number of general points can be made. The first is that they tend to be formulaic and have often been copied from those of other established FUGs. In Harpur the original name of the FUG from which the constitution was taken (Hariyali community forest in Rupandehi) had not been removed from a later section of the document. The second and related point is that the content of the constitutions largely addresses functions and structures following the listing of matters given in the 1995 Forest Regulations (Ministry of Forest and Soil Conservation 1995). Table 19.5 summarises in bold the main headings required by the forest regulations for user group constitutions and selectively illustrates these with extracts from the Dhuseri.

The extracts from Dhuseri, which do not differ substantially from other FUG constitutions, are clear with respect to the stated objectives of the User Group – the scientific management of the forest is the most important, with meeting the demand for forest products by users coming second. As noted earlier, membership requires participation and Dhuseri has established three membership categories, which relate to the way in which benefits are distributed. The rest of the constitution largely deals with rules,

Table 19.5: **Key headings for the constitutions of user groups (in bold) followed by selected relevant extracts from the Dhuseri Community Forest User Group Constitution**
Name and address of the Users Group
The name of this user group may be called the 'Dhuseri Community Forest Users' Group'
Objectives of the Users Group To promote the scientific management of the forest as prescribed in the existent Act and Laws To fulfil the forest product demand of the users by increasing the production of the forest To conduct local development activities through the income generated by implementing multi dimensional management in the forest To provide possible support for the forest management in other areas To develop coordination and mutual understanding among various organisations, groups and individuals to achieve the above objectives by developing effective role of the users on the management activities
Seal of the Users Group
Names, surnames and addresses of the users Eligibility for the membership: The person who lives near the Dhuseri FUG, uses forest products from this forest, participates in the management activities and accepts the terms of this constitution shall be the household member. Type of Membership: For the first year, each member will be consider as grade 'C' and gradually promote to second and first class according to the contribution provided by the member for FUG. An Evaluation Committee will be formed by the Executive Body for this purpose. The forest products/benefit sharing will be distributed equally in general condition and in the case of special condition it will be done according to the category of the users. The high priority will be given to the active users and low priority to the fewer actives. Other necessary provision for this purpose will be according to the decision made by the Committee.
Number of houses within the area of Users Group
Estimated population of the Users Group
Functions, duties, and powers of the Users Group
Constitution procedure of the Users Committee
Name and list of the officials of the Users Committee
Working procedures of the Users Committee
Methods to be adopted to control forest crimes
Punishment to be imposed on members of the Users Group who operate functions contrary to the workplan
Procedures to be fulfilled while imposing punishment to the members of the Users Group
Methods for the operation of funds
Methods of auditing the accounts
Miscellaneous

committee structure, and responsibility. There is a five-member board of directors, which includes a Chief of Board, and four councillors, each with responsibility for one of the divisions of protection, plantation, management, and utilisation. In other words the constitution proposes a village-level version of the Department of Forest. In the case of Dhuseri, the strictures on crimes and punishment are covered in the operational plan rules.

The Forest Regulations (Ministry of Forest and Soil Conservation 1995) also establish what should be included within the workplan and the key headings are summarised in Table 19.6. These regulations have more recently been backed up by Guidelines for the Inventory of Community Forests (Ministry of Forest and Soil Conservation 2000). These guidelines, which it is claimed have been developed to assist users and district forest field staff in assessing the condition of the forests, are a classic forest inventory. They are concerned with sampling design, stratification, sampling intensity, plot size and

Table 19.6: **Guidelines for the content of FUG operational plans**	
a)	Details of the Forest Name, boundaries, areas, condition of the Forest and types of Forest
b)	Map of the Forest
c)	Block division and their details – name, boundaries, areas, aspects, slope, soil type of the Forest, main species, useful species, age and situation in repect of natural generation
d)	Objectives of forest management
e)	Methods of forest protection
f)	Forest promotion activities – thinning, pruning, cleaning and other forest promotion activities
g)	Nursery, tree plantation, income generation programme and time schedule
h)	Details of areas suitable for cultivation of herbs, types and species of such herbs, cultivation programmes and time schedule
i)	Provisions relating to use of income accruing from the sale of forest products and other sources
j)	Provisions made for the penalties which may be inflicted on users pursuant to Section 29 of the Act
k)	Provisions relating to the protection of the wildlife
l)	Others matters prescribed by the Department

number, plot layout, data capture, growing stock culminating in the estimations of annual increment, and allowable cut. As noted earlier, going through the exercise of estimating the annual increment and allowable cut is fiction because the 1999 government order forbids the cutting of green wood. More to the point, and as Dhital et al. (2003) have recently pointed out, even the Department of Forest has limited capacity to implement these guidelines so how user groups can be expected to apply them is unclear. They found that of the 7,048 community forests that had been handed over only about 21% of these (1,518) actually had an inventory.

It is also evident from the details on the methods cited above that this information is simply not relevant or usable by those who are meant to be managing the forest, namely the FUGs. In short the requirement for an operational plan and the stipulation that a new one needs to be approved every five years have, as again noted by Dhital et al. (2003), “created a significant delay in forest handover and the renewal of [operational plans]”

As matters stand at present, given the requirement and design specifications for constitutions and operational plans, the scope for participatory processes and genuine authority sharing is very limited. These bureaucratic devices, in the name of scientific forestry, can only be seen as serious impediments to promoting livelihood opportunities.

Product and protection or livelihood oriented?

As will be clear from the discussion on the content of the operational plans and constitution, the plans and objectives of these community forests combine a mixture of product and protection objectives and do not systematically address livelihood needs or recognise employment or income-generation objectives for different social groups. Indeed, it could be argued that because the Department of Forest, out of disciplinary necessity, takes a single-sector view of planning and development, foresters cannot be expected to explore areas of convergence between forest management and other institutional management structures in communities. Such an approach cannot address the ‘joined-up livelihoods’ of people, particularly poor people, and the trade-offs they make in the management of their own and communal resources.

Community Drivers

We briefly comment here on four community drivers, which depending on the way in which they are configured or handled, will either tend to reinforce the direction in which the wider institutional configuration drives community forestry or challenge it, although the room for manoeuvre may not be so great. The evidence is that community-level processes at present tend to lead to exclusive rather than inclusive outcomes.

Established or dynamic immigrant communities

The evidence from the field sites indicated that it was the more southerly communities that were well established and the more dynamic immigrant communities were to be found on the northerly parts of the Terai. Dynamic immigration can of course lead to marginalisation of the poor, and the indigenous inhabitants of the Terai have clearly lost out. Each site has its own particular complexity but we would argue that where social relations have not become deeply structured and embedded there is the chance that this is more likely to favour equitable outcomes.

Differentiated or undifferentiated communities?

Much will depend though on the extent of differentiation within the communities. The greater the differentiation there is (or the greater the opportunity there is to generate it and here the value of the resources under community control may be a significant factor) the more likely it is that there will be a focus on production and access and the occurrence of exclusive processes.

The price of membership?

A major instrument that FUG committees have to wield is that of membership fees. It is perhaps noteworthy that the four FUGs that did not have membership categories and significant fee charges (Deurali, Buddha Mawali, Sisuwar, and Srijana) are all in the bottom 50% of the ranking of community forests (see Table 19.3) with respect to area and resource value of the community forest. Categories of use and fee rates will all tend to exclude the poor.

Distributional policies

Finally, and this is an area over which FUG committees have strong control, policies for the distribution of benefits from community forestry can have a marked influence on equity in benefit distribution. Through establishing financial barriers to meet the entry costs of participating in auctions for forest products, the poor can be effectively excluded. In addition the hidden subsidies in the price and product allocation systems adopted by FUGs can give rise to a further distributional bias in favour of the better off.

Conclusions: Are There Ways to Increase the Opportunities for the Poor to Access Benefits of Common Pool Resources?

What then are the prospects for increasing the benefits to the poor and scaling these up from common pool resources? We have argued that simply increasing the number of organisations is not enough although it can have positive effects through the pressure that can be collectively exerted on policy-making processes. More worrying, and it should be remembered that the material here relates to the Terai, is the evidence that the poor have not done particularly well with respect to benefiting from community forestry and in some cases have lost out. This is for reasons arising both from institutional and community-level processes and addressing some of these, particularly those external to the community, may provide room for manoeuvre. There should be a more relaxed practice on where communities can participate and how this is defined, an insistence on more effective implementation of the guidelines for FUG formation, and policies for a fairer distribution of benefits.

But there are broader issues as well. Livelihood 'outcomes' are the outputs of the strategies that individuals or households adopt in order to make a living. Such outcomes are often too narrowly viewed in terms of increased income or benefits. Livelihood 'outcomes' for the poorest forest-dependent people in the study areas in the Terai may include 'more income' but may also include 'increased well-being' which may come from increased social status, physical security, improved health, or the recognition of and respect for certain cultural or religious heritage and values by a wider society. Improved income and enhanced well-being are likely to contribute to a reduction in the vulnerability of the poor in the face of crises or disasters as well as an improvement in food security. Such improved livelihood outcomes may be connected to the more sustainable use of natural resources such as the forest, but for many poor women and men security comes from the diversification of livelihoods, so that if one livelihood option fails all is not lost and factors beyond income, such as social status, may be enhanced.

The question of whether adjustments to the internal processes for community forestry in the Terai provide a vehicle for uplifting the poor or not must also be considered in the context of the value of the resource in question. Table 19.3 brought out the tremendous variation in resource values across the study sites, providing background information that allows policy makers and others to judge the potential for common pool resources in making a difference to the well-being of the poor. While this potential in some sites is undoubtedly considerable, it is clearly very limited elsewhere. This variation needs to be clearly recognised in policy formulation. For high-potential sites, a pressing question is how greater equity in benefit sharing can be accomplished. While the literature on the management of common pool resources provides valuable guidance about institutional mechanisms conducive to sustainable resource management, insights into how equitable outcomes may be achieved are harder to come by. While protagonists of the community forestry approach in Nepal might argue that this is all about process, the notion of meaningful participation in the complex organisations that the user groups in the high-value forests in the Terai often are, might pose a steep challenge to such a view. In short, conventional training for participation and empowerment in some of the Terai sites may simply be less effective. It is for instance distinctly possible that the interaction between human capital and more equitable outcomes will turn out to be particularly strong in such groups because of user group complexity. Because timber is the most valuable resource in these groups, policies for redistribution need to focus on how a fairer sharing of benefits from this product can be accomplished.

Beyond the issue of greater benefit sharing in sites with valuable resources, the generation of alternative opportunities must be explored. The idea that rural households have multiple livelihood portfolios that result in a diversity of sources of income is well rehearsed in the literature (Ellis 1998) The importance of diversified livelihood portfolios for the poorest as a means to reduce vulnerability is often forgotten as we focus on livelihoods within a particular sector. So it is with forestry. Often when we consider 'pro-poor livelihood options' we begin with the resource and not the person, focusing on the 'resource users' (defined by the resource, such as the FUG) rather than upon the use of that resource by men, women, and children as part of their livelihood strategy. We should support existing practice and focus attention on the diversification of livelihoods. This means not only looking at the wider farming and non-farming economy of landed households, but also, as noted above, understanding and accommodating the uses of the forest by poor landless households as a part of their overall subsistence strategy. Such approaches do not fit in with conventional approaches to 'forest user' as articulated in the constitutions and operational plans of FUGs, a point underlined in the work of Subedi et al. (1993) on tree and land tenure in the eastern Terai.

So, we would argue that if community forestry in the Terai is to enhance the livelihood outcomes of poor people there will need to be a major restructuring of the approach to forest management that takes due account of the diverse uses of the forest and does not focus on a few particular products (for example, timber and some non-timber forest products). Alternatively the forest could be handed over to the people (we hesitate to say 'community') and managed to maximise revenue, which might be invested into the Terai for the benefit of the population. Both approaches imply the existence of a strong state and thus cannot be put forward as viable options in present-day Nepal.

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3 Symposium and Research Workshop: Analysis and Recommendations

Photo:

Farmer’s meeting

Hilde Helleman, 2003

20 CASE STUDY FINDINGS – Natural Resource Management for Mountain Communities

Roger White[1] and Michael Stocking[2]

Background

People farming small hillside holdings in the HKH region face many challenges. Heavy rainfall and poor soil and water management practices are eroding the soil and soil fertility is declining as nutrients are lost through leaching. If farming livelihoods are to be protected, then alternative farming practices are urgently needed that help to conserve water, soil, and fertility in these marginal and fragile environments.

These are not new problems but current research, knowledge, and practices have not solved them. Technologies are available but many farmers have not adopted them in spite of their demonstrated effectiveness in reducing runoff, controlling erosion and improving soil fertility. Nevertheless, farmers are not unaware of the problems they face. Studies have shown that many farmers have a sophisticated understanding of soil and water related ecological processes and make rational use of them to devise practices to combat erosion and declining soil fertility. So why do they not take advantage of the other opportunities available to them?

Current thinking suggests that the key element to successful development is the participation of farmers at all the various stages of technology development. This involves finding ways of bringing together farmers' local knowledge and practices with the scientists' knowledge and findings to develop appropriate soil and water management practices. This is the central theme of the case studies presented at this workshop and the following is a synthesis of these studies and the experiences of bringing together science and practice.

The Role of Participatory Decision-Support Systems

The case studies described in Chapters 4-7 focus on the role of participatory decision-support systems for developing and promoting improved hillside farming strategies relevant to the needs of marginal farmers. They describe the substantial research work undertaken on soil and water management in the mid-hills of Nepal and the participatory techniques for developing more appropriate technologies pioneered at the project sites at Bandipur and Landruk – the sites visited during the research workshop.

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A participatory technology development (PTD) approach is described in Chapter 4 which is designed to bring together farmers and researchers to identify problems, analyse and share knowledge, set up and run farmers' experiments, and monitor and evaluate the results. The results so far suggest that giving farmers and the farming community a leading role in experimentation and decision-making not only ensures development of appropriate technologies, but also increases farmers' empowerment and participation in the whole development process.

Farmers are interested in natural resources management practices and particularly those interventions that quickly start generating economic benefit. An example is the preference among farmers at one site for planting coffee and oranges along the outer boundary of bench terraces rather than hedgerows as they had a good niche market for such crops. At another site hedgerows, promoted by researchers for erosion protection, were unpopular as they replaced important crops such as soybean and beans. Opportunities such as this are seen as useful entry points for the promotion of natural resources management practices.

For effective scaling up, researchers make the point that the research process is just as important as the research products. The products themselves, being tangible and visible, are usually taken for dissemination and the process used to generate them is ignored. Scaling up should therefore be process-led applying the PTD approach.

The Sustainable Soil Management Project (Chapter 6) followed a similar theme of promoting improved soil management practices with the realisation that very few SSM practices could be taken 'off the research shelf' and used directly. It too attempted to involve farmers in the adaptation and testing of SSM practices. One example concerns the use of farmyard manures. The initially unworkable practice proposed by researchers was modified and adopted once farmers realised that about 65% of the excreted nitrogen is in urine and not in dung. This encouraged farmers to initiate their own experimentation. Another example is the assumption by researchers that erosion is a major problem, whereas farmers on terraced fields rarely experience this and are more concerned with soil fertility management. The challenge is to disseminate this knowledge when extension staff find it difficult to shift their thinking from erosion to soil fertility management.

The results of this work provide an open 'basket of knowledge' available for farmers to use. However, the accumulation of this knowledge begs the questions: Who is responsible for compiling it? Who updates it ? and Who makes it available? Unlike the products of a research institute the 'basket' has, as yet, no obvious institutional home and this is not helped by the decentralisation of the farmer-led approach.

The SMM Project also supports extension with competitive grants. One approach is a low-cost, decentralised, demand-driven farmer-to-farmer method. This involves training the most experienced lead farmers and making them available for hire by other farmer groups that wish to implement SSM practices. Funds were allocated to over 9,000 households in one year on a competitive basis with priority given to the most needy communities. A high rate of adoption was reported for practices that were directly linked to production (e.g. growing vegetables) with lower rates for SMM practices such as better manure management for vegetables.

The cost of farmer-to-farmer diffusion is reported to be about US$3.5/household, compared with US$45-50 for government organisations and US$20-30 for institution-led pilot projects. Although this points to the opportunities available for farmer-to-farmer extension, there is little evidence yet about the cost effectiveness of each approach.


Hanspeter Liniger

Measures to prevent soil erosion at Landruk

A national fund is now being established that is open to government and non-government organisations and recognises the diversity of actors in agricultural development.

Thematic Contributions

Chapters 8-10 address thematic topics that come principally from PARDYP and examine a range of natural resource management issues such as water management, common property management, and land rehabilitation. These illustrate both the range and the depth of the research undertaken in the PARDYP research watersheds; although the papers are country specific the aim was to draw conclusions relevant to the HKH region as a whole.

In many meso-scale catchments of the HKH, water is in short supply for both irrigation and domestic use (Chapter 8). Its availability has decreased over the past 25 years, principally through mis-management, though there has been an increase in domestic demand due to improved living standards and in some areas a four-fold increase in irrigated cropping intensity. Water quality too is becoming a cause for concern among domestic users as large numbers of livestock and intensive farming practices become sources of pollution. This preliminary study has been gathering mainly technical data about catchment water supply and demand and options for increasing water availability. The next stage is to examine the social and institutional aspects that principally affect water management to see what improvements are possible from a demand perspective.

Maps are an essential part of any land and water resources planning process as they help to locate and quantify problems and put the issues 'on the table' (Chapter 9). But in many developing countries they are either not available or out of date. Remote sensing and geographical information systems (GIS) are now used to produce rapidly accurate, large-scale maps that are ideal for resource planning and to augment data collection from field surveys and traditional participatory and rapid rural appraisal methods. In one watershed, 1:5,000 maps were used to identify and quantify forest resources and the socioeconomic characteristics of community forests with the participation of forest user groups. The extent of boundaries and individual plots are easily seen on such large-scale maps and this can open up opportunities for the poor, women, and tenants, irrespective of literacy, to indicate their views and to bring their indigenous knowledge to bear in the planning process.

The biophysical rate of recovery and the impact this has on rural livelihoods when a degraded area is rehabilitated through people's participation was the subject of research with a small community in the Indian Central Himalayas (Chapter 10). Investigations showed increases in terms of floral communities and improvements in soil nutrients and soil water. Grass production increased almost four-fold between 1993 and 1997. Improvements were also reported in human, social, and financial capital.

Techniques, Tools and Intervention Methods

Chapters 11-15 address techniques, tools and intervention methods for soil erosion and declining soil fertility as a means for local professionals and rural communities to identify 'best bet' and 'win-win' natural resources-related techniques and target them to poor households. This draws on experiences in hillside research from Nepal, Bolivia, and Uganda.

In Bolivia farmers routinely describe how their soils are getting 'thinner' and 'worn out' and how yields are declining (Chapter 11). Researchers built on such comments to develop a set of field biophysical assessment techniques that gives meaning to the quantitative terms that farmers use so that field professionals could rapidly note indicators with the assistance of farmers. An example is the 'armour layer technique'. This involves measuring the depth of coarse materials that accumulate on the soil surface as a measure of soil loss.

A method of assessing soil fertility was developed in Nepal (Chapter 13). Farmers have an in-depth knowledge of their soils and use a large number of inter-related indicators to characterise them with colour being a dominant feature. They give priority to factors they relate to soil health and productivity, especially crop growth. Farmers saw a decrease in manure as the main cause of declining productivity and soil fertility as well as increases in cropping intensity, reduced fallows, and a lack of irrigation. Scientists' evaluation and farmers' assessment of soil fertility management led to similar conclusions, from which researchers conclude that farmers' criteria can and should be used in farmer testing of soil fertility enhancements.

Hilde Helleman

Measuring nutrient losses caused by leaching at Landruk

In the highlands of Uganda (Chapter 15) there is no shortage of knowledge and practical advice on soil fertility and erosion for hillside farmers but the local professionals (LPs) lack tools and resources to give credible advice on technologies that meet both livelihoods and environmental sustainability criteria. A set of tools was developed, based on identifying and targeting appropriate technologies for farmers, to enable LPs and farmers to work together better. The tools were designed to help LPs become facilitators and not decision makers and to recognise and deal sensitively with farmers whose needs are varied and complex. A field handbook was produced for recognising nutrient deficiencies with a strong emphasis on visualisation. Analytical tools such as nutrient-flow mapping and participatory financial appraisal for soil management were also introduced for assessing farmer circumstances.

Methods of intervention rather than tools are the main focus of attention in the remote mountain communities of Bolivia (Chapter 12). LPs are seen as an important, but largely missing, link for improving the management of natural resources. LPs tend to reside in research centres and are more used to taking the lead than listening to clients' needs. Local municipalities do not have a cadre of technical staff to help communities nor do local NGOs have the necessary expertise.

Fostering good communications between LPs and remote communities was seen as central to developing locally initiated changes in household natural resources strategies that would be sustainable. As a result communities were able to articulate their needs and priorities and LPs were able to develop a deeper understanding of local and household natural resources issues particularly in the context of complex household livelihood strategies that involve frequent migration. Reaching the very poorest households was achieved through intensive personal contact with LPs and this highlighted their multi-faceted needs and the importance of more positive community attitudes towards them. Researchers now believe that LP advice has a stronger foundation and is more sensitive to community needs.

Although the principal local NGO partner recognises the value of this initiative it has not fully adopted the approach nor has much progress been made in communicating community needs to local municipalities. There was still a preference for projects that show more immediate and visible outcomes.

Chapter 14 describes a participatory technology development (PTD) approach that was used to develop improved methods for promoting appropriate soil and water management techniques in the mid hills of Nepal. Such information provides a scientific rationale for technology choice and provides a base from which to extend the technologies to other communities. Farmer-based experiments concluded that the amount of nutrient loss through runoff is very low, but significant amounts of N and P are lost through leaching. Therefore, technical efforts should focus on trapping nutrients that are lost in solution through leaching and the use of barriers to reduce soil movement and nutrient losses in eroded sediments.

Although all the papers emphasise that farmer-centred methods can help to ensure a better focus on the issues important to farmers, one expressed a note of caution. Accuracy can be compromised and information on causative relationships is less reliable.

Approaches to Scaling Up

Chapters 16-19 investigate approaches to and the issues of scaling up pilot research experiences to the wider community and links to policy. This draws on experiences from Nepal, Bolivia, and Uganda.

Scaling up is a relatively new and more comprehensive approach to research that is receiving much attention but there is very little information available on practical strategies to guide natural resources researchers to take up these ideas (Chapter 16). To fill this gap, a study was undertaken of research projects in Nepal, Bolivia, and Uganda to identify strategies for scaling up promising pilot experiences in soil, water and land resource management to the wider community. The main facilitating factors are seen as increasing use of participatory approaches and institutional collaboration, although the latter is largely amongst development oriented rather than research projects. The main limiting factors are a lack of institutional capacity, a need to improve collaboration in research-oriented projects, lack of resources, external environmental pressures, lack of sustainability, and lack of measures to assess impact.

No simple recipes for scaling up emerged from the study but there is a growing body of principles and practices in natural resources research for others to follow that are reported in Chapter 16.


Hilde Helleman

Collecting fodder from scattered fodder trees in a terraced citrus orchard

In Nepal (Chapter 17) it is recognised that successful scaling up depends as much on having enabling policies in place as on the availability of farmer-validated land management strategies (LMSs). Researchers worked on the assumption that LMSs are already available and that constraints to uptake, which are at both farm and landscape level, can be eased through policy decisions in the political and administrative arenas by using appropriate incentives for land users, both individually and collectively, to change their behaviour. This is work in progress but a number of drivers for adoption were identified related to awareness, support from external agencies, and effectiveness of farmer groups. The lack of inter-agency and inter-ministry information sharing are barriers to successful policy formulation and implementation. Lessons so far include the need for community empowerment as an integral part of any strategy to encourage improved land management, the need to recognise that policy formulation and implementation are two inter-related processes, and an understanding of the importance of change agents in the speed of adoption of land management innovations.

The need for community empowerment as a driver for improving and scaling up sustainable soil management practices is also a critical issue identified in Uganda (Chapter 18). Recent decentralisation has enabled more people to participate in policy decision-making, but it has had little impact on natural resources management. Researchers found that improving social capital enables resource-poor farmers to participate in policy formulation and implementation, in research and development activities, and in the adoption of natural resource management innovations that require collective action and collaboration. They claim to have developed a much better understanding of social capital and its role in sustaining the natural resources of poor hillside communities. They also developed and tested mechanisms for strengthening aspects of social capital in formulating and implementing local byelaws and community action plans.

Concluding Comments

The following draws together some common issues and themes in the chapters.

- A common thread in all the case studies is 'community'. Community involvement in the design, planning, and monitoring of research was constantly stressed as being a key factor in conducting 'good' research.
- The use of participatory methods, in particular participatory technology development (PTD), at all stages of development is considered to be the most important factor in legitimising interventions and tapping into local knowledge.
- Local people can and do experiment informally and come to rational decisions on how to balance their livelihood needs with the difficulties of sustaining a complex biophysical environment.
- Farmer-centred methods can help to ensure a better focus on the issues important to farmers but there are limitations. Accuracy can be compromised, information on causative relationships is less reliable.
- Involving local communities in the development of local byelaws can be an effective way of raising awareness and protecting the environment. Local communities need to be empowered to take on such roles but some form of decentralised local government system is needed that is willing and able to endorse and ratify the rules.
- A strong poverty focus is engendered in the case studies, but care is needed when applying lessons learned in one place to another place because wealth endowments can be very different and blueprint solutions never work.
- Local professionals (LPs) are seen as crucial front-line workers but their role and effectiveness varies from country to country for a variety of reasons. They need to be armed with the proper tools such as analytical methods and field guides and, equally important, ways of engaging with local people.
- Research requires suitable tools for measurement, analysis, and making recommendations. Tailoring research methods and scientific tools for use by communities and combining it with indigenous knowledge is seen as an important way forward for developing appropriate and workable soil management practices.
- Research findings must reach the end-users, local professionals, and policy-makers and not just be fed into the research system. The fact that soil erosion is relatively low on Nepal's rainfed terraced farms when the perception is that it is a major environmental issue can discredit both research and LPs in the eyes of local people.
- Dissemination strategies must be planned at an early stage of a project but some flexibility must be built in because of the very different audiences and the need for different pathways to reach them. The target groups need to include those who can best help to design methods for dissemination.
- A 'basket of knowledge' is one way of presenting the results of research as not all options suit all farmers. It is important that farmers are offered options to either test or to implement – the choice of strategy being theirs alone.

21 INCREASING IMPACT – Making it Work

Chris Garforth[1]

Introduction

After all the discussions about what scaling up is, why it happens in some situations and not others, and what determines the impact that natural resources (NR) research has on farmers decisions and livelihoods, we come to the big question: is there anything that researchers, research projects, and organisations can do to make scaling up more likely to happen and thereby increase the impact of investment in NR research? The conclusions drawn by the participants of the workshop on this question are presented in three sections. First, we look at the kinds of tools that are available to support scaling up; then we consider the need for more research into the scaling-up process; and finally we turn to the need to improve communication amongst researchers and other stakeholders. The key factors vital to the increasing of impact of NR research, such as power relations, which should be considered in the planning of all projects, are underlined in the following analysis. They include suggestions as to possible ways forward to making impact really work, such as the actor linkage matrix.

Tools to Support Scaling Up

Scaling up the benefits of NR research requires action by many different people. Without widespread involvement, the impact of research is bound to remain localised and be slow to spread. Scaling up will only happen if people outside the immediate research activity and location have information about the research and its potential and develop sufficient interest in it to use its results in their own domain of activity and promote it to others. A useful first step is to articulate linkages between the various sets of actors who might play a part in spreading the lessons from the research to a wider area or to use the lessons to introduce policies and institutional change that will create incentives for NR managers to change the way they do things. Once the key actors have been identified, research teams can plan to share the research process and emerging findings with them from a very early stage in the research.

There are tools for articulating and assessing linkages between actors which have been tested and shown to be effective. Information maps (Garforth 2001) and spider diagrams, for example, based on visualisation techniques, offer a way of describing the links of communication and influence between organisations. Within the toolkit of participatory rural appraisal (PRA) methods, Venn diagramming has been used to explore the perceived strength of influence of different organisations and institutions within a specific context.

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More specific to the context of NR research and development is the actor linkage matrix, as described in Box 21.1 (Biggs and Matsaert 1999). With the matrix complete, an NR research team can decide how to interact with the various actors during the life of the research. As NR research is usually focused as much on process as on the specific local results, this interaction should be longer term than a simple reporting of final research results. Scaling up the impact of research on agroforestry design, for example, is more likely to happen when the process of developing a design in partnership with farmers groups is understood – and has been experienced at first hand – by those who are in a position to replicate or institutionalise it. Perhaps a weak linkage between researchers and a key extension organisation or non-government organisation (NGO) can be made more effective by inviting their personnel to be actively involved in the research process from an early stage.

Assessment of linkages should include power relations, both within and between actors. These can include relationships based on gender and on organisational status (such as the relative status of research vis-à-vis extension organisations or NGOs). Linkages that operate through hierarchical structures (for example, where all communication has to be through the person at the apex of the organisation) are likely to be more difficult to activate locally than those that work horizontally across organisational boundaries. On the other hand, linkage with a centre-dominated hierarchical organisation has the potential for achieving rapid influence over the whole organisation, once the senior management is convinced that it is a good idea.

Linkages are not static and should be reviewed during the life of a research project. This begs the question of who should carry out a linkage analysis and how often. Does each project team need to analyse the linkages between actors every time they start a new project? This would rapidly lead to similar analyses being done by different teams and repeatedly by the same team for successive projects, which represents duplication of researcher effort. It also imposes a burden on those who are expected to provide the information needed for the analysis, including farmers who may be asked to comment on the nature and quality of linkage between their organisations and research or extension organisations. There would seem to be merit in research teams in cognate subject areas and in the same geographical area agreeing to share their analyses to avoid unnecessary duplication. Or a research programme that funds several discrete projects in the same area could commission an actor linkage analysis as a separate research activity, with provision for updating at regular intervals, the results of which would be made available to all research teams. A more complex arrangement would see analyses being carried out at different scales, from the local actors relevant to a specific research project to a national analysis covering the actors relevant to a national research programme to which the separate projects belong. The results could then be combined into a set of nested analyses which all research teams could use, and to which all could contribute updated information.

There are potential difficulties with such a shared resource, as with all common property resources. The institution that is given or assumes responsibility for managing and

Box 21.1: **The Actor Linkage Matrix**

The starting point for this tool is to identify the actors in the specific situation, including those with perceived negative influence on scaling up as well as those with potential for positive influence. These may include central government, local governments, international agencies (CGIAR centres, donors), organisations within the national agricultural research system, NGOs, various categories of farmers, and private sector entities such as banks, agro-chemical companies and local input dealers. The list of actors is then arranged as a set of headings for both the rows and the columns of a matrix, in which each cell represents the arena of interaction or linkage between two actors. The analysis proceeds by asking a set of questions about each cell in the matrix, questions, which can range from general ones to those that are specific to the nature of the NR research under consideration. It is this focus on the linkage rather than on the actors themselves that makes the tool useful for identifying opportunities and constraints to scaling up. The analysis will suggest avenues through which research findings can be promoted or developed further into farm-level recommendations. It will also indicate where barriers to scaling up may be encountered, in time for action to be taken to remove them. The cells on the diagonal represent linkages within each actor organisation – between headquarters and field offices of an extension organisation, for example, or between departments and research groups within a research institute.

<u>Illustration of the matrix:</u>

	Actor	1 Poorer farmers	2 Richer Farmers	3 Researchers in Public Sector	4 Researchers in Private Sector
A	Poorer farmers	A1			
B	Richer Farmers			B3	
C	Researchers in Public Sector		C2		C4
D	Researchers in Private Sector				

Cell B3 represents the flow of information from a group called richer farmers to public sector researchers. Cell C2 represents information going from researchers in the public sector to richer farmers. The cells in the diagonal of the matrix represent information that flows between people in the same group for example Cell A1 represents information that is passed between poorer farmers; the exchange of information about seeds and the actual exchange of seeds between poor farmers would appear in this cell. The text that accompanies the matrix would give details of the specific institutions involved in the transactions in each cell. For example, seeds might be exchanged on a reciprocity basis or it might be a market transaction. The full matrix represents all possible transactions between all the groups of actors.

Source: Biggs and Matsaert (1999)

maintaining it will need an incentive to do so on behalf of all potential research teams. It will need to spend resources on compiling it and making it available. In principle, research programmes should be prepared to contribute to the cost, as it will save them time and money that they would otherwise have had to expend on carrying out their own actor linkage analysis. A team carrying out an analysis on behalf of all researchers would be more likely to unearth information and knowledge that is already available, in grey literature and reports of PRA activities, than a team doing it within the narrower confines of a specific research project. On the other hand, such a degree of centralisation may be too cumbersome: a lighter touch alternative would be for all researchers to pool their actor analyses into a centrally supported resource, so that research teams can easily identify what has already been done and make an informed decision on how much original analysis of actor linkages they need to carry out. Within this pool of actor analyses, agreement would be needed on conventions, for example, on the meaning conveyed by symbols such as arrows of different kinds.

One way of making effective use of linkages for scaling up is to establish a stakeholder forum for a research project, which meets regularly or at key stages in the development of the research. There is a danger that such an arrangement may become ritualistic rather than create opportunity to share emerging research findings with those who might incorporate them into their own thinking and practice, particularly if the driving force behind the forum is the research team itself and there are few obvious incentives for stakeholder representatives to give up their time to participate. A forum organised at a higher level than the individual project and set up at the behest of the users of the research rather than the researchers themselves – a programme stakeholder committee, for example, or a national research monitoring committee set up by government to which all researchers must report regularly as a condition of being allowed to continue their research – might be more productive and could offer constructively critical feedback to research in progress.

Action to enhance uptake among the end users of research, principally farmers, will be more effective if it is based on an understanding of those users' existing knowledge of the local environment (socioeconomic and institutional as well as physical) and farming systems. This can lead both to better definition and design of research projects and to more effective extension programmes. Here again there are tools that have been developed for this purpose and that research teams can use in partnership with farmers to explore local knowledge and perspectives. These include

- the agroecological knowledge kit (AKT), which includes inductive computer software to help identify key concepts that underpin local knowledge (Sinclair and Walker 1999);
- the rapid appraisal of agricultural knowledge systems (RAAKS) methodology for investigating systems of knowledge generation and adaptation (Engel and Salomon 2003); and
- agricultural timelines, a PRA tool that puts the current technology mix within an agricultural system into an historical perspective and generates a discussion of how previous innovations have spread within local social and farming systems (Garforth 2001).

Knowledge of how to use these tools is still limited among NR researchers: more can be done to share information on their merits and on how to apply them. As with actor linkage analysis, however, it may be more realistic and cost effective for studies of local knowledge to be commissioned on behalf of a programme rather than encouraging each team of scientists to conduct such studies in the context of their own research project. In either case, the value of the information generated by such tools would need to be acknowledged in the allocating of resources (personnel, money, training) to build their use into NR research.

Scientists may be reluctant to use tools that seem complicated both in their conceptual basis and in their application and interpretation of outputs. But tools do not have to be dauntingly complex. A simple tool developed by research teams in Nepal is the 'Programme learning and response table'. This is a simple two-column matrix.

In one column, a research team lists what they have learned in the previous, say, six months, including lessons from the wider context as well as those from the project activities and outputs themselves. The former could include changes in the context since the project began, which might suggest the need for a shift in direction or emphasis for the research.	In the second column, the team notes the changes they are going to make in response to the things they have learned.

Researching Impact and Scaling Up

Much of the research that has been done on processes and successes of scaling up has been conceptualised within a linear perspective. Moreover the starting point has usually been a particular NR research project and a specific set of technologies developed within it, with the research tracing what has happened with those technologies over time. The research proceeds by exploring how many farmers have taken up the technologies and the extent to which extension and research organisations have made use of the new knowledge in their own programmes. This leads naturally to an investigation of the factors that have hindered or facilitated this horizontal and vertical scaling up and of the impact it has had on people's farming practices and livelihoods. While research within this perspective may seem logical from the point of view of those who fund NR research and who need to evaluate the impact of and the returns to their investment, it by no means gives a complete picture of the processes at work. The linearity is conceptually restrictive in two ways – temporal and institutional. It assumes, first, that technology development proceeds in discrete stages, from applied research and testing through promotion to adoption or integration into land use systems. Second, it reinforces the separation of roles between those who do research and those who use (or choose not to use) the knowledge, and technologies based on that knowledge, that researchers produce.

An alternative approach is to adopt an innovation systems perspective, which puts farmers and other NR managers centre stage. From this perspective, an NR research project and its outputs are just one of many innovation-related activities that figure in the farmer's decision-making environment. Indeed, formal research as an activity and an institution is only one of the sources of new ideas and technology. This perspective

Hanspeter Liniger

Farmer interview at Bandipur

also recognises the reality that farming systems are continually changing as people respond to the complex set of constraints and incentives that the environment (political, social, physical, economic) creates. Adaptation of existing technology, the acquisition and application of new knowledge, and the trying out of new technology play an important part in farmers' response to this changing environment.

Adopting an innovation systems perspective has two implications for the way in which scaling up and impact of NR research are studied. First, by stepping outside the conceptual confines of the linear model, we can look for lessons from instances of innovation that are going on within the wider system. By identifying changes that are taking place and then studying those changes from the farmers' point of view, we can ask questions about the pressures, opportunities, and incentives that are driving changes in technology and land use. Rather than asking through which channels and how far the knowledge created by a research project has been disseminated, we can explore what new knowledge farmers are being exposed to and from what sources. We might also enquire into the social and institutional processes involved in any local experimentation and adaptation of technology and how the policy environment supports or constrains the innovation process. The lessons learnt can then be used to improve the ways in which NR research projects interface with other elements within the innovation system. One particular area where research is lacking is in the link between policy and practice. More studies are needed of how policies and actions by the state and other actors constrict the livelihood opportunities of NR users (see earlier chapters for studies on such projects in Nepal and Uganda).

An example of such innovation is provided by the rapid development of horticulture that is currently visible in the mid-hills of Nepal. This is clearly being driven by market opportunities created by an improved transport infrastructure and changes in settlement patterns and household incomes. What is less clear, however, is how farmers are accessing the knowledge and information needed to introduce and adapt technology in new areas and which particular factors in the institutional environment are enabling the innovation processes. Extension initiatives have played a role in some areas, but only a small part of the overall increase in horticultural production can be attributed to these.

The second implication is a corollary of the first. When assessing the impact of a particular research project or output, we can look at its interaction with the innovation system as a whole, rather than simply asking whether and by whom the output has been taken up. Questions would then include whether the process by which the research was carried out has had any effect on the knowledge and technologies deployed within the farming system or stimulated any farmer experimentation or change in policy or priorities among government and other institutions. This might point to particular actors within the innovation system with whom the researchers failed to interact effectively. And as interaction implies an exchange of experience and views, questioning should include whether the research team has incorporated in its programmes any lessons from the innovation that is going on around it. Impact studies from this broader perspective would also explore how significant the research has been in the eyes of farmers: what has been its importance relative to other sources of technology in solving their problems or enabling them to identify and grasp opportunities?

One specific recommendation from the workshop, in the current climate of questioning by the Department of International Development (UK) (DFID) and other funders of NR research about the extent and nature of impact, is that impact assessment should be done within an explicit innovation system framework rather than a linear research-output-impact model.

These ideas are not new. Indeed, one of the research challenges we face is to understand how ideas about the uptake of knowledge and technology spread (or not) among those who invest in, implement, and evaluate NR research. There is literature in academic and professional journals espousing an innovation systems perspective and approach and which documents farmers' innovation systems, including the papers brought together in the Agricultural Systems issue for July-August 2001 (69:1-2). Are these ideas being effectively communicated to and critically reviewed by those who make decisions about the funding of research and draw up terms of reference for impact studies?

Information and Knowledge Flow

Knowledge generated by research cannot have any widespread impact unless it is widely shared. Whatever else is done to enhance the impact of NR research, resources need to be put into communication. Once again, however, we need to step outside the linear model, which implies that what is needed is to improve the communication of research outputs to potential users: instead, we should recognise that communication is essentially dialogue and should continue throughout the research process.

Different kinds of knowledge require different tools and methods for effective sharing. Scientists are good at communicating the results of experiments and trials to other scientists through established channels – journals, conferences, and electronic networks. But knowledge of how policies affect NR livelihood opportunities needs to enter discussions within policy-making fora and the consciousness of those who elect politicians before it can lead to any change. Information about the availability of, or how to propagate, seedlings of agroforestry species can be spread by informal networks with the help of low-cost print materials (leaflets, posters). Farmers' knowledge of the economics of various methods of nutrient management can be articulated through participatory farm management methods such as participatory budgeting (Galpin et al. 1998). Research generates knowledge: we need to put as much thought into identifying appropriate channels and tools for sharing that knowledge as we do into designing and carrying out the science that underpins it.

Knowledge needs to be documented so that people can access it when they need it. This requires appropriate sites, whether physical or virtual, where the various potential users can find it. Formats and language must be appropriate to users. Information and communication technologies, from print to searchable internet (world-wide web) based databases, offer a wide range of possibilities. More problematic than coming up with formats for the documentation and sharing of knowledge, however, is the design of effective institutional arrangements for access to knowledge and information, particularly in an era of growing concern over intellectual property rights.

A key message here, then, is that organisations need to invest in communication. Effective sharing of knowledge and information demands human resources, equipment, and time. It also demands commitment at the highest level in the organisation to give adequate priority to this activity. This may require organisational reform to improve internal communication as well as the ability of an organisation to communicate effectively with those outside. Internal capacity for external communication can be built through training and recruitment, once the organisational commitment to effective communication is in place.

There are, again, tools and resources available, that researchers can use to enhance the documentation of and access to knowledge beyond the standard scientific routes. At an international level, electronic resources such as the World Overview of Conservation Approaches and Technologies (WOCAT) enable researchers to document, disseminate, and evaluate research-based information on land management through user-friendly databases. Nationally, there are often resources that could be used more effectively. The Regional Training Centres in Nepal, for example, run courses for farmers and extension staff. Bringing researchers in as resource people for such courses, can foster dialogue through which researchers become more aware of the perspectives and constraints of the end users of the knowledge they are generating, as well as help to ensure up-to-date content.

A useful way of making knowledge and information flow explicit is to draw up a communication strategy for each research project or programme. A communication strategy

- specifies the communication partners with which the research team will interact;
- states the objectives of the interaction with each communication partner, which might include generating demand for the outputs of the research by creating awareness and interest, facilitating the research process itself, and influencing the formation of favourable policies;
- suggests the means by which the interaction will take place;
- indicates the nature of the information and knowledge content that will form the initial basis of the interaction.

Apart from helping the research team plan its communication activities from the very beginning of the research process, such a strategy will also highlight the need to allocate human and other resources to putting the strategy into effect.

Conclusions

NR research will have a greater impact on rural land use and livelihoods if researchers are committed to learning and self-monitoring. Research can be designed in ways that make learning an explicit part of the process, and which allow – and even encourage – changes to be made in response to the lessons learned. These can be lessons from the outcome of experiments that suggest a change of direction might be more productive, as well as lessons gained from being open to what is going on in the wider innovation system that might change views on the relevance of the current thrust of the research. Having in place a communication strategy, that fosters interaction among the various actors in the system, will make it more likely that this learning will take place.

It is not enough for individual scientists to learn from their work and from their interaction with farmers and other stakeholders. Researchers have a responsibility to be self-critical about their work and open to alternative interpretations of their findings. But for learning to have an effect on the way a research team or institute works and on the direction of their research, there must be procedures in place within the organisation for reflecting and learning. Such procedures, which are likely to include informal seminars, periodic reviews of work in progress, workshops, and internal newsletters, need to be backed up by a commitment to make changes in response to lessons learned.

One of the lessons we have learned through research within a livelihoods framework is that the rural poor rely to a disproportionate extent on common property resources: the irony is that they also face disproportionate structural impediments to access such resources. Despite the international commitment to the millennium development goal of eradicating, or at least reducing, poverty, NR research does not yet have a sufficient focus on the needs of poor households. Even research projects that have an explicit poverty focus find it difficult in practice to involve poor households in their work. More deliberate efforts are needed to increase the representation of poor farmers on stakeholder committees and in on-farm trials.

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