FARMERS' LAND MANAGEMENT PRACTICES IN THE HILLS OF NEPAL: A COMPARATIVE STUDY OF WATERSHEDS "WITH" AND "WITHOUT" EXTERNAL INTERVENTION

by

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Abstract

The main objective of this study is to examine farmers' land management practices and determinants so as to make combination to promote environmentally and economically sound land management practices for sustainable agricultural development in Phewatal and Yamdi-Mardi watersheds of western Hills of Nepal. Information were collected through a survey of 300 households, comprising 155 households from the project area and 145 from the non-project area, institutional survey, key informants interview, group discussion and observation. Analytical tools employed include descriptive and analytical statistics, indexes and logical reasoning.

Agriculture being the major source of household food supply, most farmers in both areas have pursued efforts to enhance land productivity to cope with shrinking landholdings size caused by ever increasing population. In this regard, they have intensified the use of *gharbari* and *bari*, adopted HYVs and shifted gradually from cereal based to cash crop based cropping system, though the pace of the change is slow and highly localized in accessible areas. Farmers have also made their efforts to improve land management so as to enhance the crop production. In this regard, they have improved terraces, intensified agroforestry practice and participated in gully control, landslide stabilization and waterway construction activities. They also have adopted alley cropping and mulching to control soil erosion and landslide, and applied chemical fertilizers, farmyard manure, compost and green manure to improve land productivity. While the overall change in land management has been positive in both areas, relatively high degree of change has been experienced in the project area due to the external financial and technical support. Some of the changes in the non-project area are spill-over effect of land management implemented in the project area with external assistance.

Despite farmers' awareness of conservation measures and continues efforts made for land management, majority of farmlands in both areas are undergoing degradation due to several natural, socio-economic and institutional causes. Specifically *tarikhet,* constituting two thirds of the total farmlands in the project area and more than two fifths in the non-project area, are facing serious problem, as farmers have not paid much attention to their management.

In pursuing their land management activities, farmers have priority to different type of lands depending on their perceived soil erosion and landslide, cropping intensity, distance from farm households, and labor force size. Project farmers have assigned first priority to *bari,* followed by *gharbari, phantkhet* and *tarikhet.* While the non-project farmers have given first priority to *gharbari*, followed by *bari*, *phantkhet* and *tarikhet.*

Different socio-economic and institutional factors have influenced the adoption of land management technologies. The logistic regression found five factors, including economically active labor force involved in agriculture, schooling period of the household heads, tree ownership, grass yield and proportion of land affected by soil erosion, as significant explanatory variables in the project area. Ethnicity, labor input in land management, proportion of land affected by soil erosion, institutional membership, and extension service were significant variables in the non-project area.

Formal acts and local rules and regulations evolved over past several decades have direct and indirect influence in land management. Most acts were formulated to improve land administration for increasing land revenue and attention has not been paid to land management. Line agencies and NGOs, with some responsibilities for land management, have

not been able to meet farmers' expectations especially in the non-project area. User groups are engaged in small scale land management activities in collaboration with line agencies and NGOs. However, their institutional capacity for land management is weak.

Considering the on going land degradation and inadequate management practices, there is need to control or even to revert this process through the promotion of locationally suitable land use and management practices. This entails the provision of appropriate enabling policies and programs. The focus of the program should be on improving the status and productivity of *tarikhet* and *bari*.

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	Definition
Adoption	Practice of introducing new or improved land management technologies through self motivation or inspiration from others.
Agricultural year	Second week of April 1998 to the first week of April 1999.
Alley cropping	Alternative rows of field crops and perennials grown in a contour pattern in sloping land.
Community forest	Natural or planted forest fully managed by local community.
Contour bund	An embankment constructed along the contour line to control soil erosion and siltation.
Check dams	An embankment along river or stream installed to protect farmlands from side cutting and flooding during rainy season.
Compost	Decomposed mixture of organic materials, including manure, utilized for fertilizing land.
District Development Committee	An executive body of the district government elected indirectly from people, with authority of planning and implementing the district level programs and projects.
Farm	An organized unit of land, labor and capital utilized for agricultural production.
Farmer	A rural resident, whether male or female, who cultivate the crops or raise livestock on the land whether his/her own or leased from others.
Farm household	A group of family members who live in a house, share same kitchen and have a common financial transaction.
Farmyard manure	Dung mixed with leaf litters and crop residues used for fertilizing land.
Green manure	Plant species containing soil nutrient.
Hill slope	Sloping land between valley floor and ridge.
Institution	Formal and informal rules and regulations, and organizations.
Intervention	Financial, technical and materials helps provided by external agencies.
Line agencies	Government organizations functioning at district area and village level.
Land use	Process of preparing plans to control or manage effective land use with authorized control for production and development.
Land management	Caring of land depending on scientific knowledge of soil, vegetation, topography, geology, climate and water for appropriate utilization, protection, hazard mitigation, development and conservation of land resources.

Mulching	The practice of covering the plowed land by crop residues and leaf litters for moisture and soil conservation.
Public land	This includes forest, grazing land, waste land and land under other uses which are legally owned by the government, but are freely accessible to people.
Retention wall	A reinforced wall constructed to protect terrace risers from being collapsed.
Slicing terrace risers	Thinly slicing of the slope between terraces by spade to remove weeds and grass.
Shrub formation in gullies	Bush formations, including bamboo, in gullies established to control gully expansion in hill slopes.
Terraces	Narrow strips of land carved out across the hill slopes for the cultivation of field crops.
Terrace bund	Small embankment constructed at the outer edge of the rice field to control water flow.
Terrace riser	Steep slope between terraces of different altitude.
Upland	Rainfed sloping farmland.
User groups	Groups of farmers organized to pursue some development activities for the common benefit of all group members.
Village Development Committee	An executive committee of local government elected directly from the people, with authority of planning and implementing the village level programs and projects. On average, a VDC has 5,000 population and 1,000 households.
Vegetative measures for landslide control	Establishment of different shrub and tree species with extensive root systems for rehabilitation and control of landslide.
Ward	Lowest administrative unit of a Village Development Committee comprising 20-300 households.
Waterways	Small canal at the inner toe of *bari* and *gharbari* constructed to prevent rainwater from entering into the farmland.

Glossary

Khet	Terraced land used for rice cultivation.
Abbal khet	First grade (best) of cultivated land based on traditional land classification system. The *khet*, which have good and moist soil, availability of water round the year, water-holding capacity for 3-4 days, normally located below 900 meter above mean sea level (amsl) and potential for more than two crops.
Bari	Non-irrigated upland maize and millet field. It is also called as *pakho bari.*
Abbal bari	First grade (best) of *bari* which have good and moist soil, normally located below 600 meter, enough temperature to ripe crops.
Doyam khet	Second grade (better) of *khet* with good soils, potential for the cultivation of two crops, irrigated for 3-4 months and normally located between 900-1200 meter.
Doyam bari	Second grade (better) of *bari* land with moderate quality of soil, normally located between 600-1200 meter suitable for maize and millet cultivation.
Sim khet	Third grade (fair) of *khet* partly irrigated for 2-3 months with sandy soil, water-holding capacity for a day and normally located between 1200-1800 meter.
Sim bari	Third grade (fair) of *bari* with sandy gravel soil, high soil erosion, no enough temperature to ripe the crops, and normally located between 1200-1800 meter.
Chahar khet	Fourth grade (poor) of *khet* fully dependent on monsoon rain, with sandy to gravel soil, water holding capacity for few hours, located between 900-1800 meter.
Chahar bari	Fourth grade (poor) of *bari* with dominantly sandy and gravel soil normally located above 1200 meter in the steep and north facing slope.
Phantkhet	Irrigated rice field located in valley floor and foothills.
Tarikhet	Non-irrigated rainfed rice field in the hill slope.
Gharbari	Homestead.
Gharkhet	*Khet* attached with the farmhouse.
Kharbari	Private land normally utilized for growing *Typha angustata* or *khar* utilized as thatching material and fodder.
Jungle	Forest
Birta land	Land granted free of cost by the state to the warriors, religious priests, politicians and bureaucrats to secure stable income for their family.
Dhikuri	An informal rotational borrowing arrangement within the registered group members.

Jagir land	Land allocated as an emolument to the employees by the state.
Goth	Permanent or makeshift livestock shed.
Guthi land	Land granted by the state to the priests and religious and charitable institutions to generate regular income for subsistence.
Ilaka	Sub-district.
Jamidary	Feudal land ownership system where landlords were permitted to keep several hundred hectares of land.
Jamindar	Landlord.
Jhara	A social system in which a household member is obliged to participate in common development and resource management activities.
Jhora	Forest area cleared for cultivation.
Kipat land	Land granted to 17 Mangoloid ethnic groups in the eastern and western hills of Nepal.
Kharka	Small patch of open grazing land in the forest.
Khola	Stream and small river.
Lalpurja	Permanent land title or land certificate given by the state to the farmers.
Mato	Soil
Pahiro	Landslide
Panchayat	Partyless political system adopted from 1961-1990 in Nepal.
Parma	Labor sharing system within like-minded farmers living close to each other.
Raikar land	Land given to the individuals by the state on payment of stipulated amount of land tax. The owner is free either to cultivate or mortgage out the land.
Rana rule	104 years dictatorial family rule of Rana dynasty (1846-1950)
Samuha	Group of people
Sanad	An informal written rule agreed by one to several villages to control livestock grazing in *phantkhet.*
Shree panchami	Religious festival celebrated in the second week of April which happens to be the beginning of a new fiscal year of farmers.
Ukhada	A feudal land tenure system in which tenants were forced to pay land rent to the landlords as per the agreement.

Abbreviations

ADB	Asian Development Bank
ACAP	Annapurna Conservation Area Project
APPN	Agricultural Perspective Plan of Nepal
CBOs	Community Based Organizations
CBS	Central Bureau of Statistics
CDO	Chief District Officer
CEAPRED	Center for Environmental and Agricultural Policy Research, Extension and Development
DA	Department of Agriculture
DSC	Department of Soil Conservation
DDC	District Development Committee
EEM	Ecological Economic Measure
ESCAP	Economic and Social Council for Asia Pacific Region
FAO	Food and Agricultural Organization
GIS	Geographical Information System
HMG/N	His Majesty's Government/Nepal
IBSRAM	International Board for Soil Research and Management
ICIMOD	International Center for Integrated Mountain Development
ICRAF	International Center for Research in Agroforestry
ICRISAT	International Crop Research Institute for Semi Arid Tropic
INGOs	International Non-governmental Organizations
ITK	Indigenous Technical Knowledge
IUCN	International Union for Nature Conservation
LAC	Lumle Agricultural Center
LRMP	Land Resources Mapping Project
LSU	Livestock Standard Units
MA	Ministry of Agriculture
MADA	Ministry of Agriculture, Department of Agriculture
MOF	Ministry of Finance
MSEC	Management of Soil Erosion Consortium of IBSRAM
MDO	Machhrapuchare Development Organization
MFSC	Ministry of Forest and Soil Conservation
MOF	Ministry of Finance
NARC	Nepal Agricultural Research Council
NEA	Nepal Electricity Authority
NGOs	Non-governmental Organizations
NPC/N	National Planning Commission/Nepal
NRMSAP	Natural Resources Management Sector Assistant Program
NTFP	Non-forest Timber Products
PRA	Participatory Rapid Appraisal
RA	Rapid Appraisal
RRA	Rapid Rural Appraisal
RPK	Rural Peoples' Knowledge
SAARC	South Asian Association for Regional Cooperation
SALT	Sloping Agricultural Land Technology
SCSA	Soil Conservation Society of America
SWOT	Strength, Weakness, Opportunity, and Threat
TDN	Total Digestible Nutrient
TOT	Transfer of Technology

UNCED	United Nations Conference on Environment and Development
UNEP	Untied Nations Environmental Programs
UNDP	United Nations Development Programs
USAID	United States Agency for International Development
VDC	Village Development Committee
WWF	World Wildlife Fund

Equivalent

Area

Measuring unit	Matomuri	Ropani	Khet	Dhur	Katha	Bigha	Acre	Hectare
Matomuri	1.0000	0.2500	0.0100	7.5117	0.3756	0.0188	0.0314	0.0127
Ropani	4.0000	1.0000	0.0400	30.0466	1.5023	0.0751	0.1257	0.0509
Khet muri	100.000	25.0000	1.0000	751.1166	37.5583	1.8779	3.1428	1.2718
Dhur	0.1331	0.0333	0.0013	1.0000	0.0500	0.0025	0.0042	0.0017
Katha	2.6625	0.6656	0.0266	20.0000	1.0000	0.0500	0.0837	0.0339
Bigha	53.2500	13.3125	0.5325	400.0000	20.0000	1.0000	1.6735	0.6773
Acre	31.8188	7.9547	0.3182	239.0123	11.9506	0.5975	1.0000	0.4047
Hectare	78.6257	19.6564	0.7862	590.6100	29.5305	1.4765	2.4711	1.0000

Source: Department of Agriculture, 1999

Weight

Crop Grain	1 Muri Equivalent to kilogram
Rice husked	72
Rice un-husked	48
Maize	63
Wheat	63
Barley	36
Millet	72
Potato	62
Mustard	59
Lentil	66
Soybean	65
Bean	65
Pigeon pea	71
Black gram	72

Source: Department of Agriculture, 1999

Nepali Calendar Equivalent to Gregorian Calendar

Nepali Months	Gregorian Month From	To
Baishak	Mid-April	Mid-May
Jestha	Mid-May	Mid June
Ashad	Mid June	Mid-July
Shrawan	Mid-July	Mid-August
Bhadra	Mid-August	Mid-September
Aswin	Mid-September	Mid-October
Kartik	Mid-October	Mid-November
Mangsir	Mid-November	Mid-December
Poush	Mid-December	Mid-January
Magh	Mid-January	Mid-February
Falgun	Mid-February	Mid-March
Chaitra	Mid-March	Mid-April

Currency

I US$ Equals NRs. 68.5 during field survey, 1999

CHAPTER I

INTRODUCTION

Mountain watersheds are source of fresh water, habitat for wildlife, resource of rich biological diversity and regulator of downstream resource stability and productivity (ICIMOD, 1997a: 2). They are susceptible to accelerated soil erosion, landslides and rapid loss of habitat and genetic diversity (UNCED, 1992:109), owing to their fragile ecosystems comprised of steep slopes, weak rock structure and poor soils (Thapa and Weber, 1990:1). Degrading resource base under constantly increasing human and livestock population pressure, declining soil fertility and under investment in development activities have threatened to jeopardize the sources of livelihood of mountain people. Little understanding of mountain specificities by planners and policy makers, and inability of development efforts to harness the local niches have further aggravated the economic woes and threatened the prospect of mountain development (Jodha, 1995:155-56).

Mountain and upland watersheds constitute 25 percent of the world's land and 10 percent of the human population, demonstrate their concern for a secure and prosperous society (Messerli, 1997:14). However, ignorance about mountains and hills in all regions appeared to be common phenomenon, as national policy makers and professionals neglected the mountain imperatives (Banskota, 1997:1; Brooks, 1993:5). More often, the policy and programs on mountain watersheds were designed and operationalized based on centralized top down modus operandi, which allows little scope for adjustment in accordance with the situation at local level. This has numerous pitfalls, including non-involvement of watershed inhabitants in management planning, which lead to raise a question on the success and validity of the programs (Chambers, 1994a: 5-6; World Bank, 1996:3-11; Brooks, 1993:5; Clark, 1995:593).

Mountain people are receiving increasing attention to their plight and problems as well as to their unique environment (Pelinck, 1997:2). They have developed a wide range of management practices to suit their diverse ecological and socio- economic settings which were poorly understood in the past. At present, a trend has already been in practice to safeguard the community stakes and prevent the erosion of grassroots initiatives in watershed management. However, it needs wider recognition and concrete action both at national and local levels.

At the beginning of 1990s mountain watersheds attracted the attention of international institutions, research communities and national governments, owing to their fragile ecosystem and rapid negative changes. It has been agreed to formulate strategies and ensure their implementation at all levels under the directives of the UN Agenda 21 (UNCED, 1992:1,109). The commitment expressed by the signatory national governments needs further work in-terms of refining the issues, problems and prospects of each individual country to guide future policies and programs. Simply analyzing issues at national level overlooks micro level variations within the national territories. Therefore, it is necessary to go further down and explore location specific issues, perspectives and complexities in watershed management and development.

Mountain watersheds are composed of heterogeneous geographical units which makes difficult to select a replicable management model for decision-makers. There are villages and towns characterised by people with diverse socio-economic background and attitude. Watershed settlers have their own interest and priority, and involve a high degree of diversity inter-linked with livelihood strategies, agroecological potentials and constraints. To sure effective management of watersheds, area specific participatory approach is necessary as

opposed to blueprint (Jenson, 1995a: 43-54). Location specific problems, contexts, constraints, and potentials have to be understood at the planning and design stage, and suitable conservation and production technologies have to be introduced. This needs to enhance and foster local knowledge and skills which is not getting due attention yet.

1. Watershed Management in the Hills of Nepal

Like many other countries, Nepal is also confronting with watershed management problems. The physiographic and climatic contrast to its small area of 147,181 sq.km has aggravated the complexity. The climate changes drastically from subtropical monsoon to alpine tundra, as the elevation gradually increases from *tarai* (60 meters amsl) in the south to high Himalayas (8848 meters amsl) in the north, forming six parallel climatic zones within a short distance of 250 km. Moving from lowland *tarai* to the high Himalayas, an array of land use and corresponding problems become apparent in watersheds (Brooks, 1993:22). Mountains and hills constituting three-fourth of the national territory of Nepal comprise four macro, 24 meso and 6,000 micro watersheds, with diverse biophysical conditions and socio-economic settings (Fig1.1). Many of these watersheds are in a state of physical and biological deterioration under the influence on-going human activities (Wagle, 1997:30).

2. Weakening Farm-forestry Linkages

Recent population growth trend in Nepal indicates that it is in the early expanding phase of its demographic cycle. The population has doubled in the last three decades between 1961 and 1991, which has increased pressure on natural resources. Given low economic growth and inadequate infrastructure, there is little prospect for stabilizing the population in the near future. As a result, all efforts to improve the prospect of sustainable mountain development have been seriously threatened (Jodha et al., 1992: 9-10). The magnitude of poverty is ever increasing in Nepal. According to NPC (1998), 45 percent of the population was below the poverty line, whereas the independent estimates reported that 71 percent of the total national population was below the poverty line in 1988/89 (SAARC, 1992:3).

Corresponding to population growth, the number of livestock has also increased over the successive years. This is explained by the ever-increasing demand for livestock products to meet the basic calorie requirement of growing population and sustain household economy. Increasing livestock number has pressurized the forest and arable lands. In some districts, the livestock density is above the carrying capacity of land resources (Table A.1). On an average, one hectare of land supports four LSU, against its carrying capacity of two LSU under the current management system (Paudel, 1997). The current consumption rate of forest and shrub based fodder far exceeds sustainable supply, at least at the current management levels (HMG and IUCNR, 1988:52), and livestock productivity is likely to decrease due to dwindling supply of fodder. Likewise, small land holders in the hills have been forced into a number of desperate survival strategies, one of which is to clear the forest, usually on very steep slopes for food crops cultivation, where the top soil will be washed away within one or two rainy season (Blaikie, 1985:127).

Hill farming system requires net transfer of nutrient from the forest and rangeland through fodder and leaf litter to animals (Mahat, 1987c: 12). Fodder and grasses are used to make up the feed deficit and leaf litters for composting mixed with dung. As the supply of these resources has declined, it has had to dwindling supply of farmyard manure, which is the main source of fertilizer.

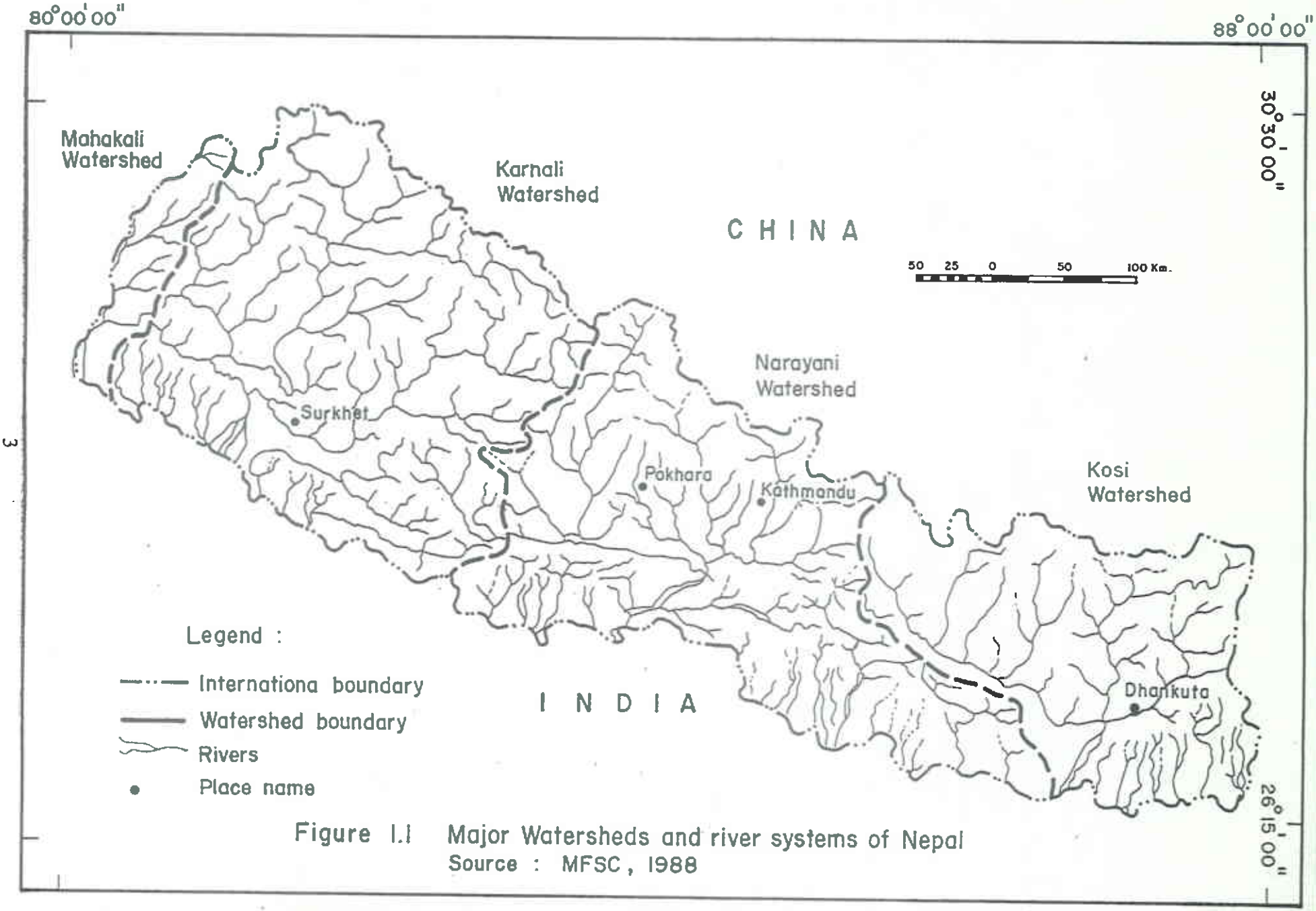


Figure 1.1 Major Watersheds and river systems of Nepal
Source : MFSC, 1988

3. Soil Erosion and Land Degradation

Deforestation in the hills and manifestation of its effect through soil erosion and land degradation pose a serious threat to subsistence farming communities. The extent of deforestation has been a much debated issue (Schreier et al., 1994:1). Most of the earlier interpretations on deforestation were either based on observation (Guthman, 1997: 55; Balikie and Brookfiled, 1987: 41) or fuel wood consumption and production estimates, which were found varying by factors of 67 and 150 respectively (Thompson and Warburton, 1985a:5 and 1985b:44), and there has been uncertainty about the pace and extent of deforestation. It is further complicated because of the statistics, as the vast area of open ground, which supports only shrubs, although they were forest earlier, are still counted as forests in official statistics, because of unrecorded deforestation (John, 1990:253; Gill, 1996:13). The consequences of deforestation are location specific, and little is known about forest replacement affecting slope hydrology and land degradation (John, 1990:253). The uncertainty has increased many folds by changing biophysical condition and spatial heterogeneity within short distance.

According to Ives and Misserli (1989) the pace of deforestation was not as high as reported by earlier studies. Likewise, the soil erosion, flooding, and related damages were mainly attributed to the on-going process of mountain building and expansion of agricultural land in flood prone areas along the major river systems. Nelson et al., (1980:22) found only 13 percent of the land under degraded condition which is not as high as it was described in many literatures.

Regarding the soil erosion, average soil loss in the upper Andhikhola watershed of the western hills was estimated to be about 60 tons/ha/yr (Pahari, 1993:62); 33 tons/ha/yr in Tanahu watershed of the western midhills (Shrestha, 1996); 18 tons/ha/yr in Trijuga watershed in the eastern Churiya hill (Sah,1996); and 44 tons/ha/yr in Nakkhukhola watershed, south of Kathmandu (Tiwari, 1990:59). Soil erosion rate in agricultural land varies depending on location, slope gradient, land use and management. But these estimations provide little information on land management systems adopted by the hill farmers. Soil erosion and land degradation need more socio economic explanation blending it with institutions and policy framework (Thapa and Weber, 1994a; Balikie, 1985 and 1989; Blaikie and Brookfield, 1987). The process that led to the land degradation need to be explained both in biophysical and socio economic terms before effective management option is to be developed (Schreier et al., 1995:51). Extrapolation of the information from one to another or from micro to meso and macro watersheds is extremely challenging. Owing to significant bio-physical and socio economic variations from one place to another, it is futile to make any statement about mountain watersheds based on findings of a few case studies and observations in selected locations (Thompson and Warbarton, 1985a and 1985b; Ives and Messerli, 1989; Blaikie and Brookfileds, 1987; Bruijeel and Bremmer, 1989; Schreier et al., 1995).

4. Declining Fertility and Production Potentials of Private Farm Land

With the exception of lowland valley bottom and narrow stretches of river terraces, most of the farming in the hills of Nepal is predominantly rainfed, typically dependent on monsoon rain (Table A. 1). Irrigation development strategy of the government has disappointing result despite huge investment in this sector (Lam, 1996:1301). The food requirement has been increasing steadily at an average annual rate of 2.64 percent, while the food grain production has been dropping down by 2.1 percent (Gill, 1996:3). Composite yield of major food crops

increased only by 0.43 percent between 1974/75 and 1995/96 (Table A. 2). Rice and wheat yields were in slight increase, while maize and millet yields were in negative trend (Fig.1.2). Low yield has pushed Nepal from surplus production of 66,921 tones in 1971 to a deficit of 518,927 tones in 1995/96. The situation in the hills is worse as the food grain deficit increased from 70,697 tons in 1971, to 491,561 tons in 1995/96. *Tarai*, which had supplied food grain in the past is also facing gradually declining surplus production due to population growth and little improvement in crop yields (Pudasini, 1997: 95). Thus, ensuring food security by enhancing crop yield has been a major challenge to farmers, scientists, planners and policy makers.

Increasing cropping intensity was sought as an alternative in response to declining crop yields and food deficit (Mahat, 1987c: 14). Accordingly, hill farmers have changed their cropping pattern through the introduction of winter wheat and early maturing paddy to allow extra crop of maize, double cropping of paddy in irrigable fields and inter-cropping of millet with maize (Blaikie, 1985:24). Facilitated by adequate supply of labor force, cropping intensification has taken place mainly in irrigated fields. Moreover, cropping intensification demands for higher amount of inputs, including farmyard manure and chemical fertilizers (Schreier et al., 1995:247). The declining forest fodder required to produce farmyard manure and farmers' inability to purchase chemical fertilizers have been serious constrains for increasing cropping intensification and farm productivity. As farmers have practiced intensified land use without adequate inputs, plant nutrients are gradually depleting in soils (Table 1.1).

Table 1.1: Nutrient loss in Nepal by soil erosion

Nutrient loss	Irrigated rice terraces	Rainfed bench terraces	Rainfed marginal land	Degraded grazing land	Good condition forest
Soil loss depth mm	0	0.4	1.0	8.0	0
Soil loss t/ha/year	0	5.0	20.0	100.0	0
Organic matter loss kg/ha/year	0	75.0	300.0	1500.0	0
Nitrogen loss kg/ha/year	0	3.8	15.0	75.0	0
Phosphorus loss kg/ha/year	0	5.0	20.0	100.0	0
Potassium loss kg/ha/year	0	10.0	40.0	200.0	0

Source: Carson, 1992

Declining soil fertility has challenged sustaining food security in the hills and mountains. Constant loss of fertility from topsoil due to various causes is a challenging issue in the hills (CBS, 1998:359) where most agricultural lands are terraced from valley bottom to the ridge for cultivation (Paudel, 1997:23). The terraced lands are likely to be exhausted of mineral nutrients and the farmers hardly can grow the seed without chemical fertilizers (Jodha, 1995:142). Farmers believe that soils are not as fertile as they once were, and that the agricultural soils are being degraded (Carson, 1992:1; Vaidya et al., 1995: 69). While, there is wider variation in soil fertility based on soil constituents, land type and soil management practices, the extent and severity of declining soil fertility is not well documented.

All hill farmers have traditionally followed integrated soil management practices based on their inbuilt indigenous knowledge. However, over the time, these technologies alone could not be able to meet the production demand for sustaining the ever-increasing population (Pandey et al., 1995:1995:43). Majority of hill farmers apply small amounts of chemical fertilizers to restore soil fertility, though some areas which are utilized intensively has lead to problem of soil acidity (Carsson, 1995:1).

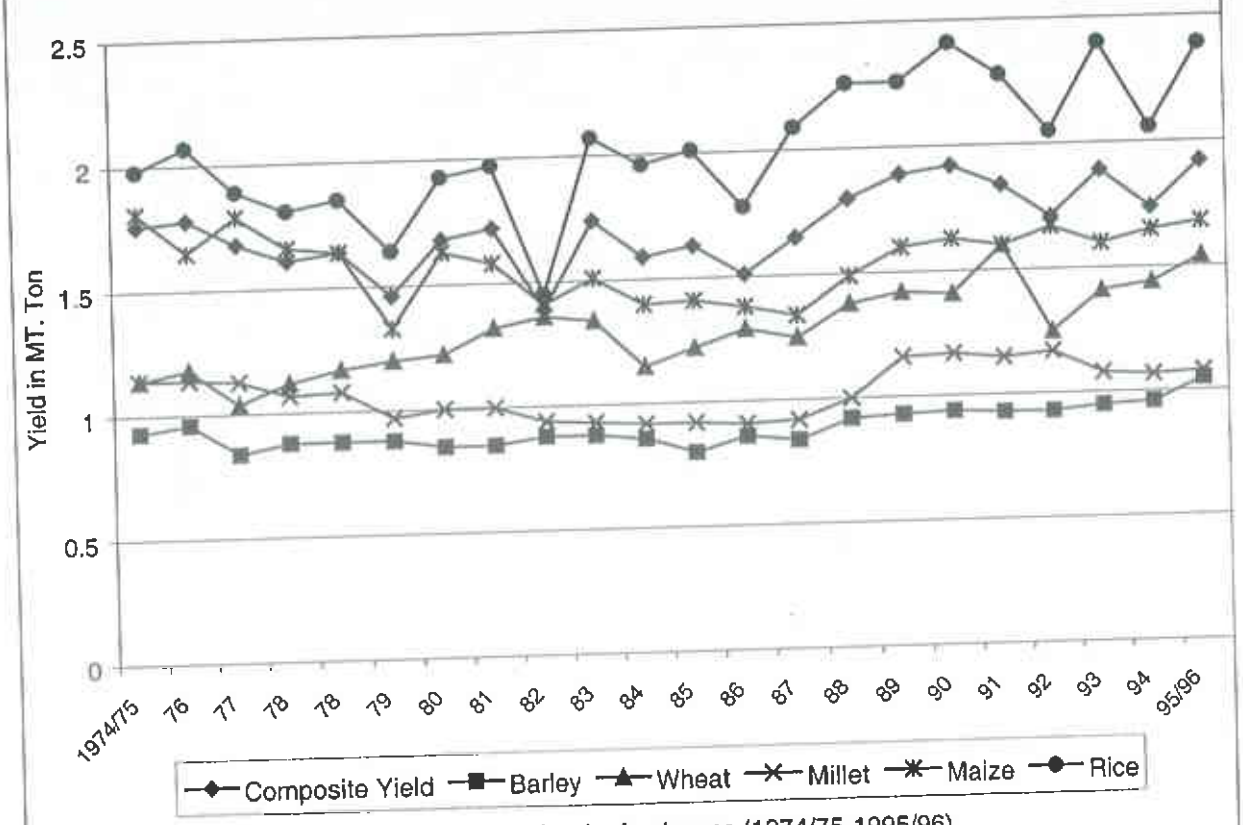


FIG.1.2: Annual yields of major food crops (1974/75-1995/96)

(Data Source: MOF, 1994 and CBS, 1997)

The soil fertility decline and resulting impact on production has been a major concern for sustaining agricultural production in the hills of Nepal (Schreier et al., 1995:249). Despite efforts made by a few aid agencies and non-governmental organizations, soil fertility has not been a priority issue in national agricultural development agenda of the Department of Agriculture (Shah and Schreier, 1995:17). Recently Nepal Agricultural Research Council (NARC) has carried out a soil sample survey in selected districts and analyzed soil constituents. It has noticed the deficiency of macro-nutrients required for cultivation. There is a major gap in understanding the complexity in fertility management as the tendency has been to focus on soil chemistry (Carson, 1992:1)

5. Weak Local Institutional Capabilities

Local organisations are being mobilised by a number of watershed management projects. But, it is not fully known which of these organisations have been effective, to achieve the objective, and to what extent they could foster people's participation in watershed management (Dani and Campbell, 1986:39). Watershed management requires a framework and interdisciplinary analytical tools including local resources and knowledge (Wignaraja, 1991:59-61). Fostering participatory watershed management needs establishment of viable local institutions which involve people in planning, implementation and maintenance of project assets (Jensen, 1995a:xxiii). The main thrust of institution building in watershed

management is to secure better performance from local organizations. In the past, the procedure of strengthening the local organizations, who might have been expected to contribute towards their design, testing, and evaluation received little attention. Central government staff, policy makers and consultants have constantly neglected this very important aspect. While most field staff and local executives themselves have not been trained in integrated watershed management, others were not rewarded for innovations. The academics also have overlooked the potential institutional role in resource management (Chamber, 1993:15).

Institutional capacity can be created to improve the work performance of local organizations, when the research figure out the way of getting more effective service from the existing functional structure, resources and manpower of the organizations. Until the value of innovative functions that an organization could perform are not proven by studies, the organization will be reluctant to invest their scarce resources in creating internal capacities for better planning (Uphoff, 1990:1405).

It is difficult to promote new technology unless there are strong local institutions capable of mobilising people, who are supposed to utilise the new technology for improved production (Lovejoy and Sandres, 1994:137). Often technologies developed and by international and national research institutions are complicated in design and expensive in monitory term, and are not suitable to local conditions. This entails adoption of farmers first approach to research and technology transfer to address the problems of complex, diverse and resource poor areas. Such approach is evolving and never will have final shape, since it is an organic rather than a structure (Chambers 1993: 73-75). It needs acceptance from professionals and policy makers, which is not easy to achieve. This needs bureaucratic reorientation reinforcing the changes (Uphoff, 1985:388). Still it is not clear, to what extent, and by what means and methods such institutional changes can be attended (Setty, 1994:46).

Both formal and informal institutions are involved in natural resource management in Nepal (Fisher et al., 1990; Thapa, 1997:290). The formal institutions have centralised bureaucratic orientation. They implement government policies and regulate action by using the existing laws, while the informal institutions have flexible structure, and are involved in natural resource management based on their indigenous knowledge. In the past, the grassroots institutions had managed forest, land, range and water resources successfully in different areas of the hills (Gurung, 1995; K.C and Pradhan, 1996; Fisher et al., 1990; Paudel, 1997; ICIMOD, 1986). But, the traditional structures and local institutions are breaking down gradually, whereas the emerging new structures have been ineffective in addressing the growing problem of watershed degradation (Acharya et al., 1995:70). This was mainly due to widening gap between farmers' practices and innovations being promoted by policy makers, planners and researchers (Tamang, 1996: 21). Each successive development plans were expected to be implemented effectively, timely and appropriately to reach the farmers. But, program implementation and delivery of services by formal institutions turned out to be inefficient and insensitive to the need of local farmers (Regmi, 1995:223).

6. Public Participation

Watershed management programs in the past had some shortfalls like absence of thematic focus, inadequate exploration of local technical know how, and alienation of community people in program preparation and implementation. Program activities and planning were not sufficiently consistent with the project mandate, which created unnecessary obstacles and delays in implementation (Ostiani and Warren, 1997:28). Watershed management has come a

long way since the days and the gap between concerned authorities and watershed communities has widened gradually due to negligence of the beneficiaries.

Until recently the programs and projects aimed at improving the socio-economic condition of the people tended to be initiated, designed and implemented by top level agencies and institutions without systematic consultation and involvement of the intended beneficiaries (Burkey, 1993:xvi). Participation in the past often meant little more than the provision of local labor and materials, with limited community involvement in decision making, with agencies retaining responsibility for and control over the system (IRC, 1993: 8). However, there have been numerous small local initiatives throughout the world, which have successfully emerged as participatory traditions with modernisation and development. Such grassroots initiatives have given impetus to a shift in the approach to development from top-down to bottom-up, from specialised to integrated, from dictation to dialogue and from modern technology to appropriate technology (Burkey, 1993:xvii). The experiences gained through such initiatives indicate that securing people's participation in development and conservation programs needs designing broad strategies based on better understanding of their perceived needs and priorities (Cernea, 1985:289; Narayan, 1997:7). In the planning process, local people should participate in the design of a land use plan (Cernea, 1985:290).

In Nepal, government has realised the utmost need of farmers' participation in resource management and other development programs to acquire acceptance as well as validation from the public for greater success. Formation of user groups has been a step forward taken to assure public participation in all watershed management programs (Wagle, 1998:101). The concept of user groups was first introduced with the advent of community forestry program in the late seventies (Joshi et al., 1997:57). The Forest Act of 1993 has given autonomy to local user groups as an independent entity (DSC, 1995). They are expected to be able to govern and manage local resources effectively. User groups' involvement in program execution is considered to be vital to foster farmers' participation in irrigation, land management and other developmental programs. But, little is known about their institutional capabilities and role in agricultural land management.

7. Rationale of the Study

Degradation of agricultural land is an emerging environmental problem in the hills of Nepal. Large proportion of the hills are not suitable for agricultural production and represents bulk of fragility (Pudasaini, 1996:95). Agricultural transformation is quite slow and the production potentials are in negative trend in some areas. Fragmented institutional efforts could not help so much for positive transformation. Environmentally incompatible agricultural practices and uncongenial development policies have led to a vicious cycle of poverty and ecological degradation in the hills. Breakthrough of the vicious cycle and reversing the degradation process into positive terms has been a prime concern in regard to the hills development.

More often, past studies focused on problems and prospects of managing forest and rangeland resources (Enk, 1971; Eckholm, 1976; World Bank, 1979; Blaikie et al., 1980; Ives and Messereli, 1989; Kawakita, 1997; Stevens, 1996; Fox, 1983 and 1993; Gilmour, 1989; Carter and Gilmour, 1989; Wallace, 1981; Bajracharya, 1983; Metz, 1994; Mahat et al, 1987a; Amacher et al, 1996; Kanel, 1998). Private lands, which constitute a large proportion of mountain watersheds, have attracted less attention of researchers. Farmers have utilized lands for field crop cultivation, but these lands are confronting with problems of soil erosion and nutrient mining. There are no coherent efforts and comprehensive management plans to understand their complexities and avert the degradation process. Formal institutional efforts

for improvement are dis-aggregated and broken down under different departments (Upadhaya, 1991:182). Considering the vast area and complex agro-ecological and socio-economic problems of rainfed agriculture, the research and development of such areas should be directed to increasing and sustaining the productivity (Puri, 1989).

Agricultural production system in the hills and mountains remained outside the research agenda for a long period of time The concentration of research efforts in irrigated *tarai* overlooked the hills (Singh and Sharma, 1995:136). Agricultural development efforts emphasized on selected crops, fertilizer and irrigation based technologies. The whole package is based on the experiences in the plains, which frequently discards the needs, diversities, and constraints of the farming communities living in rainfed hills (Jodha, 1995:168). This is further aggravated by city and *tarai* biased development policies. The hill farmers try to produce required amount of foods for household consumption (Mahat, 1987c: 11). Increased demand for food in the past was met by expanding agricultural practices into fragile steep lands. This opportunity has virtually vanished now. Confronted with scarce non-farm employment opportunity, seasonal migration has been an alternative strategy adopted by hill farmers to fulfill their basic needs. Working outside the village in the regional cities of Nepal and India during slack months enabled households to buy food grains and other consumer goods. However, the labor absorbing capacity of these cities has reached to their ceiling, owing to steady in-migration in the face of slow economic growth. Consequently, hill-farming system has been forced to absorb the growing labor force through cropping intensification. While these practices could not enable farmers to produce sufficient food, they made lands vulnerable to degradation and diminishing crop yields. Thus, hill people are exposed to the threat of food deficit and malnutrition, as there are scarce alternative employment opportunities to offset the diminishing field crop production (Thapa and Weber, 1994b: 477). Indeed, some changes have taken place in agricultural land management practices in order to increase crop production, but the changes are not examined scientifically. Low level of external inputs, declining soil fertility, shortened fallow period, low and erratic rainfall create a plethora of risk to attain food security to rainfed farmers (Adesina and Quattara, 1995:112). Farmers want sustained food security, which depends on enhanced crop production. There is no single study dealing with farmers' land management practices adopted to secure higher food production.

Local organizations that work in close cooperation with the intended beneficiaries are allocated a few resources and little attention is paid by policy makers in their institutional development (Uphoff, 1986:221). Nepal is not an exception from this reality. Until the restoration of multi-party democratic system in 1990, a few district chairmen were nominated to the National Development Council to neutralize their potential countervailing force. Neither the central government was concerned to strengthen local institutional capacity, nor the institutions themselves could play any role in shaping policies and programs. The Decentralization Act of 1982 amended in 1998 has provided sufficient rights to local level organizations to mobilize their capacities for conservation and development. But, little is known about their existing capacity and prospect of their involvement in farmland management.

The word "participation" has become a catchword in many resource management projects (Burkey, 1993:57). However, the increasing popularity of participatory methods in resource management has not been evaluated critically (Gobel, 1998:277). The impact of beneficiaries' participation in watershed management project seems to have received less attention. Empirical studies on the impact of public participation in project activities are very few, and the available empirical evidence is still inconclusive (Jensen, 1995b: 43-45). Factors

leading to greater community participation and project effectiveness need to be explored through scientific studies of projects/programs, which will contribute to formulate appropriate project design for fullest use of community participation as a vehicle for greater effectiveness (Manikatty, 1997:115-140).

There are no comparative studies on watershed management "with" and "without" external intervention in Nepal. Little is known about the effect of project intervention in bringing changes in the management of agricultural lands in mountain watersheds. Therefore, it is necessary to carry out a comparative study in two watersheds, to assess whether the external interventions have influenced the traditional land management system, and to examine how farmers have responded to the interventions.

Watershed management is basically a location specific program both in terms of agro-ecological conditions and socio-cultural situations (Thapa, 1990). Still there are some cross regional and cross cultural lessons to be learned on harnessing local community efforts in watershed management (Dwarakinath, 1995:502 and Younis and Dragum, 1993:253), blending the perceptions and desires of watershed inhabitants (Dani and Campbell, 1986:5). Any effort to manage natural resources in a prudent and productive manner needs to be adjusted to local conditions with due consideration to the physical, cultural, social and spiritual environments with its own response at the micro level (Shah, 1995:8). Policymakers, planners, and program implementers need to work in harmony with local farmers in order to achieve the goal of socially acceptable and environmentally compatible watershed management. This entails a location specific research on problems and prospects of watershed management, in general and private land, in particular (Fig1.3).

8. Research Questions

This study aims at to seeking answer to the following insufficiently understood questions.

1. What are the differences in agricultural land management practices in mountain watersheds "with" and "without" external interventions?
2. To what extent soil erosion and landslides have affected the farmlands?
3. Whether the different types of fertilizers applied by farmers replenish plant nutrient extracted by crops?
4. What are the preferences and attitude of local farmers in regard to locationally suitable land management practices?
5. What are the external and internal factors influencing changes in agricultural land management practices?
6. How hill farmers accord their priorities to management of different types of farmland?
7. What are the formal and informal institutional arrangements made in land management?
8. How to integrate technical and institutional inputs to improve the condition of agricultural lands for sustainable crop production?

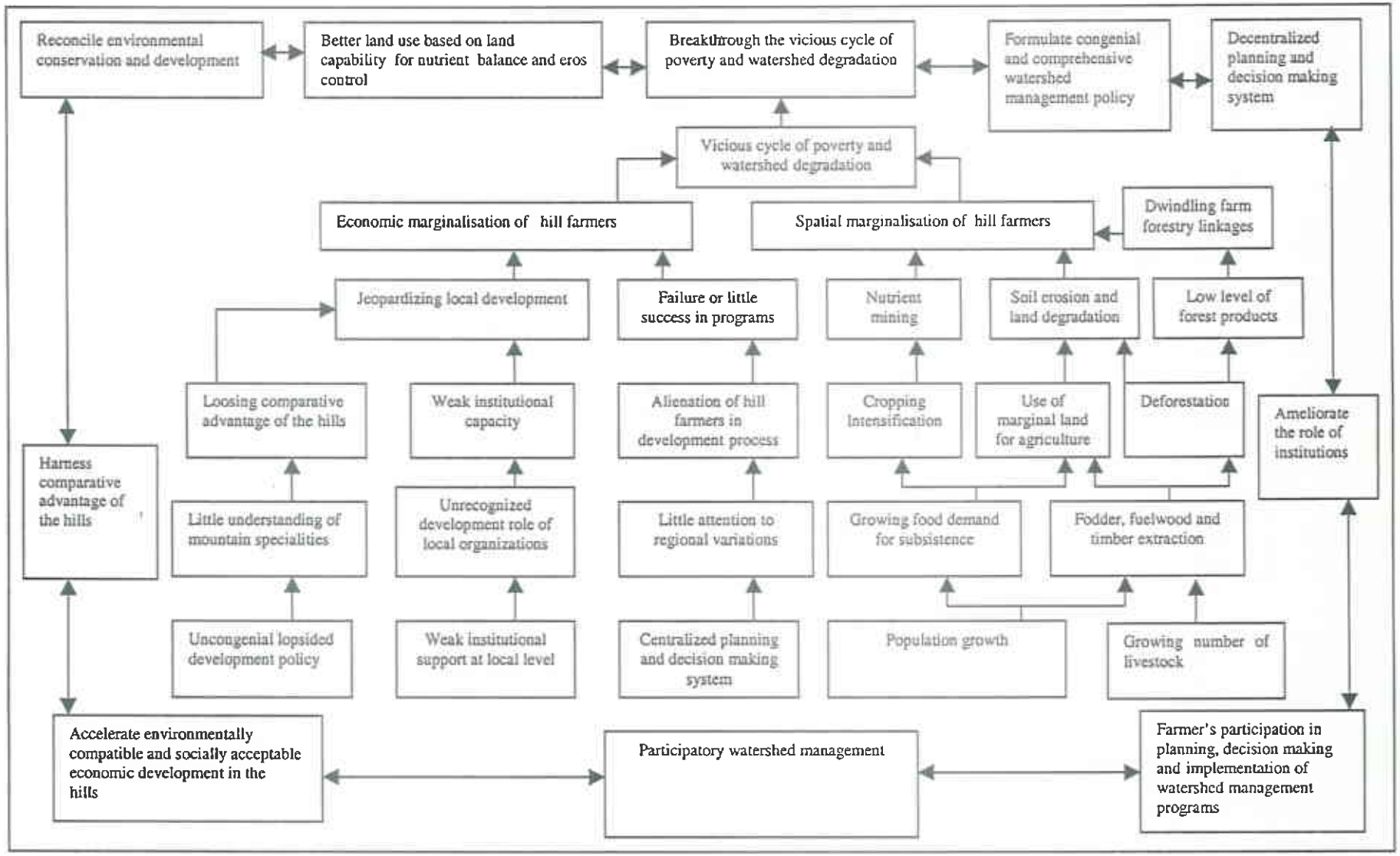


Figure1.3: Conceptual framework of the study

9. Objectives

The major objective of this study is to examine the problems and prospects of improving agricultural land management for sustainable agricultural production in the study area. The specific objectives are:

1. to examine the status of farmland;
2. to find out farmers' perceptions of and attitudes towards improving land management practices;
3. to examine the changes in agricultural land management practices under the influence of internal and external factors;
4. to analyze strategies and priorities of local farmers in utilizing and managing different types of farmland, with varying characteristics;
5. to explore socio-economic and institutional factors determining the management of agricultural land;
6. to examine existing and potential role of formal and informal organizations in promoting environmentally compatible and economically profitable land management practices; and
7. to formulate an integrated land management strategy.

10. Scope of the Study

Farmers' agricultural land management practices have been changed under the influence of internal and external factors, but little is known about them. This study sheds light on the changes and adjustments in Phewatal and Yamdi-Mardi watersheds of Kaski district (Fig 3.2). In this context, strategies and priorities of hill farmers for utilizing and managing different types of farmland have been examined and related explanatory factors are explored. This study also examined the existing and potential role of local institutions involved for improving land management systems. The Department of Soil Conservation and Watershed Management implemented soil conservation activities in Phewatal watershed from 1974/75 to 1994/95, while the adjoining Yamdi-Mardi watershed has so far not been paid attention by any agency (Fig.3.2). This study has made a comparative assessment of the management of agricultural lands in both watersheds. A schematic view of the scope of the study is presented in Table 1.2.

Innovative features of this study are as follows:

1. Much attention has so far not been paid to study management of agricultural lands in the mountain of Nepal. This study has made an attempt to cover this overlooked aspect of watershed management.
2. This study analyses changes and variations in land management in two adjoining mountain watersheds "with" and "without" external intervention. It examines external and internal factors influencing changes and management practices.
3. It examines management priorities of farmers for different type of farmlands to understand the effect of management on farm productivity and land degradation.

4. Farmers make decision on agricultural land management in light of their needs, production possibilities and constraints. This study analyzes as to how needs and production potentials and constraints have influenced land management.

5. An integrated approach blending peoples' participation and institutional response to farmland management is the most innovative feature of this study. It has analyzes the role of formal and informal institutions in land management, examines the institutional capabilities of formal and informal local organizations involved directly and indirectly in land management and identifies areas of intervention for improvements in concerned institutional capability.

Table1.2: Scope of the Study

Objective	Farmers' problems	Research Problems	Scope of the study
To examine the status of farmland.	Soil erosion, landslides and nutrient mining in agricultural land and decreasing crop yields.	To what extent the soil erosion and landslide have affected the farmlands? Whether the different types of fertilizer applied by farmers replenish plant nutrient extracted by crops?	Efforts made by farmers to control soil erosion and landslide. Farmers' efforts made to maintain soil fertility.
To find out farmers' perception of and attitudes towards improving land management practices.	Difficulty in improving land management practices.	What are farmers' perceptions of and attitudes towards improved land management?	Farmers' perceptions of and attitudes towards improved land management.
To examine the changes in agricultural land management practices under the influence of internal and external factors.	Necessity to change agricultural land management practices due to internal and external factors.	How farmers have adjusted their land management practices with changing situation?	Changes in land management practices adopted by farmers to cope with shrinking landholding size and land degradation.
To analyze strategies and priorities of local farmers in utilizing and managing different types of land.	Different production potential of farmlands.	How farmers accord land management priority?	Farmers' priority to different type of lands for the application of structural and biological measures to control soil erosion and landslide. Farmers' fertility management priority.
To explore socio-economic and institutional factors determining the management agricultural land.	Different socio-economic, institutional, ecological and spatial factors influence the adoption of land management practices	What are the actors and factors influencing the adoption of land management technologies?	Determinants of land management.
To examine existing and potential role of formal and informal local organizations in land management.	Weak institutional support for land management. Non integration of user/farmers' group in agricultural land management.	What are the contributions of GOs and NGOs to agricultural land management? Is there prospect to involve local user/ farmers' group in agricultural land management?	Farmers' satisfaction with local organizations. SWOT analysis of GOs, NGOs user groups involved in land management.

CHAPTER II

LITERATURE REVIEW

Land resources in many tropical, subtropical, and dryland regions of the world are seriously affected by land degradation, over 80 percent of the world's population live in such countries where agricultural land is the prime source of livelihood (Dengo, 2000:69). Farm land degradation is defined as loss of productive top soil by erosion, vegetation depletion, fertility loss, soil structure change and pollution of soil, which make land less useful for cultivation (Wasson, 1994:48). There will be catastrophic failure of crop production, if this process is allowed to continue (Stocking, 1997:223). Finding of its causality and appropriate remedy are not simple. It has complex link between economic, social, biological and physical processes and difficult to detect the extent and intensity. It has been single most pressing problem in developing countries where majority of the people depend on land for their subsistence livelihood (Stocking, 1997:223; Pretty and Hine, 2000:119; Dengo, 2000:69; Pretty, 1999:21; Dhaliwal et al, 1999; Farshad and Zink, 1993).

2.1 Land Management

Land use and land management is wrongly interpreted as synonymous in many literatures. But in fact, they have basic difference in application and practice. Land use has many meanings but it is often associated with the process of preparing plans to control or manage effective land use with statutory controls for production and development (Humphries, 1999:43). Land management refers to the scientific disciplines of caring land resources particularly depending on scientific knowledge of soils, vegetation, flora, fauna, topography, geology, climate and water (Humphries, 1999:43). In a broader spectrum, agricultural land management is defined as appropriate utilization, protection, hazard mitigation, development and conservation of land resources (Mcgregor and Thompson, 1995: 5).

The approach of land management is changing rapidly. In the past emphasis on land management was on maximizing production and return from land use investment based on belief that suitable lands for agricultural expansion could be found somewhere (FAO, 1993b:1). Land areas, which are moderately or well suited to agriculture, for the most country, are already in use. There is clear evidence of land shortage globally or in many individual countries. Increasing population is putting pressure on finite land resources and causing land degradation. Efficient use of land resources is becoming a matter of life for increasing population (FAO, 1993b).

Sustainable land management aims to integrate ecological with socio-economic and political principles in the management of land for agricultural and other purposes to achieve intra and intergenerational equity (Hurni, 2000:85). It combines technologies, policies, and activities aimed at integrating socio-economic principles, with environmental concerns so as to maintain and enhance productivity; decrease risk to production; protect the potential of land resources and prevent the degradation; and try to make land management economically viable and socially acceptable (Cornforth, 1999:174; Hurni, 2000:83; Dumanski and Pieri, 2000:96-98; Prasad and Power, 1997:2).

2.2 Indicators of Sustainable Land Management

Increasing population pressure and demands for production from fixed lands are threatening the quality of land resources. Sustainable management of land resources is more important than land supply for development. Land degradation and mismanagement are threatening

opportunities and flexibility for increased services from the land, requiring increased investment in soil conservation, rehabilitation and reclamation of degraded land (Dumanski and Pieri, 2000:93). Integrative indicators of the current status of the agricultural production capacity of land and their changes over time are needed for promoting land management practices to maintain or improve land productivity and sustainable use of land resources (Binraban et al, 2000:103). Sustainable land management and the choice of feasible and cost effective management options is hampered by the lack of indicators for monitoring and how land is being managed by farmers, the impact of policies and programs on land management choice at farm level, and the impact of land management on quality of land (Dumanski and Pieri, 2000:93; Zander and Kachele, 1999:311). However, some indicators have been proposed recently to assess the sustainability of farmland.

Nutrient balance is one of the major land quality indicators. However, nutrient stock and flows are location specific. Though it can be measured by deducting the total amount of nutrient removed by crop, crop residue, leaching and erosion from the total amount of nutrient gained from fertilizer application, natural recharging, fixed by legume crop and atmospheric fixation (Dumanski and Pieri, 2000:97; Bindraban et al, 2000:106). Based on nutrient balance, land management can be assessed towards or away of sustainability. Similarly, yield trend, including direction and rate of change of major food crops in an area is another land quality indicator (Dumanski and Pieri, 2000:98). This is useful indicator because it is easily understood, easily converted into economic term, and it is useful for monitoring both project and program performance. However, this indicator should be used with caution because there are many possible cause effect relationship with yield, namely, marketing, climatic change, subsidies, land management, and the indicator can be misleading without comprehensive analysis of these driving forces causing yield change (Bindraban et al, 2000:105).

Land use intensity is also an indicator to assess sustainability of land. It provides information on trend towards or away from sustainable land management (Dumanski and Pieri, 2000). It estimates the impact of agricultural intensification on land quality. It involves increased cropping, shift towards more value-added production, and increased amount and frequency of inputs. Such changes, without adjustments in land management practices, often result in nutrient mining, soil erosion and other forms of land degradation. However, agricultural intensification, if properly implemented, can also result in improved land quality and sustainability.

Land cover is a surrogate indicator for estimating major land processes and it contributes to increased understanding on the issue of agriculture and environmental sustainability (Dumanski and Pieri, 2000:98). Greater amounts of soil cover reduce erosion, increase organic carbon levels, and provides nutritional benefits to a variety of organisms. Thus, measuring or estimating changes in soil cover and tree density in farmland over time can serve as an indication of improvement towards or away from environmental sustainability (Huffman et al, 2000:116). Perennial crops provide almost complete soil cover over the year, where as production of annual crops leaves soil bare for considerable periods of time. The essence of soil cover indicator has to answer two questions. Is the amount of soil cover increasing or decreasing, and at what rate? Is the ground cover adequate to protect against land degradation during critical erosion period? (Huffman et al, 2000:116; Dumanski and Pieri, 2000:98).

Extent and impact of land degradation help to assess the sustainability of land resources. Growing volume of literature on land degradation provides theoretical basis on the process of land degradation. The major deficiency, however, is the serious lack of information

on the extent and impact of land degradation (Dumanski and Pieri, 2000:99). How to collect such information at relatively low cost covering large area, and use them for land improvement has been a challenging job for scientist, planner and policy maker.

It is not known clearly whether current land management practices contribute to loss of agricultural production potential or they enhance land's productivity. Information on land management practices at farm level is scarce and systematic recording of the practices adopted by farmers is rare (Dumanski and Pieri, 2000:99). Land management practices applied by farmers have predictable impact on quality of land (Cornforth, 1999:178).

Socio-economic indicator of sustainable land management includes viability and acceptability. Clearly a land management system is not sustainable if it does not create profit for the producers, if the local farmers refuse to accept for it and if markets reject farm produces (Cornforth, 1999:178). Therefore, socio-economic indicator includes economic factors, including cost of production and profit, commercial factors e.g. market access, consumers demand and acceptance, and social factors including farmers' needs and attitudes.

Qualitative indicators include easily observed changes occurring on land. They are associated with awareness and experience of farmers. Farmers have knowledge of their land and have access to the important temporal component of land quality; they can monitor how their system has changed (Lefroy et al, 2000:138). Farmers observe changes in crop performance; they detect soil erosion and landslide; gully expansion; sedimentation and flooding; recognized yield trends; change in soil cover; and soil fertility (Eswaran et al, 2000:158). Such common knowledge of farmers helps to assess the land quality and sustainability of the land management system (Lefroy et al, 2000:138).

2.3 Measures of Agricultural Land Management in Mountain Watersheds

Land degradation is globally recognized as a major problem for food security and sustainable development. It is universal problem and it is not merely an agricultural problem but has ramification in all aspect of society (Koohafkan, 2000:71). There is no blue print and replicable model to control land degradation (Stocking, 1997:224). Past efforts to combat land degradation and improve land management practices have been only partially successful. Existing policies and programs need to be reviewed and innovative and functioning mechanisms have to be identified (Koohafkan, 2000:80; Quezanda et al, 2000:93). Most of the programs designed for combating land degradation and sustainable agricultural improvements in 1990s throughout the world have been made without significant policy reform. Sustainable land management still remains at the verge of conventional policy processes and aims. None of the agriculture policy makers are likely to say they are against sustainable land management yet they are not fully committed to initiate comprehensive policy reform (Pretty and Hine, 2000:119).

Several structural, nonstructural and institutional measures have been applied to agricultural land management in mountain watersheds (Graaff, 1993:91). Major land management measures, which are under practice, are as follows:

2.3.1 Ecological Measures

Ecological measures in agricultural land management give more emphasis to prepare policy and programs according to ecological condition of the watershed. A careful study is

undertaken in each sub watersheds by their location and programs and activities are prepared to suit the local biophysical and socio economic conditions.

2.3.1.1 Contouring and Counter Hedgerows

Contouring is a land management measure, in which ploughing, planting and cultivation activities are carried out along the contour lines. The effectiveness of contour farming varies with the lengths and steepness of the slope. The allowable length declines with increasing steepness. This technique is more effective in areas with low rainfall intensity. Improved contour farming practices with strip cropping can attain protection against extreme storms and soil erosion (Morgan, 1995:137).

Contour hedgerow technology in agricultural land management has different name in different locations. It is called avenue cropping in Sri Lank, contour hedgerow farming and sloping land technology in the Philippines and Hindikush Himalayan Region and alley farming in Africa (Ya, 1998a: 8). This type of technology has been proved successful to increase soil fertility thereby crop production and farmland stabilisation. This technology has been promoted since last two decades as solution to soil erosion control and sustainable crop production in the uplands. Despite the efforts, adoption of this technology has not been widespread due to various factors (Mercado et al, 1997:25).

2.3.1.2 Sloping Agricultural Land Technology

Sloping agriculture land technology (SALT) is basically a package of technology models using a counter, double hedgerow agroforestry concept of diversified crop production for sloping farmland (Xuhai et al, 1995:50; Santoso et al, 1995:86; Phommsack, 1995:99, Paningbatam et al, 1995:156; Anecksamphant 1995: 181). It was devised and tested by Mindanao Baptist Rural Life Center in the southern Philippines. There are four models under this technology. SALT I is one of the models consisting of growing food crops in 45 percent of the total land in crop rotation, permanent crops in 30 percent of the land, and fast growing nitrogen fixing tress and shrubs in 25 percent of land. Food crops and permanent crops are planted in a three meter wide strip of land. The nitrogen fixing trees are thickly planted in three to five meter wide countered alleyways, depending on the slope of the land in double hedgerow. The steeper the slope, the narrower the alleyways. In the second type of SALT model, half of the land is devoted to a standard SALT one system for food production, and other half is put under forage crops for livestock. Livestock manure is applied to the field along with nitrogen fixing crop residues. In third SALT model, lower half is placed under the SALT one model for food, and remaining half of the upper part is placed under forest tree plantation. The tree species included in the method can have a maturity period from one to 20 years after planting. The fourth SALT model is an agro-fruit livelihood model. Half of the land is placed for food crops, SALT one type technology; the lower one fourth of alleyways are placed under fruit production. Fruit alleys are used for food crops until fruit trees attain maturity. This technology has been spread in many Afro-Asian countries among the practitioners, but it has little adoption at farmers' level due to lack of training to farmers.

2.3.1.3 Ecological Economic Measure

Ecological economic measure (EEM) is widely practised in China (Deyi, 1997a:12). Land management policy, programs and activities are prepared to suit the local situation with particular emphasis on elevation and potential of economic activities. The measures are classified into three subgroups, e.g. high mountain, sloping land and low land. The EEM

model for high mountain area is known as vertical farming system model, which integrates forestry, livestock, horticulture, aquaculture and crop production. In a small watershed unit, steep upper slopes are used for planting trees and grass species (Deyi, 1997a: 12). Small weirs are constructed in the hill slope to collect water from rain or stream for irrigation. The adjacent lower slopes are placed for food crop production. The crop production activities are well integrated with food processing and marketing activities. EEM for slopping land promotes counter farming, farming in the furrows and ridges, counter strip and inter-cropping, crop rotation between food crops and grasses, deep ploughing, close planting, and inter-cropping and inter-planting. The economic activities are planned according to elevation and ecology of the land. EEM approach for low land area is based on diversified economic activities and conservation measures. Dam and ditches are constructed along the riverbank to treat the water logging and flooding areas. Different crops like wheat, rapeseed, broad bean, soybean, watermelon, and vegetables are inter-cropped in one system.

2.3.2 Biological Measures of Land Management

Biological measures are vegetative measures used to protect farmland from soil erosion, enhance soil fertility for increased farm productivity and household incomes. The common biological measures are follows:

2.3.2.1 Agroforestry

Agroforestry is the deliberate growth and management of the trees, along with agricultural crops and or livestock, in a system that aims to be ecologically, socially and economically sustainable (FAO, 1996). Agroforestry encompasses all of the ways that trees and shrubs, intentionally are integrated into agricultural land use systems, provide tree products, and protect, conserve, diversify and sustain watershed economics and resources (Ya, 1998b: 85). This approach is gaining popularity among farmers in developing countries as it helps to increase their household incomes from fruit production, provides fodder for livestock and contributes to watershed conservation. Wind erosion is one of the most serious causes of watershed degradation in arid and semi-arid areas. Wind erosion erode not only topsoil of the arid plateau, but also endangers the inhabitants living close to area where rainfall is either low or sporadic (Deyi, 1997a: 12). Large tract of agricultural and pasture land are vulnerable to wind erosion and sand storms, which substantially reduce the production potential of the farmlands. To protect the land from wind erosion, a shelter belt is developed under agroforestry in which a net work of trees is established around farmlands, orchards, and pastureland. China has implemented a shelter belt program known as Green Great Wall Program (Deyi, 1997a: 13).

The people in dry zones have planted multi-storied and multipurpose perennial tree species such as coconut, mango, jack fruit, wood apple, drumstick and tamarind (Gamage, 1997:51). Farmers have planted fast growing nitrogen fixing leguminous tree with large canopy for moisture conservation. Likewise, even farmers in the humid tropic have been practicing agroforestry for environmental conservation as well as for sustaining household economies.

An integrated livestock and fodder development program has been initiated in Bhutan to improve the livestock productivity through better-feed resources, improved management and better health care (Denholm, 1991). The program promotes the production of forage grasses in recognition of niches and steep slopes for the support of livestock development. Seed of exotic grasses, legumes, fodder trees, seedlings and fertilizers are distributed free of

cost to participating farmers. A system of deferred rotational grazing has been introduced for re-vegetation and prevention of environmental degradation. The farmers have learned the low labor input production of forage and livestock through this program. The Aga Khan Rural Development Program in Pakistan encouraged local farmers to replant exotic leguminous trees in public and private lands for fodder production and livestock development. It has been highly successful due primarily its ability to transfer technology, to the village organizations effectively. A spontaneous initiative of Indian villagers known as "Chipko Andolan" in the northern India has played very important role in forest conservation. The marginal lands are reforested by fodder trees and, are cared for and harvested collectively by villagers (Denholm, 1991).

The promotional programs on agroforestry should focus to identify the problems faced by the farmers in combination with crops and livestock. The focus of agroforestry is to investigate how farmers' lots can be improved to overcome the fodder deficit (Sanchze, 1993) and control soil erosion. Most farmers have practiced agroforestry at small scale. Improvements are difficult because of the large number of physical dispersion of the landowners, the very low level of capital available, inadequate research base and lack of support services and complexity of knowledge required for the individual farmers (Briscoe, 1983). To promote the agroforestry it is necessary to mitigate the effect of land holding size, land tenure, individual preference and production plan of the farmers (Carter and Gronow, 1992; Gurung, 1984).

2.3.2.2 Strip Cropping

Protection effective crops are planted in a row in an alternative strips aligned on the contour or perpendicular to the wind. Erosion is mainly limited to the row crop strips. Soil removed from the upland areas is trapped within and behind the next strip downslide, which is generally planted with leguminous or grass crops (Morgan, 1995:119). In very steep slopes or on very erodiable soils, strip of permanent vegetation are grown to control soil erosion. Strip cropping progressively reduced soil erosion rates and physical process of washing in the hill slopes as the grasses became matured (Fullen, 1998). Similar research carried out in Indonesia demonstrated that 28 percent of land under permanent grass strips along the counter would be effective to control soil erosion in sloping land with surface 15-45 percent (Agus et al, 1997). However, this type of farming is unlikely to be popular among small landholders as much of land need to be placed for strip planting.

2.3. 2.3 Use of Live Materials in Construction

Use of live materials in construction activity is a special biological measure in which living plants and plant parts are used as building materials, and light engineering structures are constructed for soil erosion, flood, and torrent control and landslide stabilisation (Wagle, 1998:1). Small wooden check dam, gully control through bamboo plantation, use of live materials in terrace construction are some typical methods adopted by farmers. These measures are very useful for watershed management in developing countries where large scale funding for land management is not possible.

2.3.2.4 Bamboo and Tree Plantation in Gullies

Gully control by bamboo is the oldest and widely used technique in Asia Pacific region. People transplant bamboo trees in the gullies, along the river/stream and other vulnerable areas for soil erosion. The bamboo controls gullies as well as side cutting of the river from its

extensive root system. Besides farmers plant other shrub species and fast growing trees for landslide stabilization and recovery of land affected by landslide.

2.3.2.5 Mulching

Mulching is another biological measure used for land management since long ago (Morgan, 1995:123). Farmers cover the soil with crop residues such as rice and wheat straws, fodder twigs, fallen leaf, maize stalks, palm fronds or standing stubble (Augs et al, 1997:7). The cover protects the soil from raindrop impact and reduces the velocity of run off. It is also an useful alternative to cover crops in dry areas where insufficient rain prevents the establishment of a ground cover before the on set of rain or where the cover crop competes for moisture with the main crops. In semi humid tropical areas, the side effect of mulch in the forms of lower soil temperature and increased soil moisture are beneficial to increase the crop yield. Mulching can also be used under tree crops. Using pruned fronds to cover harvesting paths in an oil palm plantation reduces the soil erosion (Morgan, 1995:123). Wider application of mulching involves spreading crop residues on the surface of the soil and then the mulch is buried during drilling and planting period. Mulching in arid area needs careful attention, as the mulch cover on the surface is often blown by the wind. This practice also poses problem for farmers as crop residues make it difficult to hoe and plow land. Lamers et al. (1998) conducted a research on the cost and benefit of mulching in West African Sahal, characterized by declining soil fertility in two improved and traditional mulching systems. They found the later system was cost effective and cheaper compared with former system, though the traditional practice was limited to few farm families as crop residues were used for feeding livestock.

2.3.2.6 Reduced Tillage

Traditional farming system in the hills has higher tillage, which has increased soil erosion and reduced soil fertility. Reduced tillage is a simple method used for farmland management and to retain soil fertility. It provides a suitable seedbed for plant growth and helps to control weeds (Agus et al, 1997: 6). The soil erosion data recorded for 28 years in 9 watersheds of Appalachian Mountain with minimum tillage and planting on the contour has reduced soil erosion by 3 folds (Shipitalo and Edwards, 1998:1).

2.3.2.7 Wrapping Farmland by First Flood Water

Diverting flood for wrapping farmland has been long standing practice among the people living adjacent to the hill slopes in Asia (Zifieng, 1997:6). The first flood water coming from gullies, streams, villages and roads is diverted to the farmland during rainfall as it comprises new soils with a lot of organic materials. The unit discharge of wrapping is made perfectly as large enough to keep the deposits uniformly distributed. The wrapping time is controlled by observation on the spot.

2.3.2.8 In-situ Manuring

In-situ manuring is widely practiced in the mountains. Animals are moved from one plot to another to fertilize lands evenly. During the winter season, depending on the weather condition animals are either kept in sheds or in the open field over night after crop harvest. The livestock waste is then spread evenly over the entire farm plots (Kandel, 1997:13). During the winter sheep and goats grazing in the alpine meadows are brought down in lowland areas to feed crop residues and grasses and to prevent them from severe cold. The

sheep and goats are kept in the open field to fertilize land. Following the end of winter season, the livestock folks are carried again to the alpine meadows for grazing (Kandel, 1997:13).

2.3.2.9 Use of Dead Animals and Human Waste

Farmer buried dead animals in their farm land and plant fruit trees above them for plant nutrition. Likewise, people construct temporary toilets in their farmlands and move in next place while the first ones get saturated (Kandel, 1997:13). The human waste is than taken out and applied as manure for cropping.

2.3.3 Structural Measures of Land Management

Farmers applied different structural measures for land management. They include the terraces, contour banks, contour furrows and trenches, check dams, gully plugs, gully head protection, small size reservoir, waterways, side ditches and other hydraulic structures (Morgan, 1995:138). These measures are labor intensive and expensive as compared to the biological measures. However, they help to control the soil erosion in farmland. Structural measures are designed by both experts and local people.

2.3.3.1 Terracing

Terracing is a widely adopted traditional structural measure of land management in the mountain of Nepal, India, Pakistan and Tanzania. It was introduced with modern construction technology in Laos, Thailand, Vietnam, and Kenya (Agus et al, 1997:3). Morgan (1995) has classified the terraces into three major types according to their shape and purpose. The diversion terraces are constructed to intercept runoff and canals across the slope to suitable outlets. Bench terraces consisting a series of alternative shelves and risers are employed on the steep slopes. Terrace risers are vulnerable to damage by rain and irrigation water, therefore they are protected by grass or crop cover and reinforced wall. Bench terraces are effective conservation measure under a wide range of condition, but substantial amount of labour is required for their construction and maintenance. Third types of terraces are the retention terraces built for water conservation in the hillside. However, only terracing is not a remedy for all erosion problems (Agus, et al, and 1997:3).

2.3.3.2 Waterways

Waterways are the systems to convey runoff at a non-erosive velocity to a suitable disposal point. They are constructed either under the technical guidance of technicians or using the indigenous knowledge. Three types of waterways are in practice to accommodate the complete surface water disposal. The diversion channels are placed up-slope areas of farmlands to intercept water running off the slope and divert it across the slope to a grassway. Terrace channels collect runoff from terraces and convey it across the slope to the safe disposal point or grass way. The grass way channels are designed to transport the runoff from up-slope to the natural systems (Morgan, 1995).

2.3.3.3 Geo-Textile

Geo-textile is another structural method used extensively during the construction period of roads, irrigation canals, pipelines and deep canals to protect soil erosion and associated deposition from the up-slopes. The typical construction materials are soils, rocks, concrete and cement. The structures are covered by mat, sheet, grid or web of either natural fiber, such

as jute, or coir, or artificial fiber, such as nylon. They are supplied over the hill slope from the top and anchored with large pins. The natural fiber are biodegradable and are designed to be laid over the surface of the slope to provide temporary protection against the soil erosion until vegetation cover is established. The artificial fibber are buried and designed to give permanent protection to a slope by reinforcing the soil, once a vegetation cover is established, the plat roots and the fibber act together to increase the cohesion of soil (ICIMOD, 1998:16; Morgan, 1995:156).

2.3.3.4 Contour Bund

Contour bunds or earth banks are normally constructed across the slope to control surface run-off. The banks are spaced at a reasonable interval according to contour lines. There are no specific designs of their alignment and they are constructed according to local knowledge. The construction work requires large input of labor and incurs high cost (Margon, 1995:138).

Farmers have devised several other methods to constructs physical structures for land management. For soil trapping and water collection farmer put tree trunks and large boulders along the edge of farmlands (Thet et al; 1997:14). Sometimes they make stone bundles using ropes and wire mesh. A series of stone bundles are then arranged along the riverbank to control flood and side cutting (Bose et al, 1997:4). Besides, farmers construct reinforced wall to protect terrace risers, gabion retention wall and check dam along the stream to protect flood and side cutting.

2.3.4 Institutional Aspect of Land management

Different institutional aspects used in land management are as follows:

2.3.4.1 Land Use Titling

Land titling is one of the methods of land registration in the name of private individuals or group of people or institutions (Humphries, 1999:43). Main objective of land titling is to provide farmers with increased land security thereby stimulate the establishment of self sustain production system through increased farm investment, improve land use planning and establish a database for land management and taxation (World Bank, 1992).

Studies carried out in Honduras and Guatemala indicated that tenure security has been a significant factor adopting conservation measures. Eighty percent farmers surveyed in Honduras who owned land had adopted recommended conservation measures. While in Guatemala, only ten percent of farmers had land title therefore, limited numbers of farmers have adopted land conservation measures (Lutz et al, 1994:288). Tenural security has demonstrated significant improvement in farm productivity in China. When the farmlands were transferred from village commune to household responsibility, the crop yields increased by 4.6 percent per unit of area immediate after the transformation (Tsuji et al, 1997:180). Land is the primary source of production for rural people. The insecure and unfair land tenancy system has been major factor constraining investment in land conservation. The government agencies involved in resource management have by now recognized that land use titling or land use tenure is indispensable for effective natural resource management (Sharma, 1997b: 77). Accordingly, most developing countries have initiated land use titling through cadastrial mapping system. But the process is rather slow and the tenureal insecurity has accelerated the farmland degradation.

2.3.4.2 Integrated Land Use Policy

Land can not be reclaimed or conserved through sporadic efforts or short-term projects. What is needed is long term programs backed by sound land use policy and strategies to catalyse their development (Dent, 1996:308). Land degradation is realised as low level of policy commitment with inadequate financial, legislative and operational support (ESCAP, 1997:53). It requires a comprehensive and strongly co-ordinated legal and administrative system, which addresses production and natural resources management in an integrated way. Consolidated legislation based on the principles of sustainable land management is vital. Formulation of a comprehensive land use plan is thought as pre-requisite in land management (ESCAP, 1997:53).

2.3.4.3 Sharing Research Outcomes with Farming Communities

Major objective of land management is the transfer of technology. It is not clear to what extent the technicians and officials responsible for research have shared their experiences with local communities (Sharma and Stainburn, 1995:14). Experiences across the developing countries showed that there is little practice to share the research outcome with local communities. The land management projects/programs should prioritise and provide systematic attention to local technical knowledge and to its integration with specific know how developed by other partners in similar physical and socio-economic environment (Ostiani and Warren, 1997:34; Sheng ed. 1990). New technology should be build upon potential indigenous technologies. Enhancement of indigenous technology should be in highest priority. Primarily the research should intend to address livelihood support systems of marginal farmers and land-less upland inhabitants, by promoting bio-mass production, processing and manufacturing endeavours. Due respect should be given to pick up the experiences of farmers who are doing better in similar eco-systems and the major focus of the technology need to be on increasing the productivity.

2.3.4.4 Co-ordination

Land management, especially the integrated type, is multi-sectoral and multi disciplinary (Sheng ed. 1990:51). No single agency has the resources and manpower to cope with the complex activities. Setting a single and complete authority in each watershed is a heavy burden that the government can not afford it. The solution relies on good co-ordination among related agencies like Agriculture, Forest, Livestock, Irrigation and Road and Infrastructure Development offices. In practice, the vertical organization of these agencies usually places crop production in one department, forestry in a second and livestock in a third (ESCAP, 1994: 75; Sheng ed. 1990:51). As a result, inter- agency co-ordination is weak, and there is no coherent joint effort for land management.

2.7.4.5 Public Participation

Two types of thoughts have been emerged on participatory land management. First school of thought considers public participation as an end itself, an organisational technique intended broadly to empower marginalised, disadvantaged, disenfranchised and vulnerable farmers. (Hanchett, 1997:276; Cernea, 1991:6-7). The proponents of this view are often in favour that the development for the poor cannot occur until and unless the poor themselves control the process (Burkey, 1993:58). Second school of thought sees participation as a means to some end and a way of making technical planning socially useful. Public meetings and other forms of consultations improve the quality of planning, which, however, remains in the control of

professionals. This approach reserves the ultimate decision making authority with powerful participants. Centralist and bureaucrats support this approach of participation (Hanchett, 1997:277; Schonwalder, 1997: 756; Ashby and Sperling, 1995:166).

A participatory land management project requires a strong and flexible base of negotiation between local actors and supporting agency to ensure of people's participation in decision-making and program implementation. The negotiation process should agree on the issues to be addressed, respective role and responsibility of each partner and the technical design of the land management project/program (Ostiani and Warren, 1997:29). The communal interest is the glue in participation that binds people together than the geography, wealth, power, leadership, degree of social cohesion, ethnicity, income, gender, and education (Narayan, 1997:10).

The people at present, are no longer a passive group of people, who are happy to receive public goods and services, but now are questioning the process by which these goods and services are made available to them. In some cases, aggressive stance is taken by demanding that their opinions and ideas must sought before plans are formulated and decision are made by the responsible agency (Salleh, 1992:11). The society is composed of people with various level of socio-economic status, skill, ambition, education and awareness of land management (Burkey, 1993:35). Support staff should grasp and explore relationship among different groups within the community, and to recognized differences in interest and capability among them (Uphoff, 1985:374).

The farmers feel necessary of their empowerment and ownership of land management process. Empowerment is often a vague word, and there is no any blueprint for attaining this. Directly or indirectly, the prime concern of empowerment is to increase the control and access of the farmers to the resources (Sharma et al, 1997:22). Experience across the developing countries has demonstrated that the condition of land in mountain watersheds has gone poor to worse where the local people have no control over the resources. As the farmers became able to control over the resources, they made investment for better resource management (Sharma et al, 1997:22).

Participatory monitoring and evaluation has proven to be a powerful means for strengthening the joint decision making and management process. It allows identifying concerns of the stakeholders and the social, economic, technical and organisational conditions for successful implementation of the priority activities. The interest groups meeting and farmers' convention in Pakistan, community workshops in Nepal and Bolivia, and peoples' assemblies in Burundi have proven sound base for participatory feasibility study (Ostiani and Warren, 1997:31). However, such systems are not adopted in many developing countries in natural resources management.

2.3.4.6 User Groups Participation in Agricultural Land Management in Nepal

In the past resource management plans were prepared in isolation by the central level bureaucrats and decision-makers. As a result the plans did not address the resource degradation problems as perceived by hill farmers and gave economically viable and production oriented conservation alternatives. In the late seventies and eighties different resource conservation projects were initiated with bilateral and multilateral assistance with little consultation to local people. They used different modality of people participation and modus of operandi, according to the experience of the experts gained in other countries (Uprety, 1994). Participation was generally meant as labor and material contribution from

public, without their involvement in decision making and implementation. This was attributed by the contemporary Panchayat regime, which was reluctant for local autonomy and organized strengths of its people. Many projects were completed on trail and error basis without any concrete foundation and program achievements were far below the speculated target. The disappointing result has compelled policy makers and planners to rethink on modality and legitimized the participatory process in conservation and other development programs (Kanel, 1998:54). New democratic political system restored in 1990 has encouraged peoples' participation through user groups in natural resources management (Luetel and K.C., 1995:8). There are eight types of farmers groups in Nepal including livestock production group, fruit production group, water user group, forest user group, saving and credit group, small farmer development group, mothers' group and vegetable production group. These groups could contribute in conservation, if they have been integrated in land management.

2.3.4.7 Institutional Capacity Building

There is a strong empirical basis that local organisations are necessary to accelerate local development, farm productivity and welfare of the majority of poor (Uphoff and Esman, 1974:XI). To hasten and facilitate the people's participation in a more meaningful way, the public interventions should promote local level institutions and steer people centred development process. The programs and projects have to be designed by the people for their own benefit, and the institutions at grassroots level should facilitate or get influenced by participatory process (Sastry and Rao, 1997:33). People's organisations, which are created and run by their members, are most effective in natural resources management (Heck, 1979:24). There are two types of organisations, the formal and informal. The formal organisations are funded and supported by outsiders in a top down model. They are more formal with alien concepts, principles and policies. They are technocratic and there is no much scope for the participation of poor. Organisations spontaneously formed by people to pursue community development activities are called informal organisations. They are flexible in setting objectives, planning and implementations. Their leaders are mainly from poor class and the decisions are made based on face to face communications, and the beneficiaries themselves participate in the programs without any formal official offer (Heck, 1979:24).

Local institutional development itself is a strategy to create capacities at local levels for handling authority, take development responsibility and bring the officials decision making closer to local levels (Uphoff, 1986). Local level institutional development is crucial for overall success in land management. Indeed, majority of investments in institutional development has been made at the national level. It is unfortunate that local organizations that work closest to the intended beneficiaries and those which shape the project outcomes, are allocated so few resources and little attentions are paid by policy maker in their institutional development. Therefore, the policy support needs to create basic conditions for local level responsibility and optimize the local efforts for sustainable resource management (Gueye and Laban, 1994). The administrative support of the central government for the enhancement of local organizations has not been adequate. Democratic elections of local government and success of NGOs and other donor agencies in resource management in selected developing countries have paved the way for positive attitude of central government towards strengthening the local organizations.

The principle of institutional development of the local organizations involves sustained political momentum in dealing with major developmental issues and would require periodic review at political level to ensure satisfactory direction and guidelines to local organizations (Williams, 1992). In many instances, there are no such mechanisms and the

deterioration of local organization and depletion of natural resources has been rapid (Paudel, 1997:77).

Various institutions are being involved in land management. Their role in promoting sustainable land management is of course closely linked to their mandate, mode of operation, technical competence, and capacity (Kieler, 1995:536). The prevailing socio economic and political environments are not conducive to act these institutions jointly and their efforts are fragmented though all of them are functioning for the betterment of local communities. A mechanism has to be work out to co-ordinate the efforts of all institutions involved in land management.

Some sporadic efforts have been made in strengthening farmers' organisations, though they are not linked to land management activities. A farmer led approach would be appropriate in planning, implementation, monitoring and evaluation of land management projects. This should be carried out based on commonly agreed local rules and regulations, which are respected by all farmers (Sharma, 1997a:18). To enable local institutions to undertake such activities, their capability has to be strengthened. The main thrust of institutional capacity building therefore, is how to make effective, efficient, accountable, transparent, and user focused public and private institutions in natural resource management (Nair et al, 1998b: 377).

2.4 Factors Influencing the Adoption of Land Management Technologies

There are various measures of land management including biological and structural measures. The biological measures include shrub and tree plantation in gully and landslide areas and nitrogen fixing trees at farm edge, contour planting, strip cropping, alley cropping and use of green manure in fertilizing the land. Similarly, structural measures include terracing, contour bunds, waterways, check dams, reinforced walls and minimum tillage. These measures have been proven successful but farmers do not apply such practices on regular basis in land management. Many researches have tried to explain the factors influencing in the adoption and non-adoption of these measures. Selected recent studies are summarized briefly in following paragraphs.

Empirical study conducted on the adoption of conservation practices in three counties of Florida has demonstrated both economic and non-economic factors jointly influence the adoption process (Raquel, 1985:100). Six factors including scale of farm economies, conservation ethic, stewardship to land ethic, farming as a way of life, future of current farm and age of the respondents had influenced significantly in the adoption of land conservation measures. The first factor was economic factor and others were attitudinal factors. Similar study on the adoption of improved land use technologies to increase food security in Burkina Faso has identified three major influencing factors including non-farm income, improved capital and available inputs and intensification of crops (Savadogo et al, 1998).

Nelson and Cramb (1998) studied on economic incentives for farmers in the Philippines uplands to adopt hedgerow inter-cropping. It was recommended by the experts as biological measure to reduce soil erosion and enhance soil fertility in fragile uplands of the Philippines. They had concluded that the adoption of hedgerow inter-cropping with maize was influenced negatively by insecure land tenure, which constrained for long term planning from farmers' perspective. High establishment cost of hedgerow was another constraint, as sustain yields were not realized rapidly to compensate the establishment cost. Rather farmers were practicing natural vegetation and grass strips as an alternative measure to control soil

erosion because of low establishment costs. They concluded that farmers easily adopt the low cost technologies, and cost of technology has significant influence on deciding whether to adopt or not to adopt the land management technologies.

A study undertaken in eight *tarai* districts of Nepal for influencing factors in the adoption of fish pond management technologies has identified ten influencing factors (Rauniyar, 1998). Major influencing factors identified by this study were household size, ethnicity, educational level of the farm operator, geographical location of farm, source of information, land tenure, farm size, assess to institutional credit, proximity to market and infrastructures. There was a negative influence between adoption of the recommended technologies and farm household size. Large farmers with large household size were unlikely interested to adopt the recommended technologies. The degree of adoption was relatively higher among non-Brahmin farmers, farmers with higher level of education, farm located near to market center and all weather road, owner operated farm, farm with access to information from private source and farm facilitated with institutional credit.

Johnson et al (1999) conducted an empirical study on the adoption behavior of private cocoa farmers in Trinidad and Tobago. A technological package was recommended by the experts to avert the black pod diseases in cocoa farming, which causes 70 percent losses on cocoa holding. Farmers were not adopting the recommended package although they were loosing severe losses rather they adopted selected technologies from the package step by step. To find out the influencing factors in the adoption behavior five technological and 26 farming system variables were analyzed. All technological variables including riskiness, profitability, complexity, availability and divisibility and ten farming system variables including household size, age of trees, pod loss, farm time, education of farmers, tenancy, major enterprise, labor source, credit, accessibility, and knowledge of farmers on the extension services were identified as major determinants.

A study conducted in six conservation farming projects implemented in the Philippine and Indonesia focusing on non-adoption of new land management technologies has identified 13 socio-economic, perceptional and institutional factors influencing the non-adoption of recommended land management technologies (Maglinao and Phommasack, 1997:72). Negatively influencing factors were in-appropriate recommended technology, general unawareness, low facility of innovation, incorrect identification of adoption domain, appropriateness of ongoing farmers' practices, adverse off-side effect of new technology, problem for new innovation, high cost of innovation, lack of extension, insecure land tenure, resources mining of farmers, negative social connotations and ill-defined problems. These actors combinely slowed the adoption process of land management technologies recommended by experts.

2.5 Extension in Soil and Water Conservation

Extension in soil and water conservation is much more than routine based information diffusion and dissemination. Soil conservation began over half a century ago and the subject was treated in purely technical manner. The belief was that soil erosion problem could be solved in a straightforward way by means of field investigation and technology transfer by technically trained soil conservation extension workers (Theerawong, 1996). Traditional concept of soil conservation was developed with land use practices. Knowledge was gained through a trial and error system (Zobisch, 1996:21).

New people centered strategies and techniques have been developed in recent years to make conservation efforts effective. However, there are some impediments in the way. Soil

conservation techniques are not likely to be accepted on a broad scale until farmers are convinced that their income will increase or the cost and losses will be reduced (Hurni et al, 1996:5). Soil conservation needs to be viewed over a longer term than other farming activities. In crop husbandry, farmers see the benefit of improved seeds or fertilizer application after a single year cropping season, but it takes longer time to see the positive impact of soil conservation.

The aim of extension is to achieve the goal of assembling and applying a set of new technologies suitable to a given situation, through a process of sensitizing and educating the concerned people and involve them in the implementation of accepted activities (Dwarikinath, 1995:481). However, extension services are often criticized for lack of staff training and incentives for updating extension workers' or agents' knowledge, insufficient organizational structures, inadequate supervision of field workers and absence of organized feedback about farmers' problems (Feder and Slade, 1986:140). There is no congruence among the various institutional extension system operations in an area with a view of developing a common vision of envisioning the farmers (Hurni, 1996:7). The extension workers are attached to different institutions with little or no interaction. Information flow is from top to down, with little public participation (Aldy et al, 1998:92).

Farmers are not only recipients of technology but they also can play a part in technological development and evaluation (Zobisch, 1996:22). They can recognise the limitation of their knowledge and traditional technologies to sustain the production. The search for making it functional at community level with structural reforms is the prime agenda of extension research.

2.6 Selected Participatory Soil and Water Conservation Model

Different participatory soil and water conservation models have been developed based on local socio-economic condition and state of technology. A few selected models are discussed in following section.

2.6.1 Landcare Group System in Australia

Landcare concept is a soil and water conservation program based on the principle of partnership between government, landholders and community groups working together to prevent land degradation and sustainable use of natural resources (Jcakson, 1996:293; Rao and Padmaiah, 1996:171). This is a concept of grassroots ownership and institutionalised efforts to better land management. Australian NGOs started this program in 1985 and later it became a national program. There were 3,000 landcare groups covering 35 percent of small landholders of Australia by the end of 1995. Members of these groups come from the local community to seek the solution of local problems. These groups are formed on catchment basis to overcome the failure of governments' agricultural extension program and to transfer the technology to individual farmers. This is a new model of soil and water conservation, where agency staff empower or assist farmers to manage change and solve problems through group action (Prior, 1996:77).

Landcare groups are formed from local discussion and meeting of the landholders. Governments' soil conservation officers are invited to the meeting who provides information on what a committee might do, the way other committees in the region have operated and how they might go about forming their own committee (Jackson, 1996:295). The group discussion finally forms a committee comprising landholders, government officials, and interest groups including school teachers and rural industrialists. Then the committee is formally registered in

the Ministry of Primary Industries under the Soil Conservation Act. The committee identifies the problems (flood management, catchment management, gully stabilisation) in consultation with its members through public hearing, prepares plan and implements programs (Johnson et al, 1996: 203-207). Government officials are like educators and facilitators encouraging community groups to pursue conservation activities (Prior, 1996:82).

2.6.2 Catchment Model in Kenya

Soil and water conservation methods were changed in Kenya from export led enforced engineering measure to voluntary biological measures since the 1980s to correct the past mistakes. In the process, local administrators call public meeting to identify local issues on soil and water conservation. After preliminary identification of the issues, a survey team is formed comprising extension officers from different line agencies. The team visits small catchments of 100-200 hectares and carries out intensive need assessment and institutional survey implying PRA methods with semi-structured questionnaires. The team works with local people to analyse local ecological and social condition, and institutional strengths. At the end it prepares a detailed inventory of local knowledge and practices and develops an action plan. The action plan is discussed at open meeting where all local community members are invited for discussion on the plan. Finally, they form a catchment management committee through election to implement programs. The extension workers and the technical staff of the government facilitate and assist where the local knowledge is insufficient (Kiara et al, 1996:35-45).

2.6.3 Kuturaya Model in Zimbabwe

Introduction of commercial agriculture during the colonial rule had eliminated the local indigenous knowledge on soil and water conservation. Contour ridges and storm-drain technologies were promoted by the colonial rulers in a top-down manner. Deep rills and depressions were abundant and contour ridge technique became inefficient to prevent land degradation. Ultimately the old master farmer model became inappropriate. Against this background a participatory technology development and extension model known as "Kuturaya" (to try) was introduced on a pilot basis to overcome the overwhelming constraints. This model is based on a two-way dialogue between farmers' own experimentation and self-organising capacities of local communities. This approach combines innovation, development and extension in one process.

At the initial stage, government agencies or NGOs carryout a need assessment and institutional survey. The survey covers the role, strengths, weakness, and opportunity of local organisations and local needs as well as preference of local farmers. After completion of the survey, an awareness-raising workshop is organised for the local community, including extension workers and researchers. The information obtained from the survey are put forward in the meeting to criticise, amend, correct and to make a final selection of the programs. The farmers analyse and define their problems, needs, potentials, and the activities that they want to carry out. The outside experts facilitate the process, raise awareness, contribute to methodology, describe potential technical options, but don't dominate and push people to undertake preconceived programs and activities. Finally same meeting establishes a link between identified problems, solutions, and need for experimentation. Then the farmers themselves choose certain farmers to carry out the experiments. The technical staff of the line agencies help to record the data and provide other technical back up services required to farmers. The experiences gained from the experiments are shared with other farmers through meeting and observation. A fact sheet is prepared at the end of the experimentation jointly by local farmers and extension workers summarising the experiences gained during experiment,

techniques implied and an effective rank of the methods implied in the process. The fact sheet is discussed further before carrying out the next experiment (Hagmann et al; 1996).

2.6.4 Demonstration Model in Chesapeake Bay of USA

Natural resource conservation systems in United States (US) are working with land users. US Department of Agriculture provides direct technical assistance to encourage farmers to apply conservation measures voluntarily. Chesapeake Bay is the largest estuary of US adjacent to Washington DC, with 14 million people. Soil erosion, nutrient leaching and sediment loading in the watershed were challenging problems in the 1980s. To overcome this, seven states of the area signed an agreement to clean up the bay (Paul; 1996). The extension agents formed an alliance of farm producers, farm managers, concerned citizens and media together. Government agency established demonstration plots and then local people, media people, farm producers, local officials and other neighbours were invited to see the demonstration plots in the field. While demonstration with runoff boxes or a rainfall simulator were prepared for media to disseminate how soil erosion affects water quality. Besides an interactive model was prepared showing how different land uses like farming, forestry, construction and other activities affects soil erosion, nutrient leaching and sediment loading. The model was disseminated immediately through local alliance requesting to initiate counter measures covering large proportion of population. After two years of the initiation, 85 percent farmers replicated the conservation practices used in the demonstration plots (Paul, 1996).

2.6.5 Dry Land Farming Model of Okinawa Japan

Dry land farming is practised in sloping areas of Okinawa, which are not suitable for irrigation. Soil erosion is more severe in sloping lands. Therefore, farmers make terraces by pilling stones along the contour as main conservation measure. Public awareness of land degradation is promoted through wider mass media coverage. Farmers are requested to follow general rules of farmland conservation in accordance with the Land Improvement Act. Since 1995 farmers, contractors and other land users are obliged to participate in the soil conservation and to follow the strict regulations. It is top-down model, but local people have participated in government programs without more complains (Onaga et al; 1996:47-50)

2.6.6 Incentive based Compensation Model in Taiwan

General public, environmental groups, scholars and the press are being concerned about soil conservation and have increased their influence in decision making. Fruit farming is promoted in the headwater areas of the watersheds and vulnerable steep lands near the urban centre are gradually converted into recreational farm according to the changing socio-economic environment. Effective land use regulations and their strong enforcement with proper compensation and incentives offered by the government encouraged local people to participate in soil and water conservation (Wu et al; 1996).

2.6.7 Friendly Farmers' Forum in Rainfed Area of India

From each village of a watershed five friendly farmers are selected by consensus in the general assembly of the village. Out of these five friendly farmers, two have to be women, one land-less person to act as a livestock rearer, one has to be artisan, and one has to be enlightened farmer. The friendly farmers of all villages combined together and form a Friendly Farmers' Forum (Mitra Krishak Mandal) which acts as a representative for the watershed community. This Friendly Farmers Forum selects a president and a secretary by consensus. Watershed management activities of the government are implemented through this committee (Seth, 1995:36).

CHAPTER III

RESEARCH DESIGN

3.1 Methodological Approach of the Study

A typical farm household in the hills owns four types of agricultural lands fragmented into several parcels. Each land is endowed with different production potential influenced by their characteristics (Fig. 3.1). Farmers manage each type of land according to their location and physical characteristics. So far any study has not been undertaken about this aspect of land management. It is necessary to understand management strategies and priority of farmers for their different types of land to formulate an effective agricultural land management strategy.

This study has adopted a three pronged approach to land management analysis. Firstly, the current status of farmland, farmers' awareness of and attitudes towards improved land management practices and change in land management practices adopted by farmers are assessed, with emphasis on soil conservation and fertility management for attaining sustainable farm production. Secondly, farmers' priority for managing different types of land and actors and factors influencing to the adoption of land management practices are analyzed. Finally, it examines role of formal and informal institutions in land management, and the capability of local organizations involved in land management.

3. 2 Study Area

This study covers Phewatal and Yamdi-Mardi watersheds located in the north-western part of the Pokhara Valley, covering eleven Village Development Committees (VDCs), four wards of Pumdi-Bhumdi VDC and one ward of Pokhara municipality. Covering an area of 23,270 hectares of land, two watersheds accommodate 64,638 people and 10,836 households (Fig 3.2).

Yamdi-Mardi watershed is extended in north south direction just south of the Annapurna range. It extends from the valley bottom at Hemja village to Lwang Ghalel village on the ridge. The recently constructed Pokhara Baglung Highway passes through the former village, which is the only village with access to road transportation. Intensive rice cultivation in narrow river valleys and scattered patches of farmlands interspersed between forests on the hill slope are the apparent characteristics of this watershed.

The adjoining Phewatal watershed extends from the tail of Phewatal to the head of Harpan *khola* along the east-west direction. Phewatal is an inland natural lake formed by tectonic forces during the mountain building process. It is surrounded by spurs in the north, west and east, and has a deep outlet in the south. Harpan *khola* originating in the watershed head feeds water to the lake. The valley floor of the watershed along both sides of the lake has been utilized for rice cultivation and tourism activities, while the hill slopes and ridges are cultivated with maize and millet crops. The on-going siltation in the lake caused by accelerated soil erosion in the hill slope has posed a serious threat to the existence of the lake. Realizing the threat, a soil conservation and watershed management project was implemented by the Department of Soil Conservation and Watershed Management during 1974/75-1994/95. Supported by FAO, UNDP and FINIDA, a total of US$ 2.1 million was invested for preventive and curative measures (DSCWM, 1997:10).

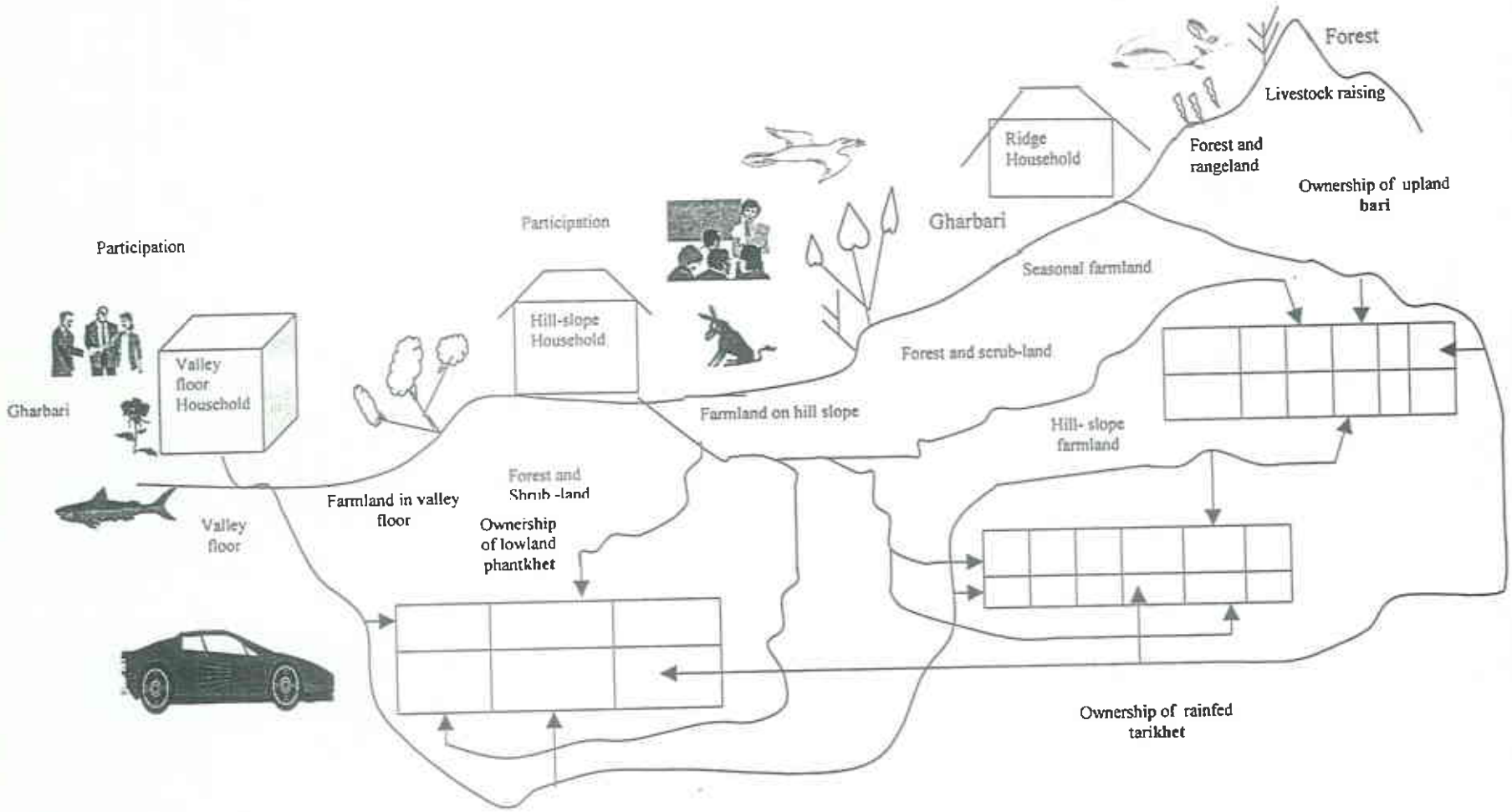


Fig. 3.1: Land ownership and management system in the Hills of Nepal

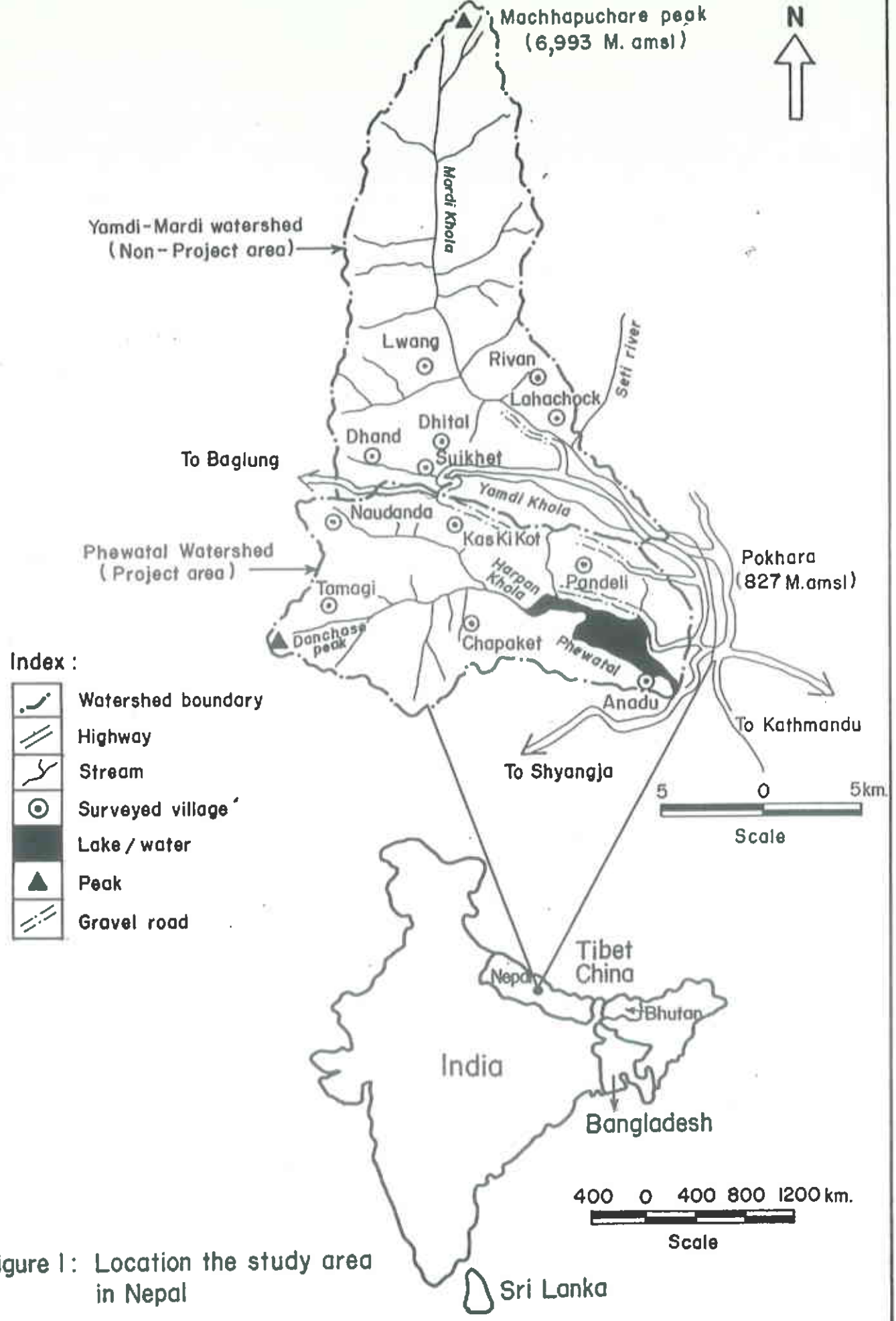


Figure 1: Location the study area in Nepal

The rationale for selecting Phewatal and Yamdi-Mardi watersheds as study area are as follows:

1. There are no comparative studies on watershed management "with" and "without" external assistance. A comparative study of Phewatal watershed "with" project intervention and the Yamdi-Mardi watershed "without" project intervention helps to understand the effect of project intervention on changes in land management practices.

2. The biophysical condition of the study area has distinctive characteristics. The elevation increases vertically from the valley floor to the ridge. Due to very heavy rainfall exceeding 5,000 mm during the summer monsoon season farmlands in these watersheds are vulnerable to leaching, soil erosion and mass wasting. This study will help to understand as to how local farmers have managed their farmland under such topographical and climatic conditions.

3. Different types of land are found in the valley floor and hill slopes. Typically irrigated farmlands (*phantkhet*) are located in the narrow stretches of river valleys. Rainfed rice fields (*tarikhet*) are found just above the irrigated rice fields; upland maize and millet fields (*bari and gharbari*) are interspersed between forests and *tarikhet*. This provides opportunity to understand management of different types of farmland.

4. The regional town of Pokhara, located adjacent to the study area, is undergoing rapid urbanization, which has paved the way for land use change by generating higher demand for agricultural produces. This study can helps to understand as to how hill farmers are participating in the transformation process utilizing the comparative advantages.

5. Several local level institutions are responsible for promotion of land management one way or other. It is essential to examine the relative role of formal and informal organizations in stimulating changes in land management.

This study focuses on the ridge and hill slope lands, which is the major area of concern, owing to their vulnerability to accelerated degradation.

2.3 Research Design

This study is based on primary and secondary data collected through reconnaissance, household and institutional surveys, group discussions and observation (Fig 3.3).

3.4 Primary Information

Primary data include the information collected through the field survey. In line with the objectives of the study, information were collected on farmers' socio- economic characteristics, land management practices, participation and institutional arrangements for agricultural land management (Table 3.1). Information on the change in agricultural land management practices under the influence of external and internal factors were collected through a household survey and group discussions. Emphasis was given to collect information on farmers' experiences in factors influencing the changes in land management. Information on changes, including structural and biological measures of land management, soil fertility management, cropping pattern, cropping intensity, crop yields, land use and other soil conservation practices were collected through the household survey (Table 3.1).

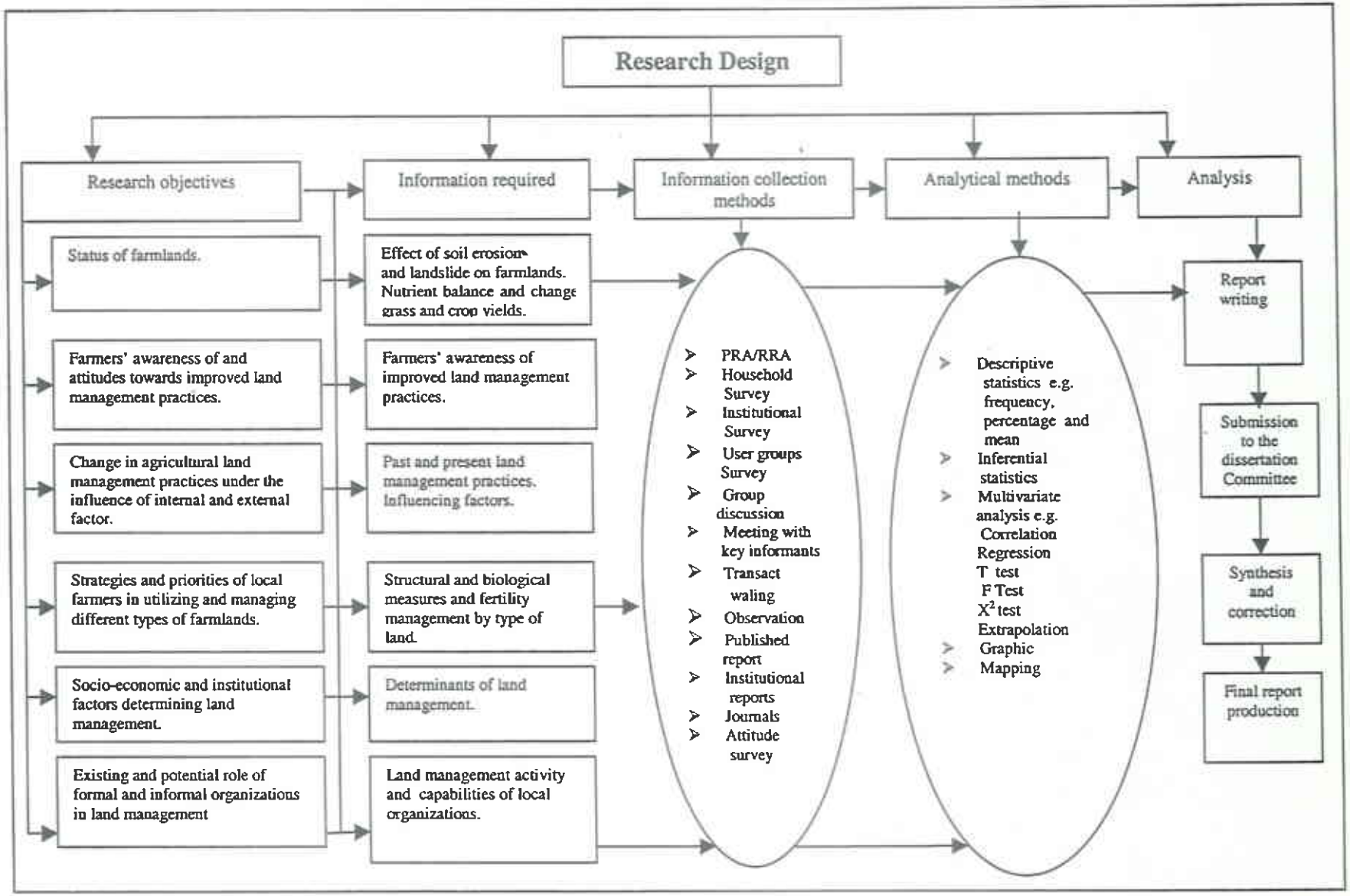


Fig.3: 3 Research design

Table 3.1: Required information and sources

Objective	Required Information	Source	
		Primary	Secondary
Examine the status of farmland	• Land severely affected by soil erosion • Landslide occurrence and its effect on land • Nutrient balance • Land with declining soil fertility • Change in crop yield • Change in grass yield	• Household survey • Groups discussion • Meeting with farmers and user groups • Landslide mapping	• Geological map
Farmers' perception of and attitude towards improved land management	• Farmers awareness of and attitudes towards improved land management technologies	• Household survey • Opinion survey • Group discussion	
Change in agricultural land management practices under the influence of internal and external factors	• Change in structural measures of land management • Change in biological measures of land management • Change in fertility management practices • Change in livestock raising and FYM production • Change in cropping pattern	• Household survey • Discussion with farmers, user groups, key informants and NGO and CBO representatives • Transects walking and observation • PRA and RRA • PRA Mapping	• District line agencies • Land use, topographical and , geological maps • Institutional reports
Farmers' strategies and priorities for land management	• Priority for application of fertilizers and structural and biological measures of land management • Factors influencing decision on land management priority	• Household survey • Discussion and meeting with key informants • Regression analysis • Transects walking and observation	• Published reports on NPK contents and uptake by crops
Socio economic and institutional factors determining management of agricultural lands	• Socio-economic and spatial factors • Role of formal and informal rules and regulations in land management • Public sector investment in agricultural sector at national, district and village level • Role of line agencies and NGOs in land management • Development of NGOs and user groups • Role of user groups in land management	• Household survey • Institutional survey • Meeting with government officials, • NGO executives, support staff and local people	• Periodic development plans • GO, NGO, VDC and DDC reports • Acts, rules and regulations
Role of formal and informal organizations in land management	• Farmers' participation in land management • Farmers' satisfaction with GOs and NGOs • Strengths, weakness, opportunities and threats (SWOT) of line agencies, NGOs and user groups involved in land management	• Institutional survey • Meeting with user groups, GO and NGO officials, support staff and local people	• Governments' policies, plans and guidelines for land management • Published acts, rules and regulations

Farmers' land management practices vary from one type of land to other depending on characteristics of lands. Therefore, information on land fragmentation, land ownership, farm

productivity, management strategies for different types of land, cropping system, cropping intensity, crop yield, food security, factors motivating investments in agricultural land, soil erosion control measures were collected through the household survey, discussion and personnel interview. Similarly, information on construction and management of terraces, bunds, hill side ditches, waterways, check dams and irrigation canals, agroforestry practices, contour hedgerows, tillage system, mulching, factors influencing land management, farmers' opinion about alternative measures of soil erosion control and experiences in soil fertility management were collected though the household survey, discussion and personal interview.

Soil fertility depends on nutrient inputs and other land management practices adopted by farmers. Information on different type of fertilizers, like farmyard manure, compost, green manure, oilseed cake, ash and mineral fertilizers, applied by farmers were collected through the questionnaire survey.

Primary information on institutional arrangements, including existing informal rules and regulations concerning agricultural land management were collected through personal discussion with local farmers. Likewise, information on strength, weakness, opportunity, threat, accountability and transparency of local organizations were collected through the institutional survey, meeting and discussion.

Information on the process of user/farmer group formation, institutionalization of groups and participation in land management related activities and factors motivating participation were collected from user/farmers groups. Information on farmers' awareness of improved land management practices were collected through the personal interview.

3.4.1 Sample Size

The total number of households within the watershed level was not easily available. Alternatively, a list of households by ward of each Village Development Committees (VDCs) located in the study area was obtained from the Election Commission. Then, the number of households within the watershed boundary was determined through the field visit. There are 10,836 households in the study area, including 5,967 households in the Phewatal Watershed and 4,869 households in the Yamdi-Mardi watershed.

A sample size of 300 was determined from 10,836 households, assuming that the expected rate of occurrence is not less than 85 percent at 95 percent confidence level, with a precision level of ±4 percent. When the proportion of the attributes in the population is known to be other than 50 percent, the expected rate of occurrence can be decided differently in desired sample for a large product (Arkin and Colton, 1963:22).

The sample was computed using the following formula.

$$n=\frac{NZ^2\,p\,(1-p)}{Nd^2+Z^2\,p\,(1-p)}=\frac{10{,}836*1.96^2\ *.85(.15)}{10{,}836*.04^2+1.96^2\ *.85(.15)}$$

$$=\frac{10{,}836*3.84*0.1275}{10{,}836*0.0016+3.84*0.1275}=298$$

Farmlands in the valley floor have relatively less management problems compared to the hill slopes farmlands. Therefore, propulsive sampling method was adopted for the field survey. Propulsive sampling is an appropriate method to select unique cases, to reach with specialized population and, to identify particular type of cases for in depth investigation (Neuman, 1997:206).

3.4.2 Determination of Sub-samples

The project area comprises five VDCs, four wards of Pumdi-Bhumdi VDC and a ward of the Pokhara municipality. Similarly, the non-project area comprises six VDCs and few villages belonging to other VDCs. As each VDC is further divided into nine administrative units, locally known as ward. The ward has been considered as appropriate representative unit for sampling purpose. To select the representative ward from each VDC, a reconnaissance survey was carried out in April 1999 to distinguish the hill slope and valley floor wards. Following this, a representative hill slope ward was selected from each VDC in consultation with VDC executives and social workers.

Table 3.2: Sample and sub-sample by watershed

Phewatal Watershed (Project Area)					Yamdi-Mardi Watershed (Non-project Area)				
VDC	Total HH	Sampled ward No	HH No	Sample size	VDC	Total HH	Sampled ward No	HH No	Sample size
B. Tamagi	732	3	74	24	Hemja	1,414	6	233	43
Chapakot	642	9	100	20	Dhampus	509	5	41	15
Dhikrurpokhari	1,185	8	94	43	Dhital	687	4	72	21
Kaskikot	1,124	5	66	34	Lwang Ghalel	1,087	3	72	33
Sarangkot	758	2	117	28	Rivan	348	2	31	11
Pumdi-Bhumdi	224	1	30	6.0	Lahachock	725	7	71	22
Pokhara municipality	1,102	-	-	-	Dhikrurpokhari and Kaskikot	99	-	-	-
Total	5,967	6	481	155	Total	4,869	6	448	145

Source: Based on voters list, 1999

To determine the sample size for two watersheds, firstly the total number of households was determined for the chosen wards, comprising 481 households in the project area and 448 households in the non-project area. The sample for each watershed was then calculated proportionally. Accordingly, the sample for the project area was found to be 155 and 145 for the non-project area (Table 3.2).

2.4.3 Household Sampling

A systematic random sampling method was adopted to select households for questionnaire survey. Therefore, a list of household heads in all selected wards was systematically numbered from 1 to n. Then each of the third household was picked up from the list for the survey. The sampling ratio was about 0.32 or about 32 percent in both project and non-project areas. The wards surveyed accounted for 12 percent of all wards in the study area.

Prior to the household survey, the questionnaire was translated into Nepali and, it was tested in the village of Dhampus Deurali in May 1999. Based on the feedback from the pre-test, the questionnaire was revised with some necessary corrections. Four local graduates were recruited and trained for the household survey. A household list of selected wards was given to them. The survey work of the enumerators was regularly monitored until its completion. The household survey was conducted from the last week of May to the second

week of August 1999. Hence, the survey covered the whole agricultural year of 1998/99. Being the peak agricultural season, all farmers were busy in rice transplanting during the survey period. Therefore, the household heads were interviewed in the morning before they left for the work and in the evening after they returned back to their homes from the farms. Households closed during enumerators' visit were interviewed in the following day.

3.4.4 Institutional Survey

The existing formal or informal organizations and related rules and regulations pertaining to agricultural land influence the management of agricultural land. Therefore, the institutional survey was carried out, covering formal organizations, NGOs and user/farmer groups. Agricultural land management is a matter of concern of different government line agencies. Therefore, an institutional survey of selected formal and informal local organizations involved directly or indirectly in agricultural development was carried out. A questionnaire was developed to assess the institutional capability of concerned line agencies, local governments and non-government organizations. Respective organizational chiefs were requested to assess their institutional strengths, weaknesses, opportunities and threats. Thirteen out of a total of 24 agencies involved in agricultural development activities at district level participated in the survey (Table 3.3). The participants included 10 government line agencies, two NGOs, and one donor supported project. Formal local organizations surveyed for information were the Soil and Water Conservation and Watershed Management Office, Livestock Development Office, District Land Administration office, District Land Survey Office, District Forest Office, District Agriculture Development Office, District Irrigation Development Office, District Cooperative Office, District Development Committee and Regional Forestry Training Center. Information were also collected from two NGOs namely, Machharepuchare Development Organization (MDO) working in the project area and the Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED) functioning in the non-project area. Besides, the Danida supported Natural Resources Management Sector Assistant Project (NARMSAP) involved in forestry and watershed management was also covered by the survey.

Table 3.3: Surveyed organizations

Organizations	District level	Village Level	
		Project area	Non-project area
District Development Committee	1	0	0
Government line agencies	9	0	0
District level NGOs	2	0	0
Natural Resources Management Sector Assistant Project	1	0	0
Village Development Committees (VDCs)	0	5	6
Agriculture service and sub-service centers	0	2	2
Forest range posts	0	1	1
Small Farmers Development Program	0	1	2
Agricultural Development Bank	0	1	0
Gramin Bank	0	0	1
Village level NGOs	0	5	2
Forest user groups	0	7	5
Water user groups	0	2	3
Cash crop and vegetable production groups	0	4	6
Livestock development groups	0	6	2
Mother's group	0	7	6
Small farmers group	0	4	6
Saving and credit groups	0	6	8
Farmers cooperative	0	3	3
Total	13	54	53

3.4.5 VDC Survey

Information on villager' access to market centers, income and investment trends in last five years, local development priorities and brief account of NGOs, CBOs and user groups, and their existing and potential role in land management was collected from 11 Village Development Committees (VDCs) of the study area (Table 3.3).

3.4.6 NGOs and User Groups Survey

A list of service centers, NGOs and user groups was prepared using the official records of line agencies and VDCs. Out of the 931 service and sub-service centers, NGOs and user groups in the study area, discussions were held with 10 service and sub-service centers, 7 village level NGOs and 79 user groups (Table 3.3). Information on group formation process, organization structure, operational system, expertise of group members, rules and regulations, operational plans, mode of participation, perception of land policy, and their existing and potential role in land management were collected through interview. Similarly, local institutions' strengths, weaknesses, opportunities and threats also were surveyed through the discussion. In addition, 69 key informants (Table A. 9), including government and NGO officials, executive chiefs of NGOs and local governments, former members of parliament, were interviewed to understand their opinion about land degradation and management initiatives.

3.4.7 Rapid Appraisal

Information were also collected through the rapid appraisal (RA) method. Information on land management and soil conservation practices were collected through observation and discussion. The well-experienced adult people who had observed the local situation for a long period of time were requested for information on the change in land management practices. Besides, topography, land use, cropping pattern and indigenous farm management practices were carefully observed. Individual and groups discussions were held with farmers, local leaders, school teachers and village heads. This helped to get detailed information on issues pertaining to the study. Informal discussions with local users groups, resource management committees and farmers facilitated relevant information on existing agricultural land management systems.

3.4.8 Participatory Rapid Appraisal

Participatory rapid appraisal techniques were applied to get information on land management. Maps of all VDCs were obtained from the Department of Topographical Survey. Local farmers were asked to trace out the changes in land use practices in their VDC maps. A farmers group was formed in each VDC, with one representative from each ward for PRA mapping. Each group prepared a land use map of their respective VDC. Finally a land use map for the study area was prepared by combining all land use maps prepared by groups. Other PRA techniques applied have been depicted in (Fig 3.4).

3.5 Secondary Data

Relevant secondary information were collected from various central, district and village level organizations. Information on existing rules and regulations concerning land management were collected from the Department of Land Administration and Planning Division, Ministry of Land Reform and Ministry of Law and Justice. Population statistics were collected from the Central Bureau of Statistics. Different maps of the study area including, topographical, land use and land capability were collected from the Department of Survey. Geological map

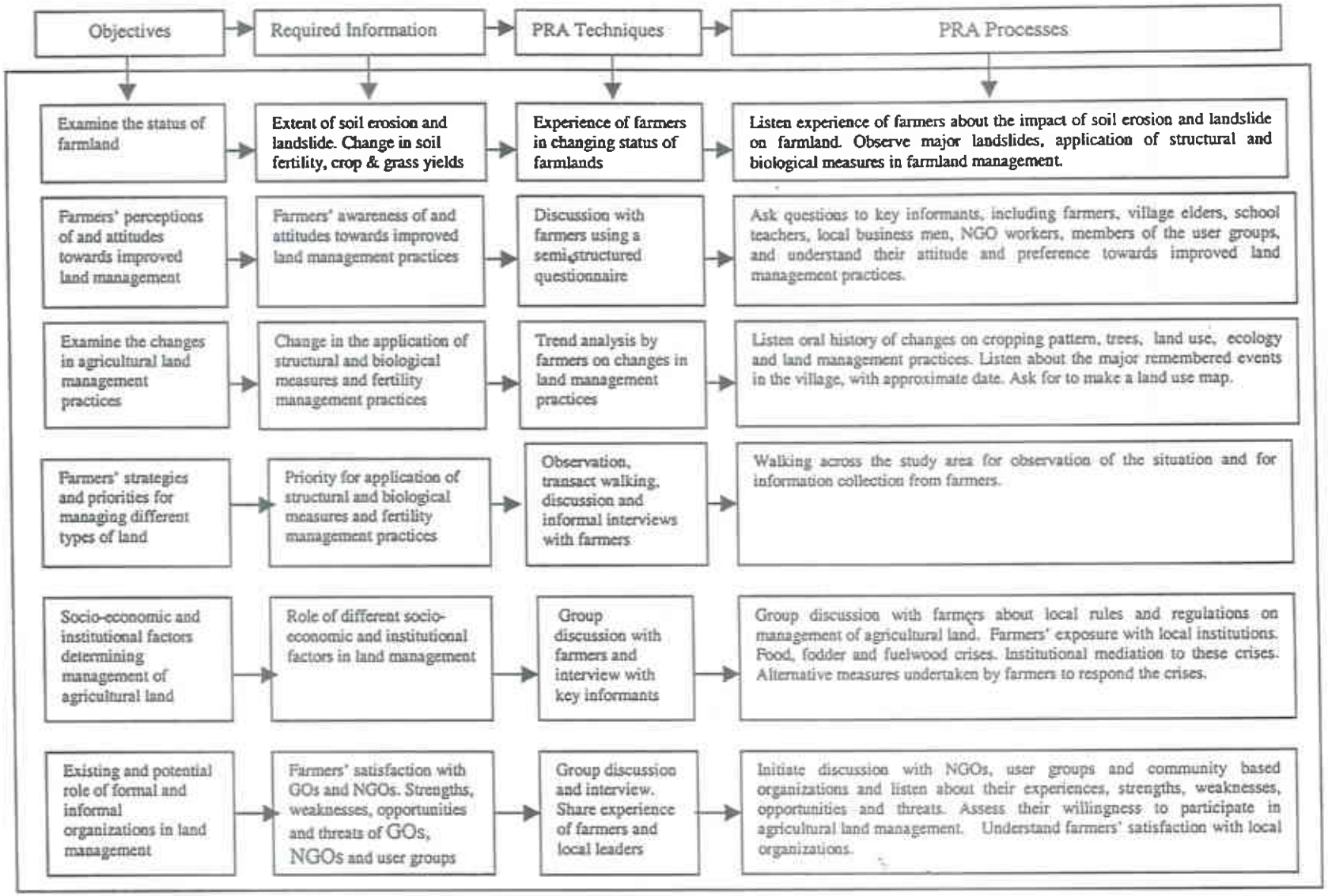


Fig 3.4 Participatory rapid appraisal method

was collected from the Department of Mines and Geology. Periodic plans and progress reports of the Phewatal Watershed Management Project were collected from the Department of Soil Conservation and Watershed Management. Information on agricultural policies, including Agricultural Perspective Plan, were collected from the Planning Division, Ministry of Agriculture and National Planning Commission. Policy information on forest, water and saving and credit groups were collected respectively from the Departments of Forest, Irrigation and Women Development. In addition, information on soil fertility were collected from Nepal Agricultural Research Council.

Information were also collected from district and village level GOs, NGOs and resource management and conservation projects. The name and location of NGOs in the study area were obtained from the Chief District Officers' Office. Likewise, list of farmer groups and their location was collected from line agencies, NGOs, VDCs and Annapurna Conservation Area Project. Program activities and policy of District Agricultural Program Implementation Committee was collected from its secretariat attached with the District Agriculture Development Office.

3.6 Data Processing and Analysis

The information collected from the field survey were processed and analyzed using SPSS. Changes in the application of farm fertilizer, structural and biological measures of land management were analyzed for four reference years 1975, 1985, 1995 and 1998. To evaluate the change in the project area and compare it with the non-project area, 1975 was considered as the base year when a watershed management project was implemented in Phewatal watershed. As the external assistance was withdrawn from the project area in 1995, information collected for 1998 contributed to examining the post project situation in the project area.

The qualitative variables were summarized in Likert type summated scale. It is a method of combining several qualitative variables that measures the same concept in an attempt to increase the reliability of the measurements (Hair et al, 1998; Miller; 1983; Likert, 1987). The variables were converted into indices and their average score were used for the analysis.

3.6.1 Index of Severity of the Problem (ISP)

The farmers were asked to rank the severity of soil erosion, declining soil fertility and other land management problems at a scale ranging from one to n based on their experience. Rank one was considered being the most severe problem and highest rating as the least affective problem (Paudyal, 1990). The index of relative rating was calculated based on their rank values as follows:

$$ISP = \frac{(fR_1 + fR_2 + fR_3 + \ldots\ldots\ldots + fRn)}{f} / (N-1)$$

Where: ISP = Index of severity of the problem
f = Frequency of rating
fR_1 = Highest rating
fRn = Lowest rating
N = Sample size

3.6.2 Index of Satisfaction

The index of satisfaction was constructed to analyze the farmers' satisfaction with support services provided by the line agencies and NGOs involved in land management. The procedure followed for its construction was as follows:

- Computation of frequency answered related to each item
- Discard the unanswered frequency from data sheet
- Valuation of the answer

The index was calculated as follows:

$IS = [fX_1 (1) + fX_2 (.80) + fX_3 (.60) + f X_4 (.40) + fX_5 (.20)]/N$

Where:

IS	=	Index of satisfaction
fX_1	=	Strongly satisfied
fX_2	=	Satisfied
fX_3	=	Neutral
fX_4	=	Unsatisfied
fX_5	=	Strongly unsatisfied
N	=	Total number of responses

3.6.3 Weightage Priority Index

A weighted land management priority index was constructed to assess the farmers' land management priority for different types of land. The index value was obtained by adding the priority value of all measures and dividing it by total number of measures applied in land management. A weightage of one was assigned to first priority and four for least priority. The lower the index value indicates the higher priority. The index was constructed as follows:

$$Wp_i = \sum_{i=1}^{n} \frac{f_i X_i}{F_i}$$

Where

Wpi	= Weighted priority index
fi	= Frequency of priority to particular measures
Xi	= Weightage of priority
Fi	= Total number of measures

3.6.4 Quantitative Analysis

Simple statistics like relative frequency, mean, median and standard deviation are used for descriptive analysis. Multivariate analyses, including logistic regression, have been done to explore the degree and direction of relationship between dependent and independent variables. The statistical significance of results is examined using " t" test, "chi square" test and "f' test.

"T" is applied to compare the significance of variation of means between project and non-project groups; "f" test is applied to trace out the significance of variations of several means within the group and "chi square" test is applied to test the significance of association of non-parametric variables.

Logistic regression is used to find out the factors influencing land management practices. It is a powerful tool to trace out the influence of independent variables on dependent variable (Miller, 1983; Hair et al, 1998). The degree of adoption of land management practices is defined as dependent variables and a set of socio-economic, spatial, ecological and institutional factors as independent variables for the analysis.

3.6.5 Nutrient Measurement

Plant nutrients, like farmyard manure (FYM), compost, green manure, oilseed cake and chemical fertilizers applied to farmlands are converted into macro-nutrients like nitrogen (N), phosphors (P_2O_5) and potassium (K_2O) shortly known as NPK. The conversion factors for green manure and compost were developed by the Lumle Agricultural Research Center according to local context (Subedi and Gurung, 1991). Thus, same factors were used to convert green manure and compost into NPK. Conservation factors for chemical fertilizers, oilseed cake and household ash were adopted from Agricultural Handbook for Nepal (Joshi and Khatiwada, 1986). As the conservation factor for farmyard manure was not developed for the local condition, it was adopted from White (1979). Similarly, the nutrient uptake rate of different crops based on per ton/hectare of crop yield and crop residue was adopted from FAO Fertilizer Manual for Asia Pacific Region (Tandon and Kimmo, 1993) (Table A. 10). Based on nutrient applied by farmers and removed by crops, a gap between supply and uptake is identified by land type to assess the nutrient status in farmland. The nutrient gained and lost by natural process is assumed equal.

3.6.6 Classification of Farm Size

There is no universal classification of farm size applicable to all area and concerned in Nepal (Regmi, 1999). Different studies have classified farm size according to their purpose. The National Planning Commission (1978) has classified the farm size in the hills into four categories based on agricultural income. The farm size of <4 *ropani* is categorized as marginal, 4 -10 *ropani* as small, 10-20 *ropani* as medium and >20 *ropani* as large. Similar classification was adopted by the Nepal Rastra Bank (1988) based on operational land holdings. Regmi (1974) classified the hill farm size into three categories based food supply. The farm households with <10 *ropani* could not meet their household food requirement from farming alone and they were classified as small. Farm households with 10-20 *ropani* of land would partly meet their needs from farm and they were classified as medium. Households with >20 *ropani* can sustain household food requirements and they were classified as large. The average amount of crop yield in the study area (including both project and non-project areas) is 153 kg/*ropani* per year. On average, a typical farm household with six family members consumes 1,903 kg of food crops per year, meaning a farm household requires net 12.4 *ropani* of land for food crop production and additional 3.6 *ropani* for settlements, vegetables, fruit and fodder production. Households with 16 ropani of land can meet their subsistence requirement, therefore, farm households with > 16 ropani of land are classified as large. Farm households with 8 -16 *ropani* of land depend on farm and non-farm sources for food and they are classified as medium and farmers with <8 *ropani* of land have to heavily depend on non-farm sources and other sources for food and they are classified as marginal farmers.

CHAPTER IV

BIOPHYSICAL AND SOCIO-ECONOMIC CONDITION OF THE STUDY AREA

4. 1 Bio-physical Condition

Biophysical condition of the study area is complex. The elevation changes abruptly from valley floor to the ridge, which influences climate, natural vegetation and human activities.

4.1.1 Topography and Drainage System

Phewatal watershed is formed of parallel homoclinal ridges comprising Pumdi-Bhumdi ridge in the west and Kaskikot ridge in the east. Thaple ridge in the north extends in east-west direction separating Phewatal from Modi watershed. The southern moiety has narrow open drain near Baidam formed by over flowing water from the lake. The entire watershed seems like a small pan with little water in the middle. Harpan *khola* and its tributaries drain the entire watershed. The northeastern part is drained by Andheri *khola*, which originates in the Thaple ridge, and the northwestern part by Sidhane *khola.* Both of these tributaries coalesce into a single system and configure Harpan *khola* near Thulakhet. This *khola* follows from north to south-east emptying water into the lake. This watershed extends between 28^0 7' N to 28^0 18' N latitude and 83^0 47' E to 83^0 58' E longitude, covering a total of 12,300 hectares of land (NPC/IUCN, 1997:5). The elevation ranges from 850 m. amsl (above mean sea level) at the dam site to 2,508 m. amsl at Panchase peak.

Yamdi-Mardi watershed extends from the valley bottom village of Hemja in the south to the east-west elongated ridge in the north between 28^0 15' N and 28^0 28' N latitude, and 83^0 50' E to 83^0 57' E longitude, covering 10,970 hectares of land. This watershed is drained by Yamdi *khola* and Mardi *khola.* Yamdi *khola* originates at the toe of Dhampus-Naudanda ridge and then flows to the south thorough the Yamdi valley. It changes its course to the east instantly after crossing the Pokhara-Baglung highway. Mardi *khola* originates at Machhapuchare range and flows to southeast ultimately joining Seti river. Mardi and its tributaries have created narrow alluvial fans along their courses (Figure 5.1). The elevation ranges from 1,097 m. amsl at Hemja Milanchock to 6,993 m. above at the peak of Machharapuchare.

The landforms are composed of complex and rugged ridges, spurs and valley bottoms in both watersheds. Ridges, alluvial fans and stream molded terraces are prominent features of landforms in both watersheds. Most area is characterized by step slops. About 60 percent of the area in Phewatal watershed falls under 20-60 percent of slope gradient, with an average slope of 40 percent. About 10 percent of lands are flat to rolling, with a slope range of 0 to 10 percent. Another 15 percent of lands are very steep with 60 to 100 percent slope gradients (Fleming, 1978:223). Landforms in Yamdi-Mardi watershed have similar characteristics. The northeastern hill slopes are steeper as compared with the southwestern part. The valley floors along Yamdi and Mardi *khola have* slope gradient below 10 percent, while hill slopes and ridges ranges from 15 to 60 percent.

4.1.2 Climate

The climate is humid subtropical in the south and humid temperate in the north marked by sharp seasonal variation in rainfall and temperature. The annual average temperature in the valley floor (1977-1997 average) is 21^0 c, with a mean range of 13^0 c in January to 26^0 c in July (Figure 4.1). The temperature decreases gradually as the altitude increases from the valley floor to the ridge.

The mean temperature at Lumle station, located about 500 meters away from the study area, is 16^0c, with a mean minimum of 9^0c in January and maximum of 20^0c in August. The mean absolute humidity over last 21 years at 5.40 am was about 80 percent in the valley floor and 78 percent in the ridge.

The rainfall pattern resembles extreme seasonal variation and high level of elevational influence. The rainfall intensity increases gradually from the valley floor to the higher elevational zone up to 1,800 meters and, then, tends to decrease gradually with increasing altitude. The annual mean rainfall at Pokhara Airport (827 m. amsl) is 3811 mm, 4,340 mm at Lamachour (1,070 amsl) 10 km apart (Table A.12). In the ridge, the amount of rainfall reaches up to 5,237 mm at Lumle (1,740 m. amsl) (Figure 4.2).

Lumle area receives highest amount of rainfall in Nepal. The highest amount of rainfall ever recorded in this station was 6,561 mm in 1995 and lowest of 3,944 mm in 1979. This indicates uncertainty of rainfall. The rainfall intensity is significantly high in the hill slope area where most agricultural lands are concentrated. It has important implication for farmland management. As farm terraces have no vegetative cover and soils are dusty in early monsoon season, torrential rain which normally occurs in May and early June, washes out the surface soil.

The summer monsoon season (June-August) receives highest amount of rainfall, accounting for more than 60 percent of the total rainfall. The autumn season starts from September and ends in November. This season gets fair amount of rainfall. The winter season, December-February, is characterized by lowest rainfall and monthly temperature decreases gradually. In the spring season, March-May, little rainfall occurs during early months and increases gradually from the second half of April. Thus, the summer climate is favorable for plant growth. In winter, moisture is a limiting factor for plant growth.

4.1.3 Vegetation

Sub-tropical deciduous forest and analogous plant species are common at the lower elevations up to 1,000 m. amsl. The vegetation is dominated by broad-leafed forest. *Shorea* (sal) forest is found along the foothills and lower parts of the hill slopes. *Cidrella* (tooni), *Euginia* (kadam), *Bombax* (simal) *and Alnus nepalensis* (utis) are typical tree species grown fortuitously along gullies, stream shore lines and landslide area. The vegetation patterns follow the elevation. The hill slopes around 1500 meter are covered with mixed warm temperate vegetation, like *Castanopsis ssp* (katus), *Schima* (chilaune), *Quercus* (oak), *Castanopsis tribuloides* (musure katus), *Diospyros montana* (tiju), *Michlia champaca* (chanp), *Eucalyptus ssp* (masala) and *Prunus persica* (painyu). These trees are not very tall and change leaves in the early spring season. The ridges have cold temperate type of vegetation. Bushy vegetation like *Rhododerndron* (gurans), *Lyonia* (angeri), *Bombox ceiba* (simal), *Eurya acuminata* (jhingane), *Grevillea robuta* (kangiyo), *Machilus gamblei* (kahulo), *Phyllanthus emblica* (amala), *Quercus incana* (banjh), *Berberoos asiatica* (chutro), *Melia azedarach* (bakaino), Premna integrifolia (ginderi), *Rhus wallichii* (bhalayo), *Rhus javanica* (bhakimlo) and *Rubus foliolosus* (aniselu) are found there. Above 2,000 meter *Quercus semecarpifolia ssp* (kharsu) trees are common in both watersheds.

4.2 Social Condition

The social systems in both watersheds are transferred one after another generation with little change in livelihood pattern. Different ethnic groups live together in harmony and follow similar type of customs and traditions. The population is in ever-increasing trend and high man land ratio has constrained development endeavors.

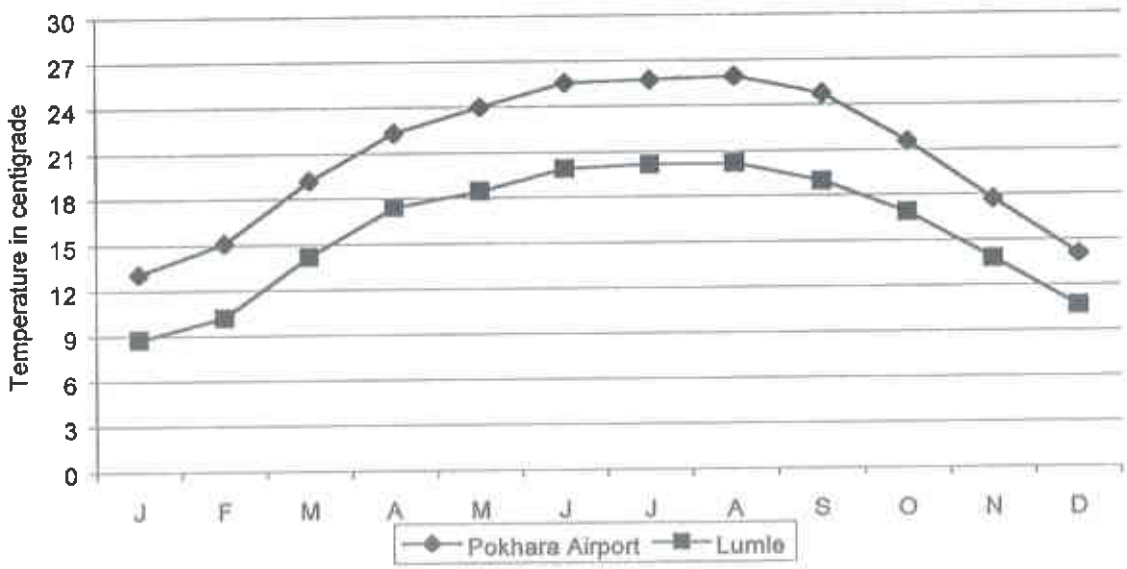


Figure 4.1: Mean monthly temperature of the study area (1977-1997)

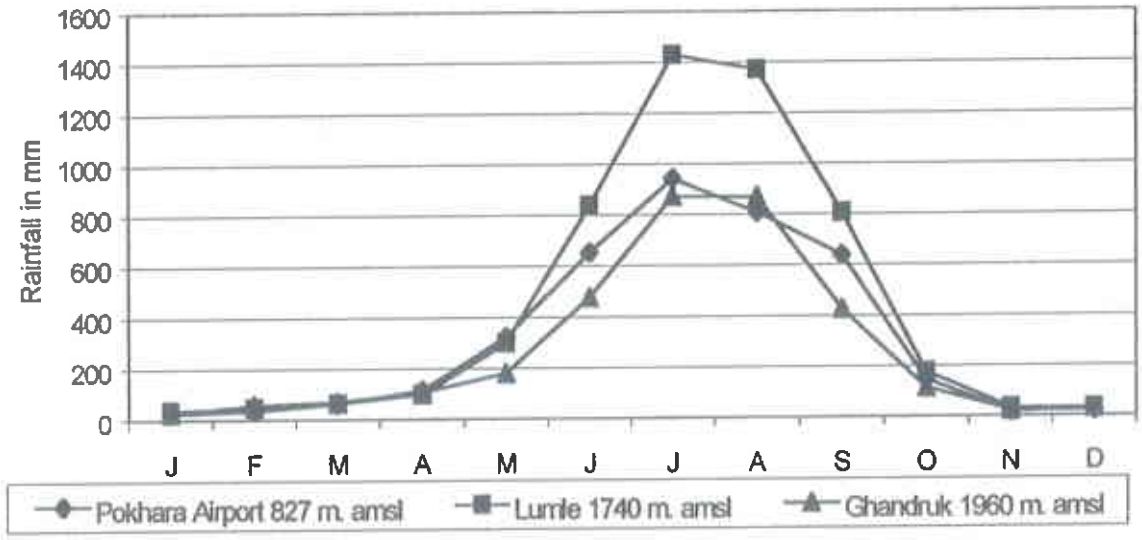


Figure 4.2: Mean monthly rainfall of the study area (1977-1997)

4.2.1 Population

The population in the project area was 30,462 in 1991, which grew to 36,398 in 1999. The crude population density is 296 persons per km^2. However, the population density in agricultural land is 745 persons per km^2 (Table 4.1).

Table 4.1 Population and households

Population and households	Project Area			Non-project Area		
	1991*	1999**	Percent Change	1991	1999	Percent Change
Population	30,462	36,398	19.5	23,265	28,240	21.4
Number of households	5,858	5,967	2.0	4,653	4,869	4.6
Crude population density per km^2	248	296	19.4	212	257	21.0
Population density per km^2 of arable land	623	745	17.4	471	571	23.0

Source: * Population census, 1991 and ** extrapolated
NB: The population and households are adjusted with watershed boundary

The population in the non-project area was 23,265 in 1991, which grew to 28,240 in 1999. The population is growing rapidly particularly in Hemja valley due mainly to in-migration facilitated by the Pokhara-Baglung highway. The crude population density in this area is 257 persons km^2. If agricultural land is considered, the density accounts to be 571 persons per km^2 (Table 4.1).

4.2.2 Ethnic Adherence to Land

There are four major ethnic groups and several minority groups in the study area. Brahmin is the single largest ethnic group constituting 31 percent of the total population in the project area and 38 percent in the non-project area. They are fully devoted to farming and livestock raising. They prefer fertile lowland for cultivation and adjacent hill slopes for settlement.

The traditional artisans combining Damai (tailor), Kami (blacksmith), and Sarki (shoemaker) is the second largest ethnic group. This group constitutes 17 percent of the total population in the project area and 21 percent in the non-project area. Traditionally they have low social status and possess small land holdings. They have some artisanal skills, like agricultural equipment and utensils making, woodcarving, tailoring, and shoe making, still they earn little form their profession. Farming is their secondary occupation. Their male household members work as construction laborers in the towns and females were as agricultural labor. Males not employed in towns work as agricultural laborers and earn some food grains to fulfill family needs. They live in clustered villages, quite apart from other ethnic groups.

Gurung and Magar combinedly are the third largest ethnic group accounting for 17 percent of the total population in both areas. Gurungs had migrated to the study area from Lamjuang and Gorkha districts around 1200 AD, and Magars from the western Nepal corresponding to the same period. The former group migrated in search of virgin pasture for livestock, wild animal for hunting and gentle sloping ridges for settlement and crop production. They prefer living together in clustered settlement on the ridge.

Being combatant by nature (Bajracharya, 1993:2), a considerable number of Gurung and Magar people are employed with the British, Indian and Nepalese army ever since the first world war. Particularly those employed with British and Indian military earn handsome

amount of money during service period and reasonable amount of pension after retirement. The first and second generations of the retired military men had made considerable amount of investment in the land until the 1970s. They purchased *phantkhet* from Brahmin and Chhetri whenever they had shortage of food grains. They have also invested their earnings in building houses both in the village and urban centers. After the 1970s, the situation in Gurung and Magar villages had changed gradually, as the retired people felt unproductive to invest their earnings in the villages. Moreover, their children preferred living in urban areas, owing to availability of amenities of life and better services and facilities. Therefore, there is growing tendency of out-migration from villages to Pokhara and Kathmandu cities. Now the houses of prosperous Gurung and Magar people are vacant and farmlands remain uncultivated due to low yields. However, the poor people who could not join British and Indian military live in villages and work either on their small landholdings or on others' as share croppers and wage laborers (Messerschmidt, 1976:43).

The Chhetri ethnic group is the fourth single largest ethnic group accounting for 16 percent of the total population in the project area and 14 percent in the non-project area. They have mixed occupational structure. The less educated young people work in Nepali and Indian military, the university graduates in civil services and the poor live in the villages and cultivate their farmlands. The origin, custom and settlement of Chhteri' are similar to Brahmin.

The minority ethnic groups comprising Thakali, Newar, Majhi, Gaine, Giri, Tahkuri and Tamang constitute nearly one fifth of the total population in the project area and one tenth in the non-project area. They have adopted trade and farming activities.

4.2.3 Employment Pattern

The people aged 11-59 years, considered as economically active, account for half of the total population. One third of the total population is economically inactive and rest is partially active (Table A. 16). The number of people economically active engaged in farming activities is gradually decreasing. It is reported that only 38 percent of the total population in the project area and 37 percent in the non-project area are exclusively engaged in farming. This indicates a trend of change from predominantly farm to non-farm based economy. However, there is a great discrepancy between sex and farm category. About three fifths of women in the project area and more than a half in the non-project area solely depend on farming activities against one fifth of their male counterpart (Table 4.2).

Table 4.2: Employment pattern

Employment (Age 11-59)	Project Area (N=155)						Non-project Area (N=145					
	Male		Female		Total		Male		Female		Total	
	n	f'	n	f'	n	f'	n	f'	n	f'	n	f'
Farming	64	18.0	203	59.0	267	38.0	70	22.0	165	53.0	235	37.0
Off-farm and farming	197	55.0	125	36.0	322	45.5	157	49.0	114	37.0	271	43.0
Migration in foreign country	81	23.0	8	2.0	89	13.0	71	22.0	8	2.5	79	12.5
Migration within country	9	2.5	2	0.5	11	1.5	13	4.0	10	3.0	23	3.5
Unemployed	7	1.5	9	2.5	16	2.0	10	3.0	14	4.5	24	4.0
Total	358	100.0	347	100.0	705	100.0	321	100.0	311	100.0	632	100.0

Source: Household survey, 1999

NB: N= Sample size, n = number of people, f'= proportion of n

About two fifths of the people are involved in agriculture and locally available off-farm activities, including petty trade, restaurant keeping along the transportation corridors and tourist routes, teaching, extension work, employment in NGOs and other clerical works in local market centers. The proportion of employment in off-farm activities is high among the men compared to women in both areas (Table 4.2).

Periodic migration for service in British and Indian army is an on-going process in both areas. Altogether 13 percent of the active labor force has migrated to different countries for higher amount of earnings (Table A. 17). The majority of migrants are male, and females have also started following them recently. Some villagers have migrated to different parts of the country for off-farm employment opportunities. Two percent of the total labor force in the project area and four percent in the non-project area are involved in periodic out-migration. A very small percentage of the labor force remains as unemployed (Table 4.2).

4.3 Economic Condition

Economic condition of the respondents is analyzed based on land ownership, farm production and consumption, household cash income and livestock ownership.

4.3.1 Land Ownership

Farmland is the primary source of livelihood of local people. They work on it, and take care to produce food and pay tax to the government to acquire rights of ownership. On average, a farm household in the project area owns 14.8 *ropani* of land, including 1.3 *ropani* of *phantkhet*, 8.4 *ropani tarikhet*, 1.1 *ropani bari*, 2 *ropani gharbari*, 1.7 *ropani kharbari* and *0.4 ropani jungle* (Table 4.3). There is great disparity in the distribution of farmland. The poorest household owns only 0.25 *ropani* and the richest household owns up to 56 *ropani*. The land holding is fragmented into about six parcels, with an average size of 2.7 *ropani*. The average number of parcels ranges from one to 26.

Table 4.3: Land holding size by household

Type of land	Project Area (N=155)				Non-Project Area (N=145)			
	Average no of parcel		Average area in *ropani*		Average no of parcel		Average area in *ropani*	
	No of parcel	Percent of total parcels	Area in *ropani*	Percent of total land	No of parcel	Percent of total parcels	Area in *ropani*	Percent of total land
Phantkhet	0.4	7.0	1.3*	9.0	1.2	18.5	3.8*	22.0
Tarikhet	2.5	46.0	8.4*	57.0	2.1	32.0	6.4*	37.0
Gharbari	1.0	20.0	2.0	13.0	0.9	14.0	2.0	11.0
Bari	0.6	11.0	1.1*	7.0	1.2	18.5	2.3*	13.0
Kharbari	0.7	13.0	1.7	11.0	0.8	12.0	2.0	11.0
Jungle	0.2	3.0	0.4*	3.0	0.3	5.0	1.0*	6.0
Average	5.4	100.0	14.8	100.0	6.5	100.0	17.6	100.0

Source: Household survey, 1999

NB: * Significantly different at 0.05 confidence level (T test, $p \leq 0.05$).

Similarly, a farm household in the non-project area owns 17.6 *ropani* of land. The land is broken into about seven parcels, with an average size of 2.7 *ropani*. The land ownership between poorest and the richest household ranges from 0.25 *ropani* to 68 *ropani* (Table 4.3).

The marginal farmers with less than 8 *ropani* of land constitute about 35 percent of the total population and own only seven percent of the total farmland. Their small land holdings are located in steep slopes and fragmented into several parcels. Most of them are illiterate and survive using small amounts of farm production supplemented by earnings from wage labor. Marginal farmers in the non-project area have same condition, but their landholdings are relatively large than the farmers in the project area. They constitute 23 percent of the total population and own only six percent of the total farmland (Table A.18).

In the project area, medium farmers with 8-16 *ropani* of land constitute about 30 percent of the total population and hold one fourth of the total farmland. The medium farmers in the non-project area constitute 29 percent of total population and own one fifth of the total farmland.

Large farmers with landholdings more than 16 *ropani* of land constitute 35 percent of the total population and have occupied 70 percent of the total farmland in the project area. In the non-project area large farmers constitute 48 percent of the total population and occupy three fourths of the total farmland. By virtue of their large landholdings these farmers can fulfill their food requirement using the crop products obtained from their lands.

There is great variation in land ownership by ethnicity. Brahmin in the project area and Chhetri in the non-project area have significantly large landholdings ($p \leq 0.05$) compared to other ethnic groups (Table A. 19).

Food consumption of an average farm household, with six family members, amounts to be 1,828 kg in the project area and 1,954 kg in the non-project area. Accordingly, a farm household in the project area requires 11.2 *ropani* and 14 *ropani* in the non-project area to meet this subsistence requirement. Overall, 45 percent of farm households in the project area and 46 percent in the non-project area have less than required amount of farmland. This is in conformity to earlier study, which indicated that a farm household requires 20 *ropani* of land in the mountains and 10 *ropani* each in the hills and *tarai* to maintain subsistence living. About 84 percent farmers in the mountains, 48 percent in the hills and 43 percent in *tarai* have less than the required land holding (FINIDA, 1990:6).

4.3.2 Food Crops Production and Consumption

Hill farmers cultivate different types of crops to meet their subsistence requirements. While they cultivate cereals as staple crops, they also produce small amount of other crops like pulses, potato, onion, garlic, ginger, fruits and vegetables. The amount of production depends on land holding size, household labor force size, land quality, availability of irrigation water, household needs and interest of farmers.

On average, a farm household in the project area produces 1,629 kg of food grains annually, comprising 986 kg of rice, 208 kg of maize, 202 kg of millet and 233 kg of wheat. Cereal crop production is relatively high in the non-project area due to relatively large land holding size. The average amount of production per household is 1,790 kg, comprising 1,159 kg of rice, 284 kg of maize, 202 kg of millet and 145 kg of wheat (Table 4.4).

The amount of field crop production varies by farm size, ethnicity and location. Large farmers in the project area, who constitute 35 percent of the total population, produce 65 percent of the total food grain. The annual average amount of production is 2,868 kg per household, which is seven times higher than marginal farmers and more than double of the medium farmers. The medium farmers produce 1,340 kg of food grain per year, which

accounts for 26 percent of the total food grain production. The marginal farmers produce only nine percent of the total amount of food grains, with annual average of 419 kg per household (Table A. 21).

In the non-project area, large farmers produce 70 percent of the total food grain and annual average amount of production is 2,629 kg per household. The medium farmers produce 22 percent of food grains, with an annual average production of 1,345 kg per household and the marginal farmers produce only 8 percent of the total food grains with annual average production of 619 kg per household (Table A. 21).

Table 4.4: Annual average balance of food grains

(kg/household/year)

Food crops	Project Area (N=155)					Non-project Area (N=145)				
	Prod.	Consu.	Sale	Purchase	Balance	Prod.	Consu.	Sale	Purchase	Balance
Rice	986	1,159	144	317	-158	1,159	1,325	101	267	-166
Maize	208	221	12	25	-13*	284	252	51	19	32*
Millet	202	209	14	21	-7*	202	238	22	58	-36*
Wheat	233*	239*	13	19*	-6	145*	139*	12	6*	-6
Total	1,629	1,828	183	382	-199	1,790	1,954	186	350	-164

Source: Household survey, 1999

NB: Prod. = production. Consu. = consumption

* Significantly different at 0.05 confidence level (T Test, $p \leq 0.05$)

On average, a farm household with six family members in the project area consumes 1,828 kg of food grain annually against 1,629 kg of production, resulting in net negative balance of 199 kg per year (Table 4.4). Both food grain production and consumption is relatively high in the non-project area compared to the project area. On average, a farm household with 5.8 members consumes 1,954 kg of food grains annually against 1,790 kg of production. It gives net negative balance of 164 kg per farm household. Except maize, there is shortage of other food grains, which is fulfilled by buying from the market (Table 4.4).

About 67 percent of the total farm households have food deficit and only 10 percent of the households could meet their requirement from their own production and 23 percent have some surplus for sale in the project area. In the non-project area, about 61 percent of farm households have no sufficient food production for consumption, 16 percent have subsistence production and 23 percent have surplus production (Table A. 23).

4.3.3 Production and Consumption of Non-cereal Crops

Farm households in both project and the non-project areas produce small amounts of non-cereal crops like vegetable, potato, garlic, onion, ginger lentil and fruit for consumption and sale.

Table 4.5:Annual average balance of non-cereal crops of a typical farm household

(kg/household/year)

Crop type	Project Area (N=155)					Non-project Area (N=145)				
	Prod-uction	Consu. mption	Sale	Purchase	Balance	Produ-ction	Consu-maption	Sale	Purchase	Balance
Vege.	119*	158*	8*	47*	-39*	317*	215*	117*	15*	102*
Potato	67	65	23	21	2	66	69	19	22	-3
GGO	13	7	10	4	6	20	20	0	2	0
Lentils	4	17	0	13	-13	2	14	2	12	-12
Fruits	77	54	23	0	23	87	61	26	0	26

Source: Household survey, 1999

NB : Vege. = vegetable. GGO= garlic, ginger and onion

* Significantly different at 0.001 confidence level (T Test, $P \leq 0.05$)

There is little surplus production of potato, fruits, garlic and onion and vegetable and lintel production could not meet household demand in the project area (Table 4.5). In the non-project area, there is considerable amount of surplus production of vegetable and fruits, while lintels and potato could not meet household requirement.

4.3.4 Household Cash Income

The household income is expressed in monitory term through assessment of actual income earned by farm households from various sources. Income from off farm sources and remittances are directly in cash and, thus easy to measure. As the farm produces are used for both consumption and sale, the value of farm produces sold has been accounted as cash income.

Most of the cash income is derived from remittances in both areas. A project farm household earns net income of Rs 62,366 per year. Out of this amount, 15 percent comes from farm sources, 30 percent from local off-farm sources and 55 percent from remittances. Similarly, a non-project household earns Rs. 83,276 cash income in a year; of which 11 percent comes from farm sources, 24 percent from local off-farm sources and 65 percent from remittances (Table 4.6). There is great income variation ranging from Rs. 3,000 to 24,8000 in the project area and Rs 4,000 to 1,600,000 in the non-project area.

Table 5. 6: Annual average cash income

(Rs/ household/year)

Farm size	Project Area (N=155)				Non-project Area (N=145)			
	Farm	Off-farm	Remittance	Total	Farm	Off-farm	Remittance	Total
Marginal	4,570	20,550	21,052	46,172*	5,119	23,864	19,818	48,801*
Medium	7,876	14,416	38,252	60,544*	6,470	12,233	57,671	76,374*
Large	15,113	21,625	43,051	79,789*	12,245	22,303	69,120	103,668*
Mean	9,292	19,111	33,963	62,366	8,951	19,742	54,583	83,276

Source: Household survey, 1999

NB: * Means in column within the area are significantly different at 0.05 confidence level (F test, $P \leq 0.05$)

4.3.5 Livestock Ownership

Livestock are an integral component of the household economy in the study area. Livestock are considered as property which could be sold in the case of financial constraints. People keep both ruminant and non-ruminant livestock as supplementary sources of livelihood. Majorities of the households raise large ruminants for milk, manure and draught power. Such ruminants constitute two thirds of the total livestock population. Farmers prefer raising female livestock, as they are source of dairy products and calves. Also farmers need oxen for plowing land and for breeding. The overwhelming majority of farmers raise buffalo and cattle. Notably the marginal and medium farmers raise goat and sheep to supplement household income. Sheep need regular grazing throughout the year, which is not convenient for farmers, owing to labor shortage. Adult he buffaloes are raised especially for breeding. Small livestock like goat, pig and sheep are kept for sale, as there is ever increasing demand for meat. Chicken and duck are kept for household consumption as well as for sale.

Farmers raise buffalo for milk and manure. Some farmers consider buffalo raising easier than other livestock raising. Dairy cattle have been raised especially for milk, and local breeds of cows are raised for reproduction of calves and milk. According to some farmers, cattle manure is more fertile than other livestock manure. Goat and sheep are raised for cash earnings and manure.

Table 4.7: Change in livestock herd size

(Heads/household)

Livestock type	Project Area (N=155)			Non-project Area (N=145)		
	Herd size 1998	Herd size 1988	Percent change	Herd size 1998	Herd size 1988	Percent change
Cattle	0.8	1.0	-20	0.6	1.3	-54
Buffalo	1.7	2.3	-26	1.8	3.1	-42
Goat/sheep	1.6	2.2	-27	1.1	2.0	-45
Pig	0.2	0.3	-33	0.1	0.1	0.0
Total	4.3	5.8	-26	3.6	6.5	-45

Source: Household survey, 1999

NB: The herd size between two areas is not significantly different at 0.05 confidence level (T Test, p >0.05)

There is no significant variation in livestock herd size by location. On average, 4.3 heads of livestock have been raised by a farm household in the project area and about 4 heads in the non-project area. The livestock herd size in both areas is relatively small as compared to district average of 5.2 heads.

The livestock herd size is gradually decreasing in both project and the non-project areas. Overall the herd size dropped by 26 percent in the project area and 45 percent in the non-project area (Table 4.7). This is explained by diminishing fodder supply particularly in the non-project area, shortage of labor force, low productive capability of local breeds, and poor marketing facility. The trend of decreasing small ruminants is considerably higher than the large ruminants in both the project and non-project areas.

Table 4.8: Annual average milk production

(Kg/household/year)

Farm size	Project Area (N=155)					Non-project Area (N=145)				
	f'	Production	Consumption	Converted to butter	Sold	f'	Production	Consumption	Converted to butter	Sold
Marginal	35.0	300 *	76*	180 *	44*	23.0	552*	132*	308*	112
Medium	30.0	614*	137*	319*	158*	29.0	881*	230*	535*	116
Large	35.0	642*	130*	302*	210*	48.0	805*	205*	480*	120
Total	100.0	515**	113**	265**	137	100.0	770**	196**	457**	117

Source: Household survey, 19999

f'= proportion of N

NB: * Means in column within the area are significantly different at 0.05 confidence level (F test, p≤ 0.05)

** Means in row between two areas are significantly different at 0.05 confidence level (T test, p≤ 0.05)

Milk production is significantly higher (p≤0.05) in the non-project area compared to the project area. The annual average milk production amounts to 515 kg per household in the project area 770 kg in the non-project area. There is remarkable variation in milk production by farm size. Marginal farmers in project area produce less than 300 kg of milk in a year. In contrast, medium farmers living in the same locality produce 614 kg and large farmers produce 642 kg. In the non-project area, marginal farmers produce 552 kg, medium farmers produce 881 kg and large farmers produce 805 kg of milk per year (Table 4.8).

4.4 Land Use and Cropping Pattern

Both land use and cropping pattern have changed over past decades, with changing socio-economic condition, in project and the non-project areas.

4.4.1 Land Use Pattern

Out of the total land area of 12,300 hectares in the project area, 37 percent or 4,487 hectares is under agriculture, 4 percent or 498 hectares is under lake and river, 47 percent or 5,764 hectares is under forest, 5 percent or 629 hectares is under shrub and pasture land, 5 percent or

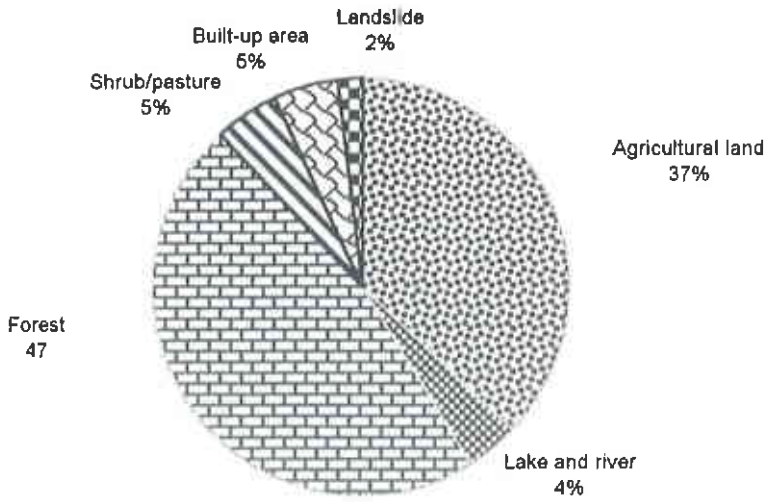


Figure 4.3: Land use pattern in the project area

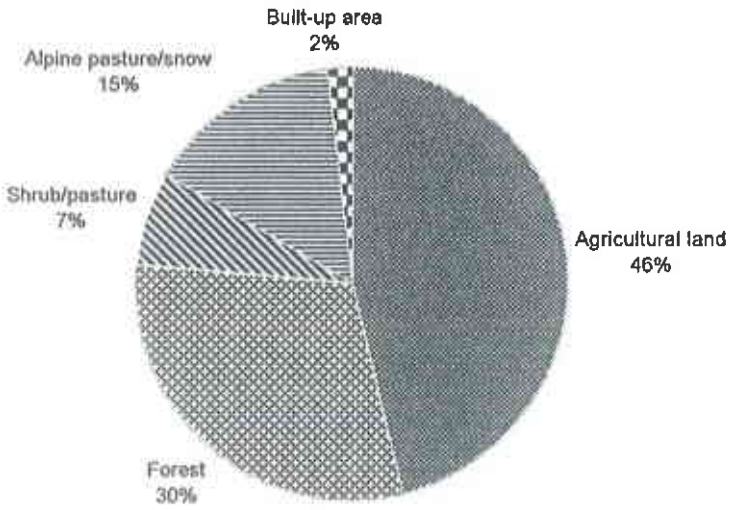


Figure 4.4: Land use pattern in the non-project area

644 hectares is under built-up area, and remaining 2 percent or 278 hectares is under landslides, sand and gravel (Sthapit and Balla, 1998:5). The total land area in the non-project area is 10,970 hectares. Out of this area, 45 percent or 4,943 hectares is under agriculture, 31 percent or 3,369 hectares is under forest and temperate pasture, 15 percent or 1,660 hectares is under alpine pasture and snow, 7 percent or 782 hectares is under shrub, and two percent or 216 hectares is under built-up area (Thapa and Weber, 1993; land use map, 1996).

4.4.2 Land Use Change

Land use change was assessed through participatory mapping technique. A participatory mapping team, comprising at least one farmer from each village, was formed in each VDC located in both project and the non-project areas. A map was given to each team and members were requested to indicate the major land use change on the map. A final land use change map was prepared by combining all maps prepared by several teams.

Four types of land use changes were noticed in the project area. The major change was noticed in declining area under water in Phewatal caused by soil erosion, landslide and siltation. According to local people, the lake area has been diminishing at the rate of three hectares per year. Reportedly, 180 hectares of the lake area had already disappeared during the last 60 years. Out of this, about a half has been converted into *phantkhet*, and rest remains as marshy land (Fig. 4.5). Second change was the conversion of "open access" grazing and shrub land into forest. Besides, small patches of grazing lands interspersed with farmlands were converted to terrace lands. Third change was plantation in degraded natural forests and increased community control over them. According to farmers, tree and shrub density in farm terrace risers and edges has considerably increased as compared to the situation of 30 years ago.

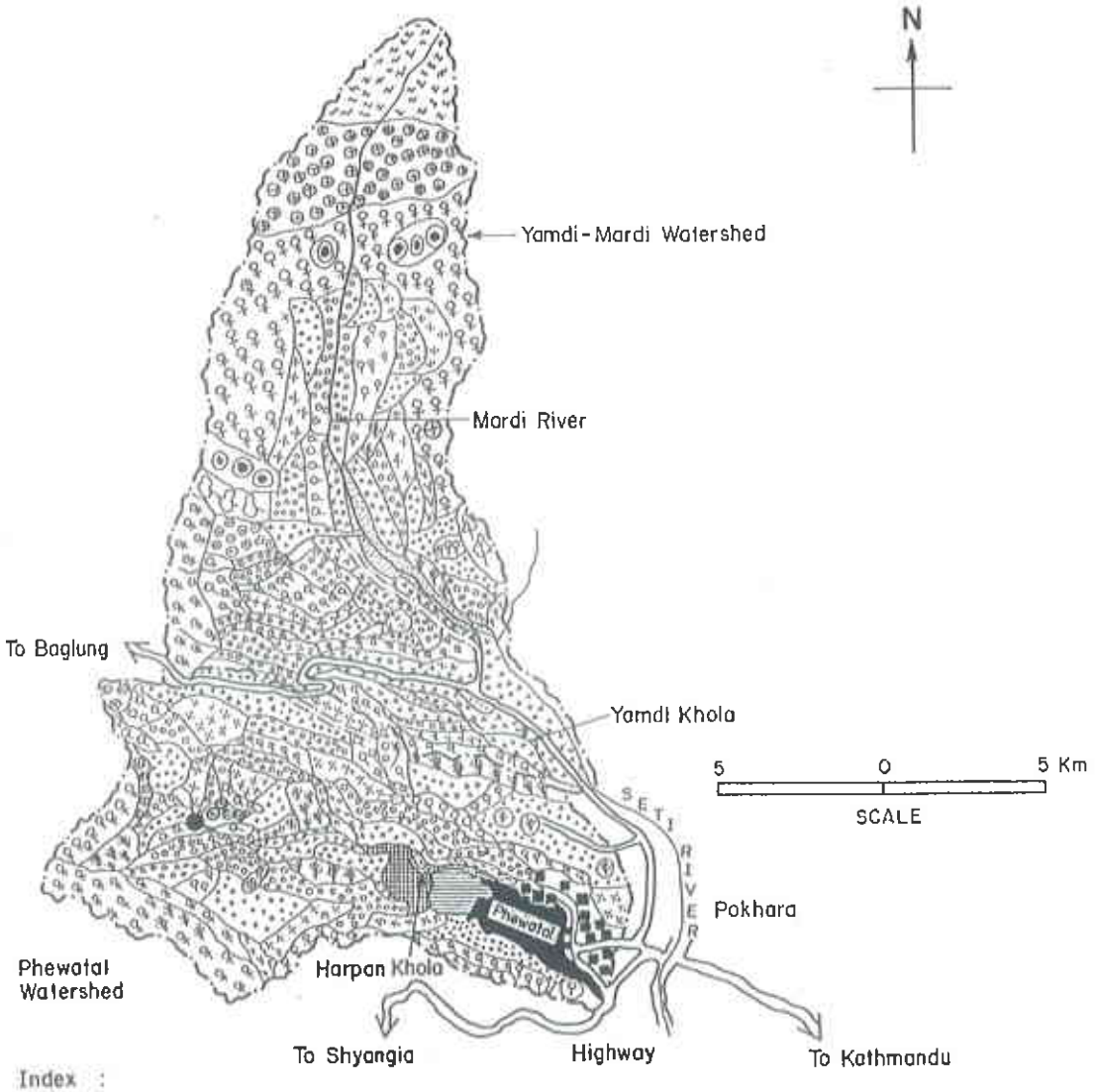
In the non-project area, the major land use changes were conversion of the river bed into *phantkhet* along Yamdi *khola*, abandoned *kharka* in the ridge, increased fallow farmland in the hill slope near Gurung settlements and conversion of grazing land into forest and tea plantation (Figure 4.5). There was not much change in the forest area compared to the area of 30 years ago.

4.4.3 Cropping Pattern

Farmers are facing difficulty in sustaining their livelihood only from cereal crops cultivation. They have adjusted cropping systems to generate more income from cash crops. The change in cropping systems is relatively slow and highly localized in the project area. Particularly with the opening of the Pokhara-Baglung highway, which provides access to the regional town of Pokhara, farmers in Kaskikot and Dhikurpokari (VDCs) are gradually shifting to dairy farming. This activity is further reinforced by growing agroforestry adoption facilitated by the Phewatal Watershed Management Project and Lumle Agricultural Research Center.

There have also been some changes in cropping systems in the non-project area. Farmers in Hemja village, for example, are pursuing vegetable farming and peanut cultivation on rotational basis in Lahachock village; and vegetable seed production in Kolelei village. Notably all these villages are located in river valleys, with relatively fertile soils and good irrigation facilities. Other villages are still under subsistence production systems.

Altogether there are 26 cropping patterns in the project area and 28 in the non-project area (Table 4.9). Rice, maize and wheat are major crops cultivated in *khet* in the project area.



Index :

	Watershed boundary		Farmland before 20 years , now protected forest
	Stream / river		Open access forest before 20 years ; now community forest
	Highway		Open grazing land and landslides before 20 years ; now community forest
	Graveled road		Tarikhet before 10 years ; now barren land
	Khorbari		Grazing land before 15 years ; now gharbari
	Gharbari		Barren bari before 5 years ; now tea plantation
	Phantkhet		Bari before 30 years ; now barren land
	Tarikhet		Shrub area before 3 years ; now tea plantation
	Bari		Perpetual snow
	Alluvial deposit		Urban area
	Lake before 60 years : now marshy land		Shrub and pasture land
	Marshy land before 60 years : now completely converted into phantkhet		Natural forest

Figure 4.5 : Land use change in the study area

NB : This map is prepared by local settlers based on their experience and observation thus, the area under different types of land should not be measured

While, rice, maize, wheat, peanuts and vegetables are the major crops in the non-project area. Maize, millet, wheat are major crops cultivated in *bari* land in both areas.

Farmers are increasingly shifting from local to high yielding varieties of crops (HYV) to produce high amount of food crops from their small land holdings. During the 1970s, all cropped areas were under local varieties in the project area, but later farmers gradually began to cultivate new crop varieties. Thus cropped area under HYV had increased from almost zero in 1975 to 54 percent of the total cropped area in 1998. Non-project farmers started cultivating HYV during the 1980s and the area under HYV was only 29 percent in 1998 (Table A. 40).

The proportion of farmers cultivating improved wheat increased from six percent in 1975 to 70 percent in 1998, maize from six percent to 85 percent and rice from two percent to 52 percent in the project area. In the non-project area, HYV wheat cultivators increased from three percent in 1975 to 40 percent in 1998, maize from seven percent in 1985 to 25 percent in 1998 and rice from seven percent in 1985 to 15 percent in 1998 (Table A. 41).

Table 4.9: Cropping pattern in the study area

Land Type	Cropping pattern (Project area)	Cropping pattern (Non-project area)
Phantkhet and *tarikhet*	Rice fallow Rice + wheat + fallow Rice + mustard + fallow Rice + vegetable + fallow Rice +lentil + fallow Rice + fallow + potato Rice + fallow + maize Rice + fallow +rice Rice + wheat + Rice Rice +wheat +maize Rice + vegetable + vegetable Rice + mustard + maize	Rice fallow Rice + wheat + fallow Rice + mustard + fallow Peanuts + mustard + fallow Rice + vegetable + fallow Rice +lentil + fallow Rice + vegetable + vegetable Peanuts + fallow +maize Rice + fallow + potato Rice + fallow + maize Rice + fallow + rice Rice + wheat + Rice Rice +wheat +maize Rice + mustard + maize
Bari and *gharbari*	Maize + millet + fallow Maize + vegetable + fallow Maize + beans + fallow Maize + soybean + fallow Maize + vegetable + mustard Maize + vegetable + vegetable Maize + millet + mustard Maize + millet + wheat Maize + Millet + potato Maize + millet + lentil Maize + millet + oat Maize + millet + buckwheat Maize + millet + vegetable Fruit tree +other cash crops	Maize + millet + fallow Maize + vegetable + fallow Maize + beans + fallow Maize + soybean + fallow Maize + vegetable + mustard Maize + vegetable + vegetable Maize + millet + mustard Maize + millet + wheat Maize + Millet + potato Maize + millet + lentil Maize + millet + oat Maize + millet + buckwheat Maize + millet + vegetable Fruit tree + other cash crops

Source: Household survey, 1999

Farmers have experienced both advantages and disadvantages of HYV. While the overall crop yield has considerably increased due to HYV cultivation, it also has increased the risk of crop failure under the condition of climatic fluctuation (Table A. 42). Likewise, it has increased insect and pest infestation, owing to weak diseases resistant capability of improved varieties of crops.

4.4.5 Cropping Intensity

Cropping intensity is defined as ratio between gross cropped area and net agricultural land in this study. It is calculated as follows:

$$CI = \frac{gca_1 + gca_2 + gca_3 + \ldots\ldots\ldots + gca_n}{nca_p + nca_t + nca_b + nca_g}$$

Where,

CI = Cropping intensity

gca_1 = Gross area under crop 1 +.....+ crop $_n$

nca_p = Net area of *phantkhet*

nca_t = Net area of *tarikhet*

nca_b = Net area of *bari*

nca_g = Net area of *gharbari*

Depending on land quality and availability of irrigation water, farmers are cultivating two or three crops annually in their farmlands. The cropping intensity is increasing in all types of lands in both project and the non-project areas. Particularly *bari* and *gharbari* are being very intensively utilized in both areas, as they are relatively better in quality and near to farm households. *Tarikhet,* with relatively poor quality of soil and without irrigation water, are less intensively utilized. Despite being good quality, *phantkhet* are least intensively cultivated, as they are owned by land speculators in the project area. In the non-project area, large farmers have less intensively utilized these lands because they do not depend only on field crops as source of household earnings (Table 4.10).

Table 4.10: Change in cropping intensity

Land type	Project Area			Non-project Area		
	1975	1998	Change	1975	1998	Change
Phantkhet	1.0	1.4	0.4	1.0	1.6	0.6
Tarikhet	1.1	1.3	0.2	1.2	1.4	0.2
Bari	2.0	3.2	1.2	2.0	2.3	0.3
Gharbari	2.2	3.3	1.1	2.3	2.6	0.3
Total	1.3#	1.6#	0.3	1.4#	1.7#	0.3

Source: Household survey, 1999

NB: # The cropping between two areas is not significantly different at 0.05 confidence level (T Test, P> 0.05)

The cropping intensity increases with decreasing farm size in both areas. Marginal farmers cultivate two or three crops to minimize food deficit. However, large farmers have not such tendency. Thus, their cropping intensity is considerably low.

4.4.6 Fruit Tree and Cash Crop Farming

Farmers have been increasingly attracted towards fruit trees plantation as they are aware of high price of fruits and have access to the regional city of Pokhara. In 1975, only 15 percent of farmers had reportedly grown at least one fruit tree in the project area. Such farmers accounted for 61 percent of the total households by 1998. In the non-project area, they comprised seven percent in 1975, and 56 percent in 1998 (Table 4.11). Fruit tree growing is localized at the lower elevations as the upper elevations are badly affected by hail stone during the pre monsoon season. On average, a farm household has planted 21 trees in the project area and 9 trees in the non-project area. Besides, one fifth of farmers in the project

area and one-sixth in the non-project area have also planted tea mainly for household consumption. ACAP has been promoting community tea plantation in the non-project area since 1996, as its area is likely to steadily increase in the future.

There is a growing tendency towards cultivation of cash crops, namely, potato, soybean, peanuts, ginger, garlic, lintel, oilseeds and cardamom, in both the project and the non-project areas for household consumption as well as for sale. The proportion of farmers cultivating cash crops in the project area increased from 37 percent in 1975 to 59 percent in 1998. There was two-fold increase in the non-project area during the same time period (Table 4.11).

Table 4.11: Change in non-cereal crop cultivation

Crop types	Project Area (N=155)				Non-project Area (N=145)			
	1975	1985	1995	1998	1975	1985	1995	1998
	f	f	f	f	f	f	f	f
Fruit trees [a]	15.0	25.0	40.0	61.0	7.0	13.0	40.0	56.0
Tea	6.0	7.0	18.0	19.0	0.0	0.0	4.0	16.0
Cash crop [b]	37.0	45.0	55.0	59.0	21.0	38.0	48.0	62.0
Vegetables	61.0	78.0	99.0	99.0	46.0	74.0	77.0	98.0
Bee keeping	1.0	5.0	8.0	8.0	2.0	3.0	3.0	3.0

Source: Household survey, 1999

f = Proportion of N

NB: [a] Includes orange, guava, pear, lemon, mango, papaya, jackfruit and prunus persica

[b] Includes potato, soybean, peanuts, ginger, garlic, lintel, oilseeds and cardamom

Farmers also cultivate vegetables for household consumption and sale. There has been significant growth in the number of farmers engaged in vegetable cultivation. The proportion of farmers in the project area grew from 61 percent in 1975 to nearly 100 percent, and from 46 percent to 98 percent in the non-project during same period (Table 4.11). Such expansion of vegetable farming was facilitated by LAC and the Phewatal Watershed Management Project in the project area and by LAC, NGOs and spell-over effect of adjoining watershed in the non-project area.

CHAPTER V

STATUS OF FARMLAND

As discussed in introduction, there is an on-going debate on land degradation in the Hills of Nepal. Most studies pursued until the early 1980s present a bleak scenario of severe land degradation caused by human activities. However, the validity of the traditional belief, which was based on casual observation of the situation is being questioned, as the result of scientific studies conducted after the mid 1980s found the land degradation caused by mainly natural factors (Ives and Messerli, 1989; Bruijnzeel and Bermmer, 1989). In view of the land management practices being pursued by the hill farmers, these studies give a kind of impression, though implicitly, that there is nothing to be worried about the status of land resources. Attempt rarely has been made to understand the land degradation problem from farmers' perspective. This chapter takes a middle path and attempts to examine the status of land resources in the study area from both farmers' and professionals' perspective. In this regard, the status of farmland is assessed based on three indicators: the extent and process of soil erosion and landslide, nutrient status of farmland and change in crop and grass yields.

5.1 Soil Erosion

Soil erosion and landslides are both active in the study area. Landslides frequently occur during the monsoon season when terrace risers or even up slope terraces collapse and soil and rocks are deposited in the adjacent terraces located below. Depending on the extent of landslide and the amount of materials deposited, it takes a few to several years to get the damaged terraces claimed. In areas with severe damage, farmers have abandoned terraces permanently. Erosion removes the productive top soils gradually, thereby causing heavy loss of plant nutrient. Apparently this problem is more severe in *bari* land than in *khet*. The process of soil erosion and extent of landslide are discussed below by land types for better understanding the status of farmlands.

Continuous topsoil erosion from the farmlands has been a common phenomena in both project and non-project areas, as more than four fifths of farmers in both areas reported about this problem (Table A. 44). Farmers experienced high rate of soil erosion especially in outward facing *bari* terraces and other marginal farmlands located in areas with more than 20 percent slope gradient. Being improved with the external assistance, *bari* terraces in the project area are undergoing relatively low rate of soil erosion compared to *bari* terraces in the non-project area. *Phantkhet* and *tarikhet* in both areas are under bench terraces and they are not facing serious soil erosion. The soil loss in the project area is estimated to be 4.5 ton/hectare/ year in terraced *khet* and 17.4 ton/hectare/ year in terraced *bari* land (Impat, 1981:26). It is estimated that about 25 percent of the soil loss is caused by dripping effect of rain and surface run-off and 75 percent by mass wasting, including landslides (Impat, 1981).

5.1.1 Landslide and Soil Erosion: Farmers' Perspective

Landslide causes the loss of very high amount of soil in affected area. About one tenth of farmlands in both project and the non-project areas are affected by landslide. As mentioned above, landslide mainly affects *bari* land in both areas, and it is followed by *gharbari, phantkhet and tarikhet* in the project area and *phantkhet, gharbari* and *tarikhet* in the non-project area (Table 5.1). Remarkably, even *phantkhet* located in the valley floors are badly affected by the deposition of soil and rocks removed from the higher elevations through soil erosion and landslide.

According to farmers, the exposure of ploughed land to the sun, rain and air for a long period helps to improve soil fertility. Therefore, they plough their lands thoroughly immediately after the harvest of crops and leave them exposed to sun, rain and air for a minimum period of a week to lands cultivated with three crops, four to five months to lands under two crops and nearly seven months to lands utilized for single crop. The ploughed lands become extremely dry and dusty during the dry summer season. When the pre-monsoon rain occurs during April-June, a substantial amount of farm soil is easily washed away by the water flowing downhill. Though maize is sown in *bari* and *gharbari*, young plants cannot control soil erosion effectively. Lands are gradually covered with vegetation following the on set of the monsoon season. If the intensity of rainfall is high during the early monsoon period, a lot of loose soil is washed away from the lands in the absence of a fully developed vegetative cover. This is corroborated by the finding of a study on soil erosion in Jhhiku Khola watershed where 50-90 percent of soil loss was caused by two pre-monsoon storm events. As a result of such events, the annual average soil loss was estimated to be 40 ton/hectare/year (Carver and Nakarmi, 1995).

Table 5.1: Soil erosion and landslide

Land type	Project Area			Non-project Area		
	Surveyed area (hectare)	Percent of total farmland affected by landslide	Percent of total farmland affected by soil erosion	Surveyed area (hectare)	Percent of total farmland affected by landslide	Percent of total farmland affected by soil erosion
Phantkhet	10.6	13.0*	8.0	28.2	5.0*	10.0
Tarikhet	66.0	6.0	16.0	47.5	7.0	16.0
Bari	8.3	33.0	40.0*	17.3	37.0	48.0*
Gharbari	15.7	17.0*	20.0*	15.0	13.0*	27.0*
Total	100.6	10.0	18.0	108.0	10.4	21.0

Source: Household survey, 1999

NB: Significantly different at 0.05 confidence level (T Test, ≤0.05)

Even bench terraced rice fields are not free from soil erosion. *Khet* terraces are puddled for rice transplantation. The puddled soil takes two three days to get set up. If a heavy rainfall occurs immediately after the rice transplantation, the rainwater enters into *khet* terraces and easily washes away soil and plant nutrients, especially when amount of water starts flowing terrace bunds. The loss of soil and nutrients may be a small to substantial amount depending on the intensity of rainfall.

The rainwater flowing towards down hills from the higher elevations enters into the farmlands and washes away the surface soil especially where waterways are not constructed to prevent surface run-off from entering into farmlands. Farmlands located below grazing lands, foot trails, gullies and other public lands are more prone to this type of erosion. About 18 percent of surveyed farmlands in the project area and 21 percent in the non-project area are being severely affected by different erosion as discussed above (Table 5.1). Significantly high proportion of *bari* and *gharbari* being affected by erosional processes in the non-project area is due mainly to sparse density of waterways.

5.1.2 Farmers' Experience in Soil Erosion by Type of Soil

There is large variation in soil properties across the farmlands. Farmers distinguish soil properties by color and texture. Primarily they were asked to classify farmlands by soil type and, then rank the intensity of erosion by soil type. There were five types of soils as identified

by farmers. Therefore, rank one was assigned to the soil considered to be most erosive and five for the least erosive to construct the index of relative erosiveness.

The *rhodustalfs* soils, locally addressed as *rato mato*, with strong red color constitute one-fourth of the total farmlands in the project area and six percent in the non-project area. They are the oldest soils found in foothills and lower hill slopes between 1100-1500m amsl. They often have crusting after tillage and have problems with phosphorus fixation. They are subject to severe gull formation and susceptible to landslides. The extensive landslides at Harpan and Pamdur villages located in the project area are attributed to this type of soil. Farmers believe that especially areas with *rato mato* and heavy rainfall extensively suffer from landslides. Most *bari* terraces comprise these soils and have low infiltration rates, slow permeability of sub soils and prone to landslides occurrence during the heavy rainfall period. The lowest index value indicates that these soils are experiencing high soil erosion (Table 5.2).

Table 5.2: Relative severity of erosion by soil type

Soil		Project Area (N=155)				Non-project Area (N=145)			
Local name	Soil taxonomy	Area (ha)	%	Index value	Relative rank	Area (ha)	%	Index value	Relative rank
Rato mato	*Alfisoil:* sub-group *Rhodustalfs*	25.2	25.0	0.001*	I	6.5	6.0	0.010*	I
Balaute mato	*Entisoil*: sub-group *Fluvents*	0.6	0.6	0.010	II	7.5	7.0	0.011	II
Khairo/ kamere mato	*Inceptisoil:* sub-group Dystrochrepts	21.0	21.0	0.011	III	23.0	21.0	0.012	III
Mashino kalo mato	*Inceptisoil*: sub-group *Umbrepts*	47.8	47.4	0.015	IV	57.0	53.0	0.016	IV
Pango mato	*Molasoils*	6.0	6.0	0.018	V	14.0	13.0	0.190	V
Total		100.6	100.0			108.0	100.0		

Source: Household survey, 1999
NB: The lower the index the higher the severity of soil erosion
* Significantly different at 0.05 confidence level (T Test, ≤0.05)

Fluvents soils, locally known as *balate mato,* are found between 800-1200m. amsl at the lower foothills in both areas. They are formed recently by stream deposition. The texture of these soils is generally coarse sandy with considerable inclusions of gravel. These soils have poor water holding capacity and high infiltration rate. They are suitable for grass and fodder tree and easily eroded by water. The area with these soils constitutes less than one percent of the total farmlands in the project area and seven percent in the non-project area. Farmers ranked these soils as second most erosive soils in both project and the non-project areas (Table 5.2).

Dystrochrepts soils, locally known as *khairo/kamere mato,* have hardly distinguishable brown and white color. They are commonly found below 1500m. amsl in south facing slopes of both areas. The humid condition creates strong leaching and low base saturation makes surface soils more acidic. Therefore, they are less suitable for field crops. A regular leaching in the hill slope during the rainy season makes them susceptible to landslides and soil erosion. Large landslides were observed during field visit in area with *dystrochrepts* soils. Farmers ranked these soils third most vulnerable to erosion (Table 5.2).

The majority of farmlands in the hill slopes are under *umbrepts* soils, locally known as *mashino kalo mato,* with light dark color. They are found between 1200- 2200-m. amsl in

both areas. They have low base saturation and high organic matters contents in the surface. High oxidation of organic matter limits the plant growth; therefore, these soils need rapid replenishment of organic matters. Most *bari* and *gharbari* have this type of soil which is considered to be the fourth most erosive soil (Table 5.2).

Molasoils, locally called as *pango mato,* are found along river terraces and lower hill slopes between 800-1500 m. amsl. They have thick dark base and high organic matters in the top layer. They are formed of calcium rich parent materials, with rapid base recycling and low leaching. Rapid oxidation of organic maters in the surface layer rapidly converts them to *ustochrepts* soil. They are extensively used for wet paddy cultivation. These soils constitute only six percent of the total farmlands in the project area and thirteen percent in the non-project area. They are less vulnerable to erosion compared the other soils (Table 5.2).

5.1.3 Farmers' Experience in Soil Erosion by Type of Land

Farmers' experience in soil erosion by land type was assessed through relative ranking. Farmers were asked to give rank one to the land most susceptible to erosion and rank four to the least susceptible land. The relative ranking revealed consistency in opinions between project and the non-project farmers. Farmers experienced high soil erosion in *bari* land, followed by *gharbari, tarikhet* and *phantkhet* in both project and non-project areas (Table 5.3).

Table 5.3: Farmers ranking of the severity of soil erosion by land type

Land type	Project Area		Non-project Area	
	Index value	Rank	Index value	Rank
Bari	0.021	I	0.020	I
Gharbari	0.023	II	0.024	II
Tarikhet	0.030	III	0.027	III
Phantkhet	0.038	IV	0.041	IV

Source: Household survey, 1999
NB: The lower the index value higher the rate of soil erosion

5.1.4 Landslide

Heavy rain accompanied by thunderstorm is a common phenomenon in the study area during the pre-monsoon and monsoon seasons. According to farmers, lands are highly susceptible to landslide especially during the days with continuous rain over 24 hours accompanied by thunder. Rainfall data recorded in six stations in and around the study area over the last 21 years (1977-97) confirmed that there were at least five such days in a year. The rainwater percolates through porous soil and reaches to bedrock comprising slate and phylite, with low permeability, eventually saturating rocks and weakening their load bearing strength. In this type of situation, repeated thunder creates vibration in saturated soils and triggers landslips, especially in areas with steep slope. Thus, even well managed farmlands are vulnerable to landslide. Occasional shocks caused by earthquakes and heavy extreme rainfall events aggravate the landslide as happened in 1833, 1933, 1957, 1971 and 1989 (Table A. 45).

Landslide occurrence is a natural process. According to farmers, about 90 percent of the landslides occur due to natural causes. This is in conformity to an earlier study which indicated more than 90 percent mass wasting in the project area was caused by natural factors (Ramsay, 1985). However, the magnitude of landslide depends on the slope gradient and height of terrace risers and the nature of bedrock materials. More than 60 percent of landslides occur in areas with slope gradients over 20 percent. Most of the landslides are small in scale

ranging from 2 to 150 m^2, with an average size of 10 m^2. According to farmers, landslide has affected about 10 percent of their farmlands in each year. It takes 10-15 years to recover the soil fertility in terraces affected by landslides.

Table 5.4: Landslide density in farmland

Landslide occurrence (In single year 1998)	Project Area				Non-Project Area			
	Phantkhet	*Tarikhet*	*Bari*	*Gharbari*	*Phantkhet*	*Tarikhet*	*Bari*	*Gharbari*
Surveyed area (hectare)	10.6	66.0	8.3	15.7	28.2	47.5	17.3	15.0
Number of landslides	89.0	752	147	225	35.0	654	186	128
Mean density/hectare	8.4*	11.4*	17.7*	14.3*	1.2*	13.8*	10.8*	8.5*
Labor workdays/hectare for landslide treatment	4.2*	11.4*	21.3*	14.3	1.8*	16.5*	16.2*	12.0
% of land with landslide	36.0	60.0	59.0	47.0	6.0	52.0	41.0	35.0

Source: Household survey, 1999

NB: * Significantly different at 0.05 confidence level (T Test, $P \leq 0.05$)

Barilands are more vulnerable to landslides, owing to relatively high terrace risers and location on steep slopes, normally over 20 percent. There are about 18 landslides per hectare of land in the project area and 11 in the non-project area. In *tarikhet,* landslide density per hectare of land is 11.4 in the project area and 13.8 in the non-project area (Table 5.4). Even *gharbari* and *phantkhet* have not remained unaffected by landslide, though most attention is paid to their management. The occurrence of landslide in all types of land is significantly higher ($P \leq 0.05$) in the project area compared to the non-project area, as the bedrock is predominantly composed of slate and phylite (Table 5.4). This clearly indicates that, despite substantial investments, the watershed management project could not control landslide in the project area.

5.1.5 Farmlands Severely Affected by Soil Erosion

Despite efforts made by farmers, land degradation by soil erosion is under way in both project and the non-project areas. About one fifth the total farmland in both areas are seriously affected by soil erosion. As a result, overall crop yields in eroded farmlands dropped substantially in both areas between 1988-1998 (Table 5.5). Relatively high dropping rate of crop yield in the non-project area indicates that the effect of soil erosion is relatively high there.

Phantkhet located in the valley floor and foothills are less affected by soil erosion. But about eight percent of the *phantkhet* in the project area and one tenth in the non-project area, located near streams, canals and adjacent to the public lands, are influenced by the surface run-off. The effect is not as severe as in other lands, still the crop yield dropped by seven percent in the project area and by 28 percent in the non-project area. A significant reduction in crop yield in the later area is attributed to deposition of sand and boulder by stream in *phantkhet* along Mardi *khola* (Table 5.5).

Tarikhet are ploughed and puddled for rice transplantation by collecting rainwater from adjoining foot trails, gullies and terraces. These lands have poor water holding capacity and, thus, become dry immediately after rice transplantation. There will be often surface crusting, if there is no rain for 3-4 days. Therefore, the farmers leave the waterways open to divert rainwater into *tarikhet* whenever the next rain occurs. If the rainfall intensity is high, a large amount of water enters into the puddled terraces and washes away soil nutrient. About

16 percent of *tarikhet* in both areas are affected by soil erosion. As a result, the composite crop yield in eroded *tarikhet* dropped by 21 percent in the project area and by 50 percent in the no-project area during 1988-1998 (Table 5.5). Besides, high soil erosion and the higher dropping of yield in the non-project area is attributed to inadequate amount of fertilizer application to farmlands.

Table 5.5: Farmland seriously affected by soil erosion and impact on crop yield

	Project Area					Non-project Area				
Land type	Area in hectare	% of total area	Crops yield 1988 #	Crops yield 1998#	Yield change %	Area in hectare	% of total area	Crops yield 1988#	Crops yield 1998#	Yield change
Phantkhet	0.8	8.0	3,714*	3,448*	-7.0	2.8	10.0	3,314 *	2,387*	-28.0
Tarikhet	10.7	16.0	2,520*	1,990	-21.0	7.5	16.0	3,979*	1,989	-50.0
Bari	3.4	40.0	3,183	2,653*	-17.0	8.3	48.0	2,918	1,989*	-32.0
Gharbari	3.2	20.0	2,785*	2,387	-14.0	4.1	27.0	3,846*	2,520	-34.0

Source: Household survey, 1999

NB: # Composite crop yield in kg/hectare

* Significantly different at 0.05 confidence level (T Test, P ≤0.05)

Despite the efforts made by the Phewatal Management Project to improve the *bari* land, nearly two-fifths of them in the project area are seriously affected by soil erosion. The composite yield of maize, millet and wheat decreased by 17 percent during 1988-1998. Nearly half of the *bariland* in the non-project area are affected by high soil erosion, as they have outward facing terraces. In this type of situation, rainwater easily erodes the soil and reduces the crop yield. As a consequence, the composite crop yield dropped by 32 percent between 1988-1998, which is nearly double compared with the project area (Table 5.5).

Even one-fifth of *gharbari* in both areas are affected by soil erosion. Mostly the *gharbari* owned by large farmers are affected by soil erosion, as farmers could not install conservation structures permanently due to labor shortage. The crop yield in erosion affected *gharbari* had decreased by 14 percent in the project area and by 34 percent in the non-project area between 1988-1998. The decline of the crop yield at a higher rate in the non-project area is partly attributed to the outward facing terraces, which are prone to relatively higher rate of soil erosion. Being leveled, there was not much drop in crop yield in *gharbari* terraces in the project area.

5.1.6 Grazing Pressure on Farmlands

The traditional livestock raising system is gradually changing with change in natural resource stock utilization rights and reorientation of household labor force. Forests adjoining to the settlements, which were open for all in the past, are now under community control. At the same time, increased enrollment of children in schools and out-migration of young have forced farmers to reduce their livestock herd size. The average livestock herd size in the project area was about six heads in 1988, which had declined to four by 1998. In the non-project area, the herd size declined from about seven heads to about four heads during the same period. The reduction in livestock herd size particularly in the non-project area is due partly to declining system of *khark* or small patches of grazing lands amid forests and *goth* or the system of keeping livestock away from farmsteads for a short period. . Out of 250 *khark* in the non-project area, three fourths are not being utilized. About half of a total of 60 *kharka* in the project area remain unutilized.

Annually two fifths of farm households in the project area grazed one-fourth of their livestock for 73 days in private farmlands and 204 days in public lands (Table A. 46). Specifically, farmers in the western part of the watershed graze livestock in public land, while it was prohibited in the eastern part since the 1980s by the Phewatal Watershed Management Project, as those areas were considered critical for soil erosion. In the non-project area, about one-fifth of farm households grazed 17 percent of their livestock in private lands for 162 days and for 72 days in public lands. Besides, non-project farmers invite large sheep herders from Ghandruk area to graze their sheep in fallow land during the winter season to enhance soil fertility. Grazing pressure on public lands has gradually decreased due to grazing ban in selected areas and community control over these resources. As a result, the pressure on private lands has increased.

Livestock are most intensively grazed in farmlands from the last week of November to the end of December. Farmlands are opened for grazing immediately after crop harvest in November and remain fallow until next crop is sown. Large livestock herds grazing in the field inflict substantial destruction upon farm structures. However, in *bari* and *gharbari,* as they are cultivated up to three times a year in the project area, there is virtually no livestock grazing in these lands. Most of the *phantkhet* and *tarikhet* are left fallow during the winter and spring seasons and livestock intensively graze in these lands from November to June. In the non-project area, *gharbari* and selected parcels of *phantkhet* in the non-project area are cultivated up to three times a year, and livestock grazing is often confined to *bari* and *tarikhet.*

Livestock destroy terrace risers made from clay and loosen the surface soil by hoof trampling which makes it easier to remove the soil by water. Trampling also makes the soil compact, thereby reducing the infiltration rate increasing the surface run-off and soil erosion. Occasionally, the damaged terrace risers collapse during the rainy season.

Livestock grazing not only disturbs soil structures, it also removes organic materials required for improving soil structure and plant nutrient. Regularly grazing large herds of livestock constrains the growth of grass in terraces. As a result, the amount of organic matter supply to farmlands is considerably reduced. Besides, the nutrient loss by surface run-off is much higher in grazing land compared to land unaffected by grazing. Thus, erosion reduced water retaining capacity and loss of nutrient combinedly make terraces less productive and prone to further degradation.

5.1.7 Geology and Its Impact on Land Management

Natural factors are largely responsible for soil erosion and landslide in the hills, which affect large proportion of farmlands. Natural events including landslide, debris flow and soil erosion are traditionally considered to be the result of human induced activities (Carson, 1985, Chalise et al, 1993:41). The relative role of natural factors including geology, slope gradient, rainfall intensity, and nature of rocks is often overlooked. Erosion and landslide in the hills are a combined result of geological and climatic factors and to a laser extent to land use factor (Bruijnzeel and Bremer, 1989:104). Though, human induced accelerated soil erosion can not be ignored. The impact of geology in land management has to be examined to understand its role in land degradation.

Both watersheds are formed of weak bedrocks comprising slate with many structural faults. These rocks are moderately metamorphic and sedimentary types with major constituent

of phylite, quartzite, schist, genesis, granite, limestone and conglomerate. Soils are made from these parent materials.

There are seven structural faults in the eastern flank and one in the western flank of Phewatal. Four faults run parallel in the east-west direction, three in north-south direction and one in north-southwest direction (Fig. 5.1). There are two large structural faults in the non-project area. The largest fault originates in the valley bottom near Suikhet in the south and extends up to Toro village in the north. Another structural fault originates near Nayagaun in the west and terminates near Lwang village in the east. Besides, there are two main central thrust lines extended in the east-west direction (Fig. 5.1). Naturally farmlands near these faults and central thrust lines are more susceptible to landslide and soil erosion. The rainwater percolates down through the fault and increases pressure considerably on sub-surface soil and rocks and loosens them. The repeated occurrence of thunder during the rainy season creates vibration and triggers landslide. This explains why slope failures, landslides, slumps, and debris torrents are found mainly along fault lines and substantial amount of soil is lost annually due to such natural causes.

Farmland management is difficult in areas covered by the metamorphic rock, as phylite and schist have low infiltration rate and are prone to erosion by surface run-off. Extensive gully and large landslides are common characteristics in weathered phylite and schist covered areas. Farmers find it difficult to maintain terraces due to frequent occurrence of landslide. The fagfog quartzite is another constituent of the metamorphic rock. It is confined in the northwestern part of the project area (Figure 5.1). It is less susceptible to erosion and landslide compared to phylite and schist. However, the sheer strength varies by intensity of weathering. Wedge and planar failure are common on jointed quartzite. Permeability is high in jointed rocks and low in other areas. Farmland management is relatively easier in quartzite covered area. Besides, the slate mixed with phylite is another constituent of metamorphic rock. It is widespread in north-eastern part in the non-project area near main central thrust (Figure 5.1). Slate has low permeability and phylite has low resistance to run-off. As a result, landslide occurrence in hill slopes and deep gully formation in weathered slate have been common phenomena in areas with these rocks, which makes farmland management extremely difficult task.

Sedimentary rock is found in lower foothills, valley floors and along the rivers and streams in both areas. On the basis of its deposition and compaction, this type of rock can be classified into two categories: unconsolidated and unconsolidated. Unconsolidated sedimentary rock constitutes mainly sand, gravel, silt and sand formed by deformation of parent materials, including phylite, quartzite, schist and slate. It was formed by river and stream deposition during the last several centuries. Alluvial deposits with main constituent of sand and clay are found along rivers. Its thickness near surface varies from one meter to five meters. It has moderate load bearing capacity, high infiltration rate and prone to soil erosion and mass movement. Areas with this type rock are affected by flood during the rainy season. Farmlands comprising alluvial deposits are highly productive, but are frequently swept away by flood. Therefore, they need intensive protection check dams. Unconsolidated sedimentary rock with main constituents of gravel, silt and sand deposit is found in the foothills (Figure 5.1). Thickness varies from one location to another. It has moderate load bearing capacity, high infiltration rate and sensitive to disturbances. Extensive landslides are found in farmlands below Sarangkokt in the project area formed with this type of rock. Farmland management is difficult even in the foothills, where terrace risers are relatively high.

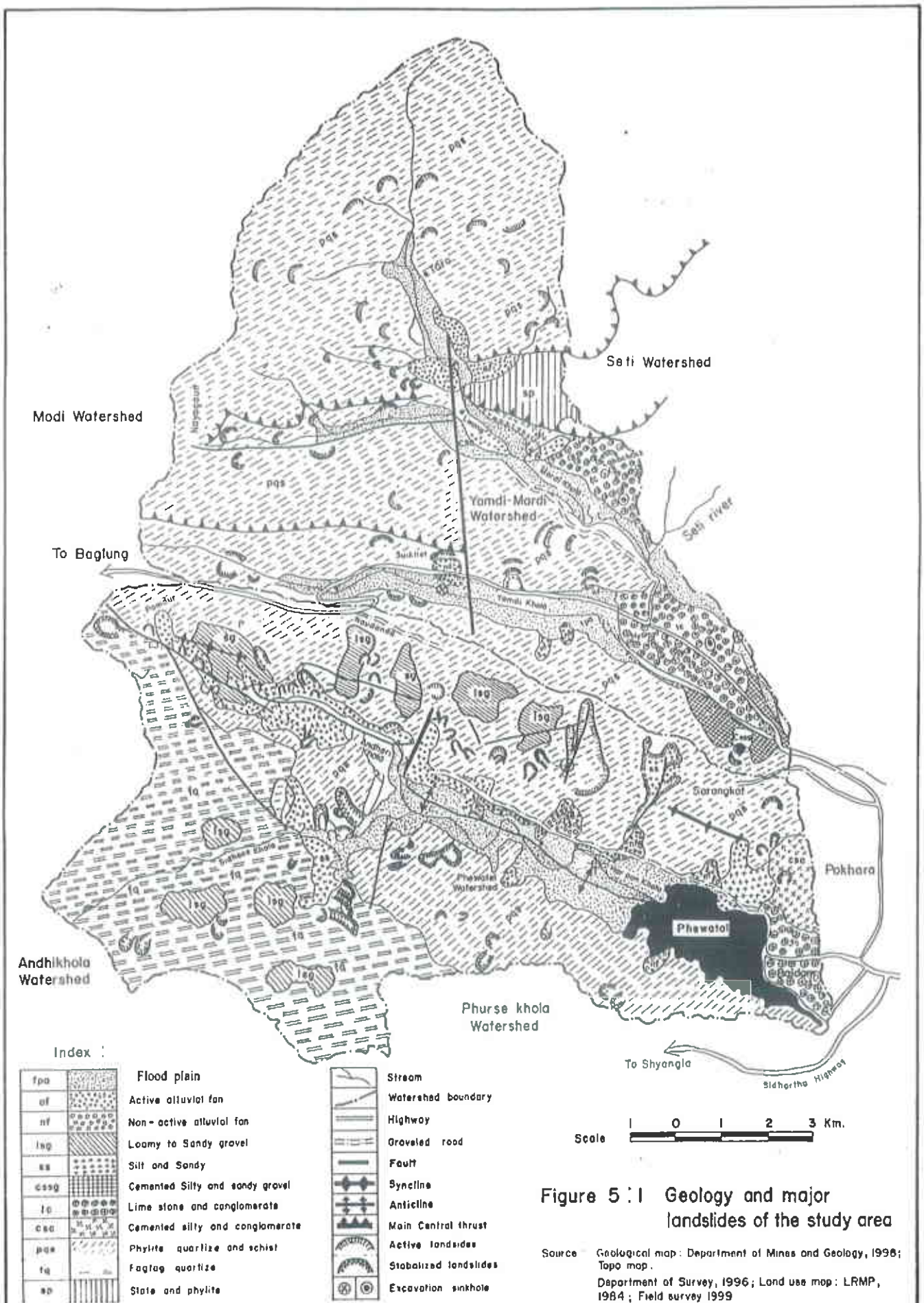


Figure 5 : 1 Geology and major landslides of the study area

Source Geological map : Department of Mines and Geology, 1998; Topo map. Department of Survey, 1996; Land use map : LRMP, 1984 ; Field survey 1999

The consolidated sedimentary rock, includes three types of land. The cemented silty and sandy gravel areas, with main constituent of limestone, schist, genesis and granite (Figure 5.1) are found in Baidam at the southern fringe of the project area and near the confluence of Yamdi and Seti river in the non-project area. Soil thickness varies from one place to other and normally ranges from 2-80 meters. Krast landforms are common near surface and they are prone to subsidence and underground krastification. Farmlands comprising these rocks need high amount of fertilizer to enhance land productivity. Limestone and conglomerate areas are found in the southern parts of both watersheds (Figure 5.1). The thickness is up to 100 meters in the central part and 1-3 meters in some areas where weathering is relatively high. Krastification is widespread in the form of sinkholes and caverns. They are prone to slope instability and bank collapse along steep slopes. Soil acidification is the major problem for crop cultivation. Limestone fragments are found in the southeastern hill slopes of the project area and along Mardi khola of the non-project area. The rock thickness is up to 200 meters and weathering has lost surface soil up to 10 meters deep. Areas with such rock have moderate load bearing capacity, high infiltration rate and prone to sinkhole development.

5.2 Soil Fertility

The overwhelming majority of farmers in both areas indicated declining soil fertility as their most severe problem. This problem has been more severe in the non-project area due to declining supply of farmyard manure.

5.2.1 Farmers' Experience in Soil Fertility by Type of Soil

More than one-fourth of farmlands in the project area and nearly two fifths in the non-project area are confronting with declining fertility problem. Farmlands with *pango mato* (*molasoils*) and *balaute mato* (*fluvents* soils) account for a small proportion of the total landholdings in the project area. The major proportion of these lands are experiencing declining fertility due to rapid oxidation of organic mater in the surface soils in the project area. However, in the non-project area relatively small proportion of lands with these soils are facing such problem (Table 5.6). The fertility decline of *rato mato* (*rhodustalfs* soils) was due to accelerated soil erosion and nutrient removal by runoff, leaching and nutrient uptake by crops. Even the *mashino kalo mato* (*umbrepts* soils) have a tendency towards declining soil fertility due to these factors. The proportion area with declining soil fertility in *rato mato*, *balaute mato*, and *pango mato* is significantly high in project area. While the proportion area with declining soil fertility in *mashino kalo mato* is significantly high in the non-project area due to declining supply of FYM (Table 5.6).

Table 5.6: Declining soil fertility by soil type

Local name	Soil taxonomy	Project Area		Non-project Area	
		Surveyed area with declining fertility (In hectare)	% of soil type	Surveyed area with declining fertility (In hectare)	% of soil type
Rato mato:	*Rhodustalfs* soils	9.8	39.0*	2.0	24.0*
Balaute mato:	*Fluvents* soils	0.6	85.0*	1.4	16.0*
Khairo/kamere mato:	*Dystrochrepts* soils	2.8	13.0	3.6	13.0
Mashino kalo mato:	*Umbrepts* soils	10.7	26.0*	26.0	38.0*
Pango mato:	*Molasoils*	4.1	66.0*	6.6	38.0*
Total		28.0	28.0*	39.6	37.0*

Source: Household survey, 1999

NB: * Significantly different at 0.05 confidence level (T Test, $P \leq 0.05$)

5.2.2 Farmers' Experience in Soil Fertility by Land Type

By type of land, the fertility decline trend is most severe in *tarikhet* in both areas (Table 5.7). Though other types of land are also undergoing fertility decline, but the severity of the problem in terms of area coverage is low. As farmers accord least priority to *tarikhet* for the application of fertilizers (see Chapter VIII), these types of lands are facing fertility decline extensively. The declining fertility as mentioned above is aggravated by dwindling supply of fertilizers.

Table 5.7: Causes of declining soil fertility

Cause	Project Area				Non-project Area			
	Phantkhet	*Tarikhet*	*Bari*	*Gharbari*	*Phantkhet*	*Tarikhet*	*Bari*	*Gharbari*
Farmlands with declining soil fertility (in hectare)	1.4	24.1	1.5	1.3	2.5	27.2	6.1	3.8
% of total farmland	13.0*	36.0*	18.0*	8.0*	9.0*	57.0*	35.0*	25.0*
Causes								
Crusting/water shortage	6.0*	11.0	0.0	0.0	0.0*	12.0	0.0	0.0
Landslide/siltation	2.0*	11.0	9.0	4.0*	5.0*	10.0	12.0	7.0*
Reduced fertilizers	5.0	14.0*	0.0*	0.0*	4.0	34.0*	23.0*	14.0*
Shortened fallow period	0.0	0.0	9.0*	4.0	0.0	1.0	0.0*	4.0

Source: Household survey, 1999

NB: * Significantly different at 0.05 confidence level (T Test, $P \leq 0.05$)

According to farmers, about six percent of *phantkhet* and 11 percent *tarikhet* are facing declining fertility due to soil crusting and water shortage, five percent *phantkhet* and 14 percent *tarikhet* due to decreasing fertilizers supply, and nine percent *bari* and four percent *gharbari* as a result of shortened fallow period in the project area. Similarly, landslide has affected all types of land. (Table 5.7). In the non-project area, 12 percent *tarikhets* are facing declining fertility as a consequence of soil crusting and water shortage. Landslide and decreasing fertilizer supply have affected all types of land, while shortened fallow period has affected *tarikhet* and *gharbari* (Table 5.7). The proportion of land with declining soil fertility is significantly high in all types of land in the non-project area (Table 5.7).

5.2.3 Plant Nutrient Status in Farmlands

The preceeding sections indicated that farmers in both project and non-project areas are experiencing problem of soil fertility decline. But the nutrient status could not be examined from these estimates. To fill this gap, nutrient balance is examined by type of land. Different types of fertilizers, including farmyard manure, compost, green manure and chemical fertilizers, applied by farmers to their farmlands were converted into nitrogen (N), phosphorous (P_2O_5) and potassium (K_2O), shortly known as (NPK), to examine the aggregate amount of nutrients applied to farmlands. Similarly, the NPK extracted by crops was estimated based on their yields. Then, the nutrient status was analyzed by deducting the uptake from input.

There is great variation in nutrient balance between different types of land. In the project area, there is net negative balance of nitrogen (N) in all types of land except *gharbari.* Potassium (K) is negatively balanced in *phantkhet* and *tarikhet* and positive balanced in *bari* and *gharbari.* While the amount of phosphorus (P) removed by crops is replenished in all types of land (Table 5.8). In the non-project area, similar situation is found in regard to nitrogen (N) and potassium (K) balance. However, there is net positive supply of phosphorus

(P) in all types of land, but *tarikhet* has small amount of negative balance (Table 5.8). There is significant difference in nutrient balance (P ≤0.05) between two areas. Nutrient mining is significantly high in *phantkhet* and *tarikhet* of the non-project area compared to the project area. Similarly, NPK balance in *gharbari* and prosperous (P) balance in *bari* are significantly high (P ≤0.05) in project area compared to the non-project area (Table 5.8).

Table 5.8:Nutrient balance by crop

Land type		Project Area			Non-project Area		
	Input output	N kg/hectare	P kg/hectare	K kg/hectare	N kg/hectare	P kg/hectare	K kg/hectare
Phantkhet	Input	57*	13	40*	35*	17	14*
	Uptake	91	13	100	88	13	95
	Balance	-34*	0.0*	-60*	-53*	4.0*	-81*
Tarikhet	Input	40*	11	28	31*	9.0	23
	Uptake	56	8.0	44*	65	10	71*
	Balance	-16*	3.0*	-16*	-34*	-1.0*	-48*
Bari	Input	124*	33*	121*	67*	14*	66*
	Uptake	145*	21*	84	90*	12*	34*
	Balance	-21	12*	37	-23	2.0*	32
Gharbari	Input	198*	47*	178*	114*	23*	110*
	Uptake	96	14	54*	104	13	30*
	Balance	102*	33*	124*	10*	10*	80*

Source: Household survey, 1999

NB: This analysis is based on Table 5.10 (for crop yields), Table 7.4 (for amount of fertilizers applied in farmland) , Table A. 10 (for conversion factors), and Table A. 40 (for area under different crops)

* Significantly different at 0.05 confidence level (T Test, P≤0.05)

5.3 Change in Crop and Grass Yields

Crop and grass yields can also be considered as indicators of the status of farmland. Therefore, the following sections analyze these yields based on information obtained from the household survey.

5.3.1 Change in Crop Yield

Overall yields of maize, millet and wheat are found significantly (P≤0.05) higher in the project area compared with the non-project area due to terrace improvement combined with the adoption of HYV crops and application of chemical fertilizers subsidized by the Phewatal Watershed Management Project (Table 5.9). *Bari* and *gharbari* were targeted by the project, which contributed to increased yield of these crops. Contrarily, rice yield is found significantly higher (P≤0.05) in the non-project area compared to the project area due to completion of several small-scale irrigation projects in the valley floor.

Table 5.9: Change in crop yield

(Crop yield kg/hectare)

Crop	Project Area				Non-project Area			
	Yield (1975)	Yield (1998)	Yield change	Percent change	Yield (1975)	Yield (1998)	Yield Change	Percent change
Rice	2,760	2,386*	-374*	-14.0	2,815	2,820*	5.0*	0.2
Maize	1,225	1,442*	217*	18.0	1,015	998*	-17*	-2.0
Wheat	1,195	1,367*	172*	14.0	1,158	1,016*	-142*	-12.0
Millet	1,210*	1,656*	446*	37.0	1,713*	1,138*	-575*	-34.0

Source: Household survey, 1999

NB: * Significantly different at 0.05 confidence level (T Test, P≤0.05)

In the project area, millet, maize and wheat yield had increased over last 23 years. Contrarily, the rice yield dropped by 14 percent. Regarding the non-project area, millet, wheat and maize yield had decreased, as farmers could not get any external assistance, while there was no change in the rice yield due to the completion of several small-scale irrigation projects in *phantkhet* (Table 5.9).

Table 5.10: Change in crop yield

(Crop yield kg/hectare)

Land Type	Crops	Project Area (N=155)				Non-project Area (N=145)			
		Yield (1975)	Yield (1998)	Yield change	Percent change (23 years)	Yield (1975)	Yield (1998)	Yield change	Percent change (23 years)
Phantkhet	Paddy	3,792*	3,655*	-137*	-4.0	2,948*	3,340*	392*	13.0
	Wheat	1,041*	1,277*	236*	23.0	472*	550*	78*	14.0
	Maize	589	5,30*	-59*	-10.0	845*	845*	0.0*	0.0
Tarikhet	Paddy	2,594	2,181	-413*	-16.0	2,731	2,512	-219*	-8.0
	Wheat	1,100	1,454	354*	32.0	1,022	943	-79*	-8.0
	Maize	1,120	1,061	-59*	-5.0	1,199	825	-374*	-31.0
Bari	Wheat	1,376	1,847*	471*	34.0	1,493	1,041*	-452*	-30.0
	Maize	1,356*	1,709*	353*	26.0	982*	1,120*	138*	14.0
	Millet	1,415*	1,945*	530*	37.0	1,847*	1,375*	-472*	-25.0
Gharbari	Wheat	1,120	1,041	-79*	-7.0	1,493	1,336	-157*	-10.0
	Maize	1,238	1,454	216	17.0	982	1,376	394	40.0
	Millet	1,120*	1,513*	393*	35.0	1,552*	865*	-687*	-44.0

Source: Household survey, 1999

NB: * Significantly different at 0.05 confidence level (T Test, $P \leq 0.05$)

There is great variation in crop yield by type of land. Crop yields except maize are found significantly higher ($P \leq 0.05$) in the project *phantkhet* compared with the non-project *phantkhet*. Despite good quality of soil, rice and maize yield in the project *phantkhet* dropped by four and 10 percent respectively over last 23 years, as those lands have been increasingly owned by land speculators who are not interested in crop cultivation. Rice and wheat yields in the non-project *phantkhet* had increased by 13 and 14 percent respectively over a period of 23 years due to the completion of several small-scale irrigation projects, while there was no any change in maize yield (Table 5.10).

Decreasing soil fertility in *tarikhet* has adversely influenced crop yield. Rice and maize yields had dropped by 16 and five percent respectively in the project area and by eight and 31 percent, respectively in the non-project area over a period of 23 years (Table 5.10). As a result farmers have been vulnerable to food shortage.

All crop yields are found significantly higher in the project *bari* ($P \leq 0.05$) compared with the non-project *bari* due to the application of higher amounts of farm inputs and terrace improvement (Table 5.10). Such appreciable change however, could not increase food supply considerably as *bari* accounted for only eight percent of the total farmlands. In the non-project *bari* wheat yield had dropped by 30 percent and millet yield by 25 percent between 1975 and 1998 (Table 5.10)

Millet yield is found significantly higher ($P \leq 0.05$) in the project *gharbari* than in the non-project *gharbari* (Table 5.10). It is attributed to the application of relatively high amount of farm inputs and improved land management practices. Non-project *gharbari* experienced a declining trend, as wheat yield had dropped by 10 percent and millet yield by 44 percent during 1975-1998 (Table 5.10).

Diminishing crop yield in *phantkhet* and *tarikhet* in the project area and *bari*, *gharbari* and *tarikhet* in the non-project area is attributed mainly to declining soil fertility. Climatic factors, including temperature and rainfall also influenced the crop yield. However, there was no significant variation in rainfall and temperature in 1975 and 1998. The annual average temperature in the valley floor was 22.5^{0}c in 1975 and 21.4^{0}c in 1998. While, the annual average rainfall was 4,667 mm in 1975 and 4,880 in 1998. More than 85 percent of rainfall occurred between May –September in both years.

5.3.2 Grass Yield in Terrace Risers

According to farmers, the declining soil fertility has negatively influenced even the grass yield, which varies depending on land type and quality (Table 5. 11). Grass production in project *phantkhet* and *tarikhet* has gone down but farmers experiment positive change in *bari* and *gharbari*, as they applied relatively high amount of fertilizers to these lands. Besides, the increased grass yield in *bari* and *gharbari* is attributed mainly to the introduction of improved varieties of grasses in terrace risers. In the non-project area, grass yield declined in all lands during 1988-1998 resulting dwindling supply of farmyard manure. As explained by farmers, declining supply of farmyard manure has affected grass production (Table 5. 11).

However, the grass yield in all types of lands is significantly high in the project area ($P \leq 0.05$) compared to the non-project area. This is attributed to the regular convectional rainfall around Phewatal during the pre-monsoon and monsoon seasons and plantation of improved varieties of grasses promoted by the project.

Table 5.11: Ground grass production

(Grass yield kg/hectare in fresh weight)

Land type	Project Area				Non-project Area			
	Yield (1988)	Yield (1998)	Yield Change	Percent change	Yield (1988)	Yield (1998)	Yield Change	Percent change
Phantkhet	3,500*	3,000*	-500*	-14.0	1,642*	1,542*	-100*	-6.0
Tarikhet	2,980*	2,329*	-651*	-22.0	2,287*	2,082*	-205*	-9.0
Bari	4,849*	5,510*	661*	14.0	2,814*	2,676*	-138*	-5.0
Gharbari	3,890*	4,346*	456*	12.0	3,078*	2,902*	-176*	-6.0

Source: Household survey, 1999

NB: *Significantly different at 0.05 confidence level (T Test, $P \leq 0.05$)

5.2.3 Barren Farmland

In both watersheds, declining soil fertility, landslide and soil erosion severely affected to some farmlands located in steep hill slopes and close to gullies. As a result, despite land scarcity, about one tenth of farm households in the project area and one fifth in the non-project area have left some of their lands parcels permanently barren, which constitute about five percent of the total farmlands in both areas (Table A. 48). Terraces in abandoned lands have thereby aggravating soil erosion and land degradation. Group discussion held with farmers revealed that large proportion of farmlands in the non-project area are vulnerable to severe degradation.

CHAPTER VI

FARMERS' AWARENESS OF AND ATTITUDE TOWRDS IMPROVED LAND MANAGEMENT PRACTICES

Preceeding chapter has revealed farmlands undergoing degradation due to several natural and socio-economic factors. Under such condition, promoting locationally suitable and socially acceptable land management technologies entails evaluation of farmers' awareness, attitude and experience. Many watershed management projects in the past had failed to achieve their objectives, as farmers did not accept technologies being designed and promoted without any consultation with them. Therefore, farmers were asked unstructured open questions about their awareness of and attitude towards improved land management practices. They were also asked about their experiences in tree-crop mixed farming, tree and shrub growing in marginal land, crop rotation, legume cultivation, domestication of green manure species, compost making, mulching and reduced tillage. Farmers' responses to these queries are expected to help to devise locationally suitable and socially acceptable land management programs.

6.1 Tree-crop Mixed Farming

Biophysical condition in the Hills is most suitable for forestry, horticulture, agroforestry and livestock raising. However, the government policies were directed towards horticulture promotion since the 1960s. Still in most areas, farmers did not follow the government policies and recommendations, which could not reflect their needs and aspirations. It is widely accepted that technologies which are diverse and responsive to location specific needs of farmers and communities have greater chance of being adopted than narrow focused and researchers' perception based technologies (Hildebrand and Russell, 1996: 178). The study area is occasionally affected by hail stone during the pre monsoon season, which prevents fruit farming as a monoculture. However, there is prospect for promoting tree-crop mixed farming characterized by growing fodder trees in association with vegetables and cereals.

Farmers in both areas know well about direct and indirect advantages of mixed cropping that would yield high benefits. Though the awareness of different types of advantages significantly varies in both areas (Table 6.1). They know that this practice helps to conserve soil moisture during the winter and spring seasons, when there is little rainfall. Farmers can grow vegetables and other crops under trees during the dry season. Some high value crops like cardamom grown well under tree shades. About two fifths of farmers in the project area and more than half in the non-project area mentioned that the mixed farming helps to reduce soil erosion and landslide (Table 6.1). About one fifth of farmers in both areas know that the mixed farming helps to improve soil fertility, legume trees fix nitrogen in the soil and fallen leaves decomposed and enhanced soil fertility.

Farmers also mentioned about negative impacts of mixed cropping, which constraints wider adoption of this type of cropping system. The awareness of different types of negative impacts varies significantly in both areas (Table 6.1). About two fifths of farmers in both areas felt that due to shade effect yields of cereal crops cultivated under trees are adversely affected (Table 6.1). To cope with this effect, farmers in the project area were replacing tall trees with dwarf, high fodder yielding and deep-rooted tree species since the 1980s. In the non-project area, most tree species were still tall and farmers feared that the crop yield would go down, if they plant more trees in farm terraces.

Table 6.1: Farmers' awareness of advantages and disadvantages of tree crops

Farmers' awareness	Project Area (N=155)		Non-project Area (N=145)	
	Frequency of respondents	Percent	Frequency of respondents	Percent
Advantage				
Moisture conservation	7	4.0	16	11.0
Enhanced crop diversity	55	36.0	22	15.0
Reduced soil erosion and landslide	57	37.0	81	56.0
Improved soil fertility	36	23.0	26	18.0
Total	155	100.0	145	100.0
X^2 value	41.6		75.1	
Significantly different 0.01 confidence level	(X^2 test, P≤0.01)		(X^2 test, P≤0.01)	
Disadvantage				
Shade effect on cereal crops	58	38.0	58	40.0
Difficulty in ploughing land	13	8.0	18	12.0
Increased weeds	17	11.0	19	13.0
Increased demand for labor and production cost	67	43.0	50	35.0
Total	155	100.0	145	100.0
X^2 value	59.5		35.7	
Significantly different 0.01 confidence level	(X^2 test, P≤0.01)		(X^2 test, P≤0.01)	

Source: Household survey, 1999

Mixed cropping promotes weeds, which adversely influence crop yield, as weeds compete with crops for nutrient, water, space and light. Ploughing controls weeds by destroying them or by physically altering their relationship with soil. It also makes soil soft and facilitates smooth water and air circulation into the soil, which is essential for healthy crop growth. But the plantation of trees in terraces makes it difficult ploughing land. The wooden plough driven by bullock is often blocked by roots, eventually increasing land preparation time and labor required for land. Traditionally, farmers have been controlling weeds by burning residues during the dry season. If trees are planted in terraces, it constrains weed residue burning. As a result of these limitations, farmers could not grow trees in association with field crops.

6. 2 Crop Rotation

Farmers have been practicing crop rotation traditionally according to temperature condition and availability of water. Following the prevailing rotation system, every year same crop is cultivated in the same plot of land. *Phantkhet*, with irrigation facility throughout the year, are cultivated with rice during the summer and spring seasons and wheat in the winter season, though the area under wheat and spring rice is relatively small. *Tarikhet* have no irrigation facility and are used for rice cultivation during the rainy summer monsoon season using rainwater, wheat in the winter season and maize and potato in the spring season. In *bari* and *gharbari*, maize and millet are inter-cropped in the rainy season, and wheat, lentil and mustard in the winter season. Such efficient use of land resources helps to increase crop production for enhanced food security.

Farmers know well about the advantages of crop rotation and the awareness of different types of advantages significantly varies in both areas (Table 6.2). Crop rotation helps to maintain and improve soil fertility. Nutrient uptake rate varies considerably from one crop to other. Maize and millet need higher amounts of nutrient than rice and wheat to produce same amount of crop per unit of land (Tandon and Kimmo, 1993). Legume crops fix nutrients in the soil, while cereal crops remove them. Soils are exhausted due to regular cultivation of a crop; crop rotation helps to balance their fertility.

About three fifths of farmers in the project area and two fifths in the non-project area are aware of the role of crop rotation in fertility management. They mentioned that the crop rotation helps to improve soil fertility and crop yield. In both areas, 10 percent of farmers had managed to secure higher crop yield through crop rotation. Crop residues are the major source of livestock feed especially during the winter season, when fodder scarcity is reportedly severe. About one fourth of farmers in the project area and one third in the non-project area had secured higher amounts of crop residue through crop rotation (Table 6.2).

Table 6.2: Farmers' awareness of advantages and disadvantages of crop rotation

Farmers' awareness	Project Area (N=155)		Non-project Area (N=145)	
	Frequency of respondents	Percent	Frequency of respondents	Percent
Advantages				
Increased feed production to livestock	37	24.0	50	35.0
Increased crop diversity	9	6.0	22	15.0
Increased crop yield	12	8.0	15	10.0
Improved soil fertility	97	62.0	58	40.0
Total	155	100.0	145	100.0
X^2 value Significantly different 0.01 confidence level	128.9 (X^2 test, $P \leq 0.01$)		36.3 (X^2 test, $P \leq 0.01$)	
Disadvantages				
Cannot practice intensively due to land fragmentation	25	17.0	32	27.0
Increased demand for labor and production cost	72	49.0	54	45.0
Disturbs the tradition based cereal crop production	49	34.0	33	28.0
Total	146	100.0	119	100.0
X^2 value Significantly different 0.05 confidence level	22.6 (X^2 test, $P \leq 0.05$)		7.8 (X^2 test, $P \leq 0.05$)	

Source: Household survey, 1999

Despite their awareness of its advantages, farmers experienced several problems in practicing to alternative crop rotation. The awareness of different types of disadvantages significantly varies in both areas (Table 6.2). A typical hill farmer produces a mix of crops according to his/her household needs, resources available at his/her disposal, evolved traditions and the opportunities available. Poor farm households derive high proportion of household income from field crops and livestock. Even those small farmers engaged in cash crop cultivation earn barely enough to fulfill basic subsistence requirements, including food. Being concerned about the household food requirement and not being quite sure about the benefit from the alternative crops, farmers hesitate to cultivate other crops that they have not experience so far.

As discussed earlier, landholdings in the study area are fragmented into several parcels, which has been a serious constraint for intensification of the rotational cropping system. Due to fragmentation, land parcels in a small area are owned by several farmers living in different villages with different needs and priorities. Since the different crops have different cultivation and harvesting schedule, stray livestock and wild animals would badly destroy the late ripening crops, if they are cultivated by a few farmers. In this type of situation, it is not possible to impose a community sanction on livestock grazing in the field. As a consequence, about one fifth of farmers in the project area and one fourth in the non-project area could not cultivate alternative crops, despite their willingness (Table 6.2).

The rotational cropping system demands high labor input and increased the cost of production (Table 6.2). Some crops like peanuts, potato and vegetables require high labor

input during sowing, weeding and harvesting times. Thus, for farm households with labor shortage, it is difficult to adopt rotational cropping system. A few farmers in the non-project area have, however, practiced crop rotation mainly rice in the first year and peanut in the second year. According to farmers, the yield of rice is 20 percent higher under this system as compared to the traditional system. An extensive scale of adoption of alternative crop rotation system is not feasible as long as farmers depend on their landholdings to fulfill their household food requirement.

Notably about six percent of farmers in the project area and nearly one fifth in the non-project area are willing to adopt such practice which could not be pursued due to their neighbors' reluctance.

6. 3 Legume Cultivation

Legume cultivation has multiple advantages. Farmers know well about its advantages though the awareness of different types advantages significantly varies in both areas (Table 6.3). It helps to enhance soil fertility, crop yield, feed production for livestock and household income. Fibrous green pods are consumed as vegetable, seeds as *dal* (curry) *and* residues as forage for livestock. Decomposed roots are incorporated into the soil. Most farmers in the non-project area and three fourths in the project area are aware of multiple role of legumes (Table 6.3). About one tenth of farmers in both areas know legumes as a source of protein, and three fifths consider them as a source of soil nutrient. One fifth of farmers in the project area and six percent in the non-project area consider legumes as a source of palatable forage for livestock.

Table 6.3: Farmers' awareness of advantages and disadvantages of legume cultivation

Farmers' awareness	Project Area (N=155)		Non-project Area (N=145)	
	Frequency of respondents	Percent	Frequency of respondents	Percent
Advantages				
Source of portion	11	8.0	15	11.0
Increased feed for livestock	30	21.0	8	6.0
Enhanced soil fertility	99	71.0	82	83.0
Total	140	100.0	105	100.0
X^2 value	91.9 (X^2 test, P≤0.01)		95.4 (X^2 test, P≤0.01)	
Significantly different 0.01 confidence level				
Disadvantages				
Don't know about their soil fertility improving capability	50	32.0	37	26.0
Increased pest infestation in other crops	46	30.0	48	33.0
Requires high labor input and production cost	31	20.0	49	34.0
Not profitable	28	18.0	11	7.0
Total	155	100.0	145	100.0
X^2 value	9.15 (X^2 test, P≤0.05)		25.9 (X^2 test, P≤0.05)	
Significantly different 0.05 confidence level				

Source: Household survey, 1999

Farmers also have some negative experiences in regard to legume cultivation. Their awareness of different types of disadvantages significantly varies in both areas (Table 6.3). About one third of them in both areas feel that cultivation of legumes lead to increased pest infestation in cereal crops especially when they are mixed cropped. Similarly, one fifth of farmers in the project area and one third in the non-project area mentioned that particularly the harvesting of the legume crops like bean and rice-bean is highly labor intensive. Likewise, about one third of farmers in the project area and seven percent in the non-project

area, who had off-farm income, said that small-scale legume cultivation is not economically attractive. Interestingly, one third of farmers in the project area and one fourth in the non-project area did not know about soil fertility improving capability of legumes.

There is a wide gap between farmers' knowledge and practice in regard to legume cultivation. Despite their awareness of advantages, legume cultivation is limited to only 34 percent of farmers in the project area and 38 percent in the non-project area. However, 42 percent of farmers in the project area 30 percent in the non-project area are interested in cultivation, provided they are demonstrated the effect of legumes cultivation on soil fertility improvement. About one fourth of the farmers in the project area 30 percent in the non-project area are not interested to legume cultivation due to small land holdings and labor shortage.

6.4 Trees and Shrub Growing in Marginal Lands

The practice of tree and shrub growing in gullies, terrace risers, farm edges and marginal sloping lands is growing considerably since the 1980s in the project area and 1990s in the non-project area, as farmers are confronting with the shortage of fodder and fuel wood. Farmers' awareness of different types of advantages significantly varies in the project area, where as there is no significant variation in the non-project area (Table 6.4). About one fifth of the farmers in both areas mentioned that trees and shrubs planted in farm edges are working as windbreaker, protecting particularly maize crops from the pre monsoon storm (Table 6.4). Similarly, one fifth of the farmers experienced reduced soil erosion and landslide due to trees and shrubs. Nearly half of the farmers in the project area and one third in the non-project area considered trees and shrubs growing in marginal land as an efficient use of scare land resources, which helps to fulfill household needs of food, fodder and fuel wood. A small percentage of farmers in both areas had experienced improved soil fertility and crop yield contributed by organic materials available from trees and shrubs.

Table 6.4: Farmers' awareness of advantages and disadvantages of trees and shrubs growing

Farmers' awareness	Project Area (N=155)		Non-project Area (N=145)	
	Frequency of respondents	Percent	Frequency of respondents	Percent
Advantages				
Wind breaker	36	23.0	40	28.0
Reduced soil erosion and landslides	31	20.0	24	17.0
Improved soil fertility and crop yields	19	12.0	39	26.0
Efficient use of marginal land	69	45.0	42	29.0
Total	155	100.0	145	100.0
X^2 value Significantly different 0.01 confidence level	35.4 (X^2 test, $P \leq 0.01$)		5.6 Not significantly different at 0.05 confidence level (X^2 test, $P > 0.05$)	
Disadvantages				
Reduced grass production	23	15.0	18	12.0
Difficult to meet food requirement	18	12.0	25	17.0
Demand for high labor input	38	24.0	6	4.0
Attracted wild animals	76	49.0	96	67.0
Total	155	100.0	145	100.0
X^2 value Significantly different 0.01 confidence level	53.3 (X^2 test, $P \leq 0.01$)		136.4 (X^2 test, $P \leq 0.01$)	

Source: Household survey, 1999

Farmers also experienced some negative effects of trees and shrubs grown in marginal lands. Their awareness of different types of negative effects significantly varies in both areas

(Table 6.4). The yield of grass under trees and shrubs had gone down in both areas due to shade effect. Particularly very poor farmers, who have utilized the marginal lands for cereal crops, could not use these lands for trees and shrubs growing as it leads to reduced food supply, though small in amount. The conversion of marginal land into forest is tantamount to creating habitats for wild lives, in general and monkey, in particular, which are destroying rice and maize crops located close to their habitats. Around half of the farmers in the project area and two thirds in the non-project area reported that the wild animals had inflicted heavy damage upon their field crops (Table 6.4). This particular problem is severe in the non-project area, as ACAP has imposed ban on killing any kind of wild animals.

The advantages of trees and shrubs growing in marginal land out weights its disadvantages. About 88 percent of farmers in the project area and 83 percent in the non-project area expressed their strong desire to expand this practice in the future. Farmers preferred trees and shrubs characterized by rapid growth and regeneration after lopping, high volume of foliage, short height, and useful for multiple uses.

6. 5 Domestication of Wild Green Manure Species

Traditionally, several species of wild leafy plants, including *Adhatoda vasica* (ashuro), *Artemisiia vulgaris* (titepati), *Trichilia connoroides* (ankhetari), *Strium insigne* (khirro) and *Albizia spp* (dhurseli) are being used by farmers as fertilizers or green manure. These species have been vulnerable to extinction due to regular harvesting by ever increasing number of farmers who have not paid much attention to proper conservation and domestication of these plants. There is good prospect for maintaining or even improving land productivity through domestication of green manure species especially in a situation where farmyard manure supply is steadily dwindling and farmers are finding difficult to afford buying chemical fertilizers.

Table 6. 5: Farmers' awareness of advantages and disadvantages of green manure species

Farmers' awareness	Project Area (N=155)		Non-project Area (N=145)	
	Frequency of respondents	Percent	Frequency of respondents	Percent
Advantages				
Increased FYM/compost production	13	10.0	12	11.0
Reduced soil erosion	12	9.0	8	7.0
Increased soil fertility	104	81.0	90	83.0
X^2 value	129.8		116.8	
Significantly different 0.01 confidence level	(X^2 test, P≤0.01)		(X^2 test, P≤0.01)	
Total	129	100.0	110	100.0
Disadvantages				
Shade effect on crops	99	86.0	101	83.0
Low survival rate	12	10.0	15	12.0
Risk to health during harvest	5	4.0	6	5.0
Total	116	100.0	122	100.0
X^2 value	141.8		135.3	
Significantly different 0.01 confidence level	(X^2 test, P≤0.01)		(X^2 test, P≤0.01)	

Source: Household survey, 1999

Majority of farmers in both areas are aware of advantages of green manure species found in farmlands and in wild, though the awareness of different types of advantages significantly varies in both areas (Table 6.5). They understand well about their value and, therefore, are applying them to rice and millet seedbeds and to the puddled rice field. They also use green manure as livestock bedding, which is later converted into farmyard manure.

As long as they are available, farmers use green manure. Some of the farmers knew that green manure species help to control soil erosion.

Despite being aware of their advantages, farmers hesitate to grow green manure species in farmlands. They also know about the negative aspect of these species and their awareness of different types of disadvantages significantly varies in both areas (Table 6.5). The majority of farmers in both areas fear that due to their shade effect green manure species would adversely affect crop and grass yields in farmland (Table 6.5). For some farmers, domestication of these species, is not an easy task, as they are not aware of required propagation methods. Moreover, latex of some species, like *Strium insigne*, is dangerous for eyes.

Nearly three fourths of farmers in both areas are interested in plantation of green manure species. Due to their small landholdings, they want to utilize community lands, including forest and grazing lands, located relatively close to villages for this purpose. In this regard, they emphasized on the need for village based nurseries producing and distributing saplings, as many of them lack know how required for producing and growing saplings.

6.6 Compost Making

Compost is better than the farmyard manure interms of plant nutrient contents. Farmers are making compost in both project and non-project areas to offset the fertilizer deficiency caused by dwindling FYM supply. They know well about compost and their awareness of different types of advantages significantly varies in both areas (Table 6.6). About four fifths of farmers in project area and three fourths in the non-project area know that compost enhances soil fertility (Table 6.6). Moreover for a small percentage of farmers, composting helps to reduce livestock pressure on natural resources, as they do not need to keep large livestock herd size for FYM. Unlike FYM, which demands a lot of labor for its transportation from livestock shed to the field, composting is not much labor demanding, as farmers can make it in the farmland. This alleviates pressure on household labor force. A small percentage of farmers in both areas mentioned that compost making it is a good way of converting domestic and farm waste materials into useful fertilizer.

Table 6.6: Farmers' awareness of advantages and disadvantages of compost

Farmers' awareness	Project Area (N=155)		Non-project Area (N=145)	
	Frequency of respondents	Percent	Frequency of respondents	Percent
Advantages				
Conversion of waste materials into fertilizer	5	3.0	8	6.0
Reduced livestock pressure	14	9.0	25	17.0
Increased soil fertility	122	79.0	106	73.0
Reduced cost of crop production	14	9.0	6	4.0
Total	155	100.0	145	100.0
X^2 value Significantly different 0.01 confidence level	289.5 (X^2 test, $P \leq 0.01$)		184.9 (X^2 test, $P \leq 0.01$)	
Disadvantages				
Requires high amount of labor input for preparation	51	33.0	47	32.0
Shortage of composting materials	15	10.0	17	12.0
Takes long time for preparation	84	54.0	73	50.0
FYM is sufficient for small land holdings	5	3.0	8	6.0
Total	155	100.0	145	100.0
X^2 value Significantly different 0.01 confidence level	100.7 (X^2 test, $P \leq 0.01$)		72.7 (X^2 test, $P \leq 0.01$)	

Source: Household survey, 1999

Despite being aware of its benefits, farmers are facing difficulties in compost making. They also know about disadvantages of this practice and their awareness of different types of disadvantages significantly varies in both areas (Table 6.6). About one third of them in both areas reported that it requires high labor input for domestic and farmyard waste materials collection which is difficult at a time when they are facing increasingly labor shortage (Table 6.6). For a small percentage of farmers, with very small land holdings, collecting composting materials from distant forests is a very difficult task. Half of the farmers in both areas reported that long time required to get the waste materials decomposed has constrained its production at large scale. A few of the farmers, with very small land holdings, do not need compost, as the FYM available at their disposal is sufficient to meet the demand for fertilizer.

Currently, 12 percent of farmers in the project area and 34 percent in the non-project area are producing compost to complement FYM. Additional 40 percent of farmers in the project area and 30 percent in the non-project area are interested in compost making in the future. They are, however, not well aware of the related know how.

6.7 Mulching

Mulching, a practice of covering land with crop residues and other dry vegetation, contributes to conserve soil moisture, to reduce soil temperature and soil erosion and to protect crops from hailstone. Farmers are well aware of direct and indirect benefits of mulching, though their awareness of different types of advantages significantly varies in both areas (Table 6.7). More than two thirds of farmers in the project area and three fifths in the non-project area consider mulching as an effective means of erosion control especially during the spring and early monsoon seasons (Table 6.7). Every year, soil nutrient is washed away by surface run-off and farmers have to apply additional amounts of fertilizers to restore soil fertility which incurs high cost. A small percentage of farmers in both areas experienced reduced soil erosion and nutrient loss in farm plots covered with mulch (Table 6.7).

Table 6.7: Farmers' awareness of advantages and disadvantages of mulching

Farmers' awareness	Project Area (N=155)		Non-project Area (N=145)	
	Frequency of respondents	Percent	Frequency of respondents	Percent
Advantages				
Reduced cost of fertility management	15	10.0	20	14.0
Reduced soil erosion	110	70.0	88	60.0
Increased soil fertility	12	8.0	29	20.0
Increased crop yield	18	12.0	8	6.0
Total	155	100.0	145	100.0
X^2 value	175.2		104.6	
Significantly different 0.01 confidence level	(X^2 test, P≤0.01)		(X^2 test, P≤0.01)	
Disadvantages				
Feed deficit for livestock	82	53.0	125	87.0
Swept away by wind	55	36.0	5	3.0
High labor demanding	8	5.0	6	4.0
Obstructs ploughing	10	6.0	9	6.0
Total	155	100.0	145	100.0
X^2 value	100.8		289.9	
Significantly different 0.01 confidence level	(X^2 test, P≤0.01)		(X^2 test, P≤0.01)	

Source: Household survey, 1999

Farmers have been constrained to adopt mulching widely for several reasons. Their awareness of different types of constrains significantly varies in both areas (Table 6.7). More than two thirds of farmers in the project area and three fifths in the non-project area have

shortage of mulching materials (Table 6.7). Normally they use crop residues and leaf litters as mulch materials. But these materials are also being used as fodder, fuel wood and livestock bedding materials. According to farmers, if all these materials could be used for mulching, there would be severe feed and forage deficit for livestock eventually undermining the important source of their livelihood. Another problem is that during the pre-monsoon season mulch materials are easily blown away by gusty wind.

Mulching is a high labor demanding task, as it requires considerable amount of labor for collection and transportation of mulch materials. To prevent the wind from blowing away the mulch has to be pressed by heavy clay. For a small proportion of farmers in both areas inconvenience in land plowing is a constraint for mulching. Farmlands are plowed by traditional wooden plough, which is frequently obstructed by clogged with mulch materials. Therefore, most of the mulch materials are either removed or burnt before the plowing of lands.

Despite some disadvantages, 70 percent of farmers in the project area and 47 percent in the non-project area are practicing mulching to control soil erosion. Additional 10 percent of farmers in the project area and 25 percent in the non-project area expressed their interest in expansion of this practice. Their desire is likely to be fulfilled, as there is increasing tendency towards fodder and fuelwood tress plantation in farmlands.

6.8 Reduced Tillage

It is estimated that 40 percent of land degradation in the world is associated with tillage, either high tillage or use of heavy tilling machines (IAD, 1998:25). Tilling lands frequently and deeply is considered to be one of the major causes of land degradation particularly in the mountains. Farmers in the study area plow lands normally twice to control weed as well as to make soil soft for healthy growth of crops. Depending on the cropping intensity, lands are plowed two to six times a year. Besides, they remove weeds from maize crop and cultivate millet and bean in *bari* and *gharbari*. Such frequently hoeing and plowing disturbs soil structures and the topsoil becomes very loose in the dry season. The first monsoon rains easily wash way considerable amount of loose soils under the influence of steep slope gradients.

Farmers are aware about the advantages of reduced tillage though their awareness of different types of advantages significantly varies in both areas (Table 6.8). It helps to improve soil quality by reducing the loss of soil nutrients and organic matters. About three fifths of the farmers in both areas are aware of this system (Table 6.8). Besides, this practice according to farmers, would alleviate pressure on household labor force, as it would require relatively less labor for land preparation. For some farmers, it contributes to increase the grass yield required for livestock.

Farmers are equally concerned about the disadvantages of the reduced tillage. However, their awareness of different types of disadvantages significantly varies in the project area, while there is no significant variation in the non-project area (Table 6.8). About three fifths of farmers in the project area and more than one third in the non-project area believe that the reduced tillage will have adverse impact on crop yield (Table 6.8). According to farmers, the weeded maize crop using a hoe grows very well and gives higher yield than the crop not weeded in this way. While the un-weeded maize crop gets yellow after few weeks, as the crop cannot extract required amount of nutrient easily. If the soil is clay type, it gets hard and constraints the growth and yield of the crop severely.

Table 6.8: Farmers' awareness of advantages and disadvantages of reduced tillage

Farmers awareness	Project Area (N=155)		Non-project Area (N=145)	
	Frequency of respondents	Percent	Frequency of respondents	Percent
Advantages				
Reduced labor requirement	51	33.0	50	34.0
Increased yield of ground grass	9	6.0	10	7.0
Reduced soil erosion and landslide	95	61.0	85	59.0
Total	155	100.0	145	100.0
X^2 value Significantly different 0.01 confidence level	71.6 (X^2 test, P≤0.01)		58.3 (X^2 test, P≤0.01)	
Disadvantages				
Increased soil compaction	50	32.0	46	32.0
Decreased crop production	96	62.0	54	37.0
Increased weed and pest	9	6.0	45	31.0
Total	155	100.0	145	100.0
X^2 value Significantly different 0.01 confidence level	73.3 (X^2 test, P≤0.01)		1.0 Not significantly different at 0.05 confidence level (X^2 test, P>0.05)	

Source: Household survey, 1999

About one third of farmers in both areas see the risk of soil compaction due to reduced tillage. Specifically, *tarikhet* are prone to this problem. Therefore, farmers plow these lands immediately after rice harvest and leave the soil exposed to sun, rain and wind until the next crop is cultivated. Farmers also believe that the reduced tillage promotes weeds and pest.

There is widening gap between knowledge and practice in regard to the reduced tillage practice. Majority of farmers are aware of advantages and disadvantages of this practice. Still, it is not widely practiced, as under the current economic situation, farmers are more concerned about securing adequate amount of food crop production.

CHAPTER VII

CHANGING FARMERS' LAND MANAGEMENT PRACTICES

Preceeding chapter V indicated that farmlands in the study area are undergoing degradation due to natural and cultural factors. Analysis of farmers' experience towards improved land management practices in chapter VI revealed their excellent knowledge on the condition of their land. This chapters examines how farmers have changed their land management practices to cope with shrinking farm size and land degradation so as to maintain farm productivity and increasing food production for subsistence living.

7.1 Change in Land Management Practices

Mountain watersheds have increasingly been a matter of global concern due to the threat of serious environmental and socio-economic implications arising from natural resources degradation (Messerli and Ives, 1997). In the popular eye, mountain watersheds have been perceived as vast, rugged, and remote landscapes, seemingly inured to human environment (Ives et al., 1997:9). Short-sighted policy-makers and planners find investments in conservation and development of mountains less attractive compared to the adjacent plains, as normally their positive externalities are overlooked. As a result, mountain watersheds are either undergoing, or are vulnerable to, degradation, despite local people's efforts to prevent such adverse effects. Above all, the pursuance of a benign neglect by policy has resulted in the mountains being areas with the poorest of the poor deprived from even minimum basic needs, including adequate food and access to educational facilities and health services. In China, poverty tends to be regional, concentrating in the mountains or loess plateau, characterized by remoteness, lack of transportation and communication, and poor natural resource reserve and ecological condition (Lo and Xing, 1999:167). The Middle mountains, hereafter referred to as the Hills of Nepal, are not an exception.

While Nepali hill people's socio-economic condition was paid little attention to until the early 1990s, there has been ever increasing concern over environmental degradation since the 1970s. An overview of work done until the late 1980s reveals the dominance of the Malthusian view, seeing environmental degradation as a consequence of reckless exploitation of natural resources by a steadily increasing population (Enke 1971; Eckholm, 1976). Overlooking people's adaptive strategies to secure their livelihood on a sustainable basis through assorted types of technology evolved over a period of several centuries, some environmentalists and development policymakers (Enke, 1971) influenced by Hardin's theory of "tragedy of commons" (1968) have gone as far as branding local people as enemies of the environment, destroying forest and land resources in the pursuit of maximizing their personal benefits. Such conventional wisdom and theory based on erratic observations, individual perception and vested interest have gradually lost their favor, as results of scientific work have begun to reveal a quite different picture since the early 1990s (Thompson and Warbarton, 1985; Blaikie and Brookfield, 1987; Ives and Messerli, 1989; Bruijnzeel and Bremmer, 1989; Schreier et al., 1995, Guthman, 1997). Contrary to the traditional line of thinking, these micro-level studies pursued in different parts of the Hills have found, despite the steady growth of population, the condition of natural resources gradually improving, as people innovated and practiced effective management technologies to cope with the aggravating resource scarcity (Mahat et al, 1987a; Gilmour, 1989; Messerschmidt, 1990; Fox, 1993). Such experiences are in conformity with Boserup's thesis that considers population growth as a stimulator of technological innovations.

It is very encouraging that there is growing attention to understanding location specific natural resources situations and management systems in the Hills. However, the attention has

so far been overwhelmingly focused on common properties, in general, and forest, in particular. Studies have also been pursued on private property or agricultural lands, with emphasis on their use and degradation. A few studies shed light on hill farmers' land management practices (Johnson et al., 1982; Carson, 1992), but their areas of concern have been selected aspects of management, including landslide prevention and repair measures. In view of the hill farmers facing ever more pressing socio-economic problems arising from gradually dwindling per capita share of land resources, on the one side, and scarcity of non-land based employment and income opportunities, on the other, efforts should be made to enable farmers to increase land productivity through enhancement of their land management technologies built upon their traditional knowledge. This entails understanding of the location specific farmers' overall land management practices evolved over the past several centuries. This chapter is a small step in this direction.

A typical farm household in both areas owns six types of land including *phantkhet, tarikhet, bari, gharbari, kharbari* and *jungle*. On average, a farm household in the project area owns 0.75 hectare of land, fragmented into about 6 parcels, of which 86 percent is farmland, and 14 percent is non-agricultural land. Per household farmland availability declined substantially from 1.4 hectare in 1978 (Fleming, 1983) to 0.65 in 1998. A typical farm household in the non-project area owns 0.90 hectare of land, of which 17 percent is non-agricultural land, and 83 percent is farmland. The land is fragmented into about 7 parcels. As in the project area, per household farmland availability declined from 1.6 hectare in 1978 (Land Administration Office, 1979) to 0.75 hectare in 1998.

Confronted with declining land-holding size, growing food deficit and scarce non-farming employment opportunities farmers have changed land management practices to control land degradation and eventually maintain or increase the farm production. The following section examines the change in land management practices adopted by farmers.

7. 2 Change in the Structural Measures

Farmers have adopted different structural measures in land management. They have changed the technologies and management practices to adjust with changing bio-physical environment.

7.2.1 Terracing

Terraces are narrow strips of land, carved out across the hill slopes for cultivation of cereals, including paddy, maize, wheat and millet. Regardless of land type, most terraces in both watersheds were constructed several centuries ago. Some of them were, however, constructed a few decades ago in response to ever-increasing food demand for a steadily growing population. About 95 percent of farmers in the project area had practiced terraced farming in 1975; their relative number grew to 99 percent in 1998. In the non-project area, the proportion of farmers practicing terraced farming grew from 97 percent in 1975 to 98 percent in 1998 (Table 7. 1).

Leveled bench terraces are the dominant structural measure adopted by hill farmers to stabilize irrigation water required for rice cultivation in *phantkhet* and *tarikhet*. Terraces are relatively wider in the valley bottom and tend to narrow gradually with increasing elevation and slope gradient. Terrace risers are slightly inwardly inclined at the foothills and outwardly facing in the hill slopes (Figure 7.1 A and B). Bench terraces are found up to 1,800 meters above the amsl, which is the upper limit of rice cultivation. The height of the terrace risers ranges from 50 cm at the valley bottom to 4 meters in very steep hill slopes. There is no

significance difference between project and non-project areas in the construction and maintenance of particularly *khet* terraces.

Table 7.1: Changes in the structural measures of land management

Measures	Project Area (N=155)				Non-project Area (N=145)			
	1975	1985	1995	1998	1975	1985	1995	1998
	f'	f'	f'	f'	f'	f'	f'	f'
Terraces	95.0	98.0	98.0	99.0	97.0	98.0	98.0	98.0
Waterways	61.0	90.0	91.0	92.0	69.0	85.0	89.0	92.0
Gully control	7.0	27.0**	28.0**	30.0**	10.0	14.0**	18.0**	20.0**
Retention walls	10.0*	26.0*	41.0*	42.0*	3.0*	8.0*	10.0*	12.0*
Check dams	6.0	11.0	14.0	14.0	3.0	12.0	15.0	15.0

Source: Household survey, 1999

NB: f'= Proportion of N

*Significantly different at 0.01 confidence level (T Test, P≤0.01)

** Significantly different at 0.05 confidence level (T Test, P≤0.05)

Grasses grown in the terrace risers promote pests and insects that damage crops. To prevent this, farmers slice terrace risers regardless of land type at the outset of each cropping season. To maximize production from their small landholdings, they cultivate soybean in all terrace risers in valley floors and foothills. Soil and vegetation sliced from terrace risers are added in the farmlands, which contribute to enhance soil fertility. This system is being extensively practiced in the non-project area, but relatively small proportions of farmers practice it in the project area.

A remarkable change in the project area is that majority of *bari* terraces which were normally outward facing have been converted into inward facing terraces under the support provided by the Phewatal Watershed Management Project (Figure 7.1 C). *Bari* terraces in the non-project area are, however, characterized by outward facing slopes that facilitate quick drainage of water required for millet, maize and legume crops (Figure 7.1 D). At upper elevations, with relatively very steep slopes, the slope gradient of outward facing *bari* terraces is relatively high compared to terraces at lower elevations. Two converging ridges form a pass, locally known as *bhangjyang*. Wherever it is possible, farmers have constructed terraces on either side of the pass (Figure 7.1 E). These terraces are different from other hill slope terraces, as terrace risers are relatively short and terrace widths are relatively wide. These terraces have been maintained without any change in both project and non-project areas.

Remarkably, sloping terraces have been abandoned gradually since the early 1980s, as farmers found it difficult to maintain them due to labor shortages caused by the out-migration of adult household members and schooling of children. Some farmers with adequate labor are, however, gradually converting the steep sloping terraces into gentle sloping terraces to reduce the rate of soil erosion essential for increasing land productivity (Figure 7.1 F)

7.2.2 Terrace Bunds

Khet terrace bunds, facilitating stabilization of irrigation water, vary in width and height depending on their location and soil type. Terrace bunds used to be relatively wide in the past when the population pressure on land resources was relatively low. With the increased household size and no prospect for expansion of agricultural lands, farmers have gradually sliced terrace bunds to increase the area under crop production. Irrespective of location, large farmers have still maintained relatively wide bunds, while small farmers have relatively thin terrace bunds. The width of risers varies from 20 to 40 cm. The tiny fraction of land

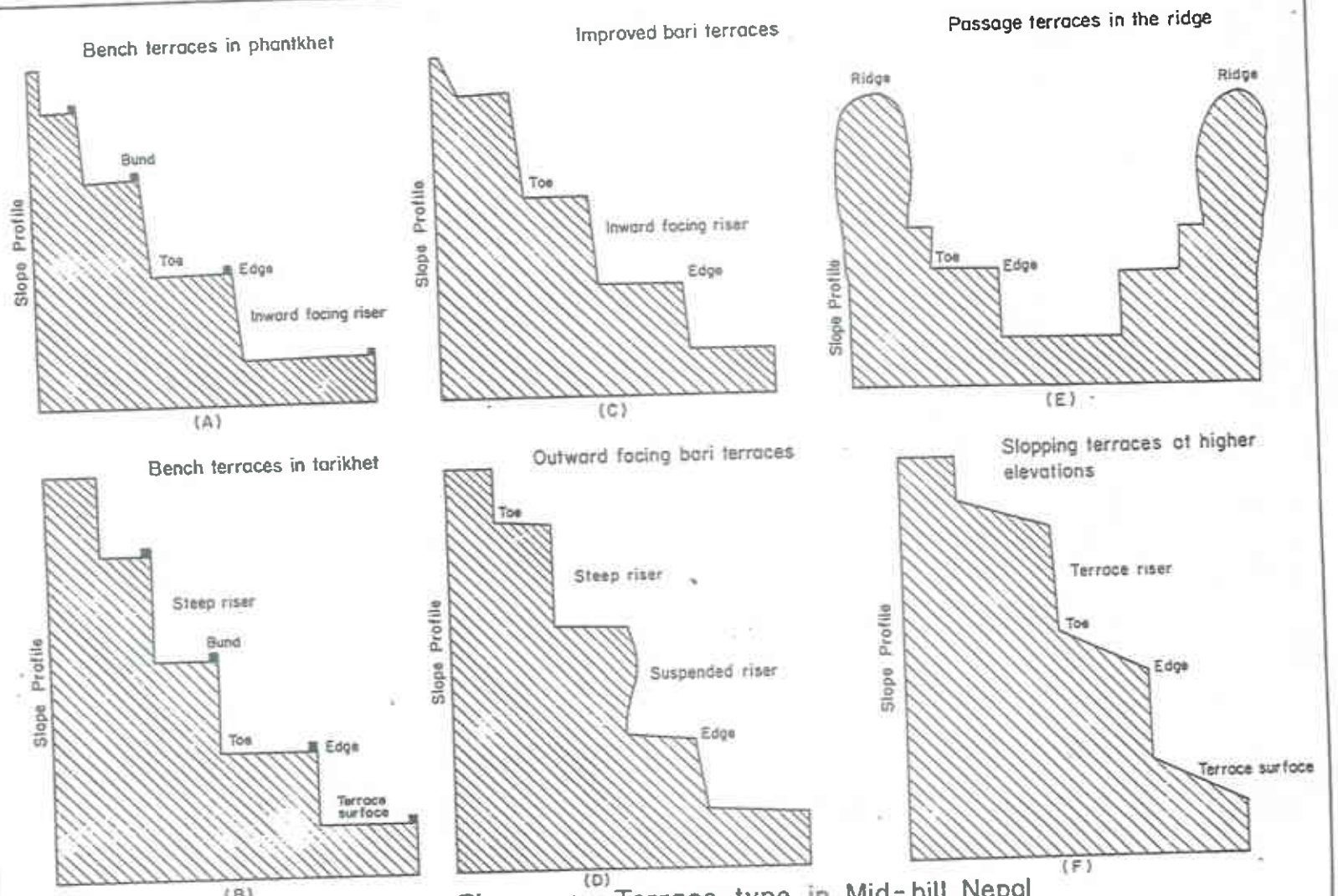


Figure 7.1: Terrace type in Mid-hill Nepal

allocated to bunds has been intensively utilized for legume crops, while this was not the practice until a few decades ago. Terrace bunds in relatively distant farm plots are normally thin as they are not being utilized for legume cultivation, owing to farmers' inability to protect crops from wildlife and stray livestock. Soil type also influences the size of terrace bunds. They are relatively wide and high in erosion prone soils. In both watersheds, every year farmers slice the walls of terrace bunds and heap new soil on them to maintain height. This contributes to replenish nutrients required for legume cultivation.

7.2.3 Contour Bunds

Farmers have constructed counter bunds across the farm edges (Figure 7.2). Mostly made from stone, these bunds prevent the surface run-off from entering farmlands and control soil erosion and siltation. Besides, counter bunds prevent stray livestock from sneaking into farmlands. These bunds are a common feature in the project area, as farmers were provided financial support for their construction. In the non-project area, where such support has not made available yet, contour bunds are rare.

7.2.4 Construction and Maintenance of Waterways

Waterways have been an integral part of the terraced farming system (Ojha, 1995). The main purpose of waterways in land management systems is to convey runoff at a non-erosive velocity to a suitable location or the disposal points (Morgan, 1995:139). Uncontrolled surface runoff moving down slope across hill slopes destroys terrace risers and removes fertile soils from the farmlands, eventually aggravating crop yields and increasing cost of terrace maintenance in several locations. To cope with this natural hazard, farmers in both watersheds have constructed waterways (Figure 7.2). About one fifth of farmlands in the project area and one tenth in the non-project area are protected by waterways.

According to their location, waterways constructed to prevent land degradation in the study area can be categorized into three types. Inter-terrace waterways are constructed across the inner toe of *bari* terraces. A narrow waterway is constructed across terraces for the diversion of surface run-off which is channeled through waterways and drained into either gullies or grassways. This type of practice has been common in the project area as watershed management officials made farmers aware of the advantages of this technology. Confronted with the damage to farmlands caused by surface run-off, farmers in the non-project area have also constructed waterways across *bari* terraces using the knowledge acquired from the project area. Intra-terrace waterways are constructed to prevent land from water logging, as it adversely affects the yield of some crops. Such waterways are also utilized for uniform distribution of water in farm plots during the dry season. Especially in the project area, farm edge waterways are constructed about 10 to 50 meters above the farm boarder. Waterways, especially in high erosion prone areas, have been paved with stone to prevent gully formation. These types of waterways are extremely limited in the non-project area due to lack of external assistance.

7.2.5 Gully Control

Gullies are relatively permanent steep-sided watercourses with momentary flows during rainstorms (Morgan, 1995:19). According to farmers, gullies were extensively formed during the 1960s and 1970s when forests on hill slopes were cleared for the expansion of farm and grazing lands. Once gullies were formed, they started expanding both vertically and laterally, eventually engulfing adjacent farmlands. Having been confronted with this problem, farmers

in the project area started making contributions to the gully control program in the 1980s under the technical and financial support provided by the Phewatal Watershed Management Project. In this regard, check dams were constructed along the vertical axes of gullies. Besides, gabion retaining walls were installed at critical points where the small stones used in check dams could be washed away by floodwater (Figure 7.3). As a result of joint efforts made by local people and the Watershed Management Project, 261 gullies covering an area of 123 km^2 have been stabilized. Only seven percent of the farmers had participated in gully control in 1975. The proportion of participants grew substantially over the successive years (Table 7.1). Farmers in the non-project area have not been able to control large gullies due to lack of technical and financial resources. They controlled the expansion of small gullies using resources at their disposal. About one tenth of farmers had contributed to gully control in 1975; the proportion of contributions reached to one fourth by 1998 (Table 7. 1). Nearly half of the surveyed farmlands in the project area and one fifth in the non-project area have been protected by this measure.

7.2.6 Landslide Repair and Prevention

Contrary to the traditionally held belief, farmers in the study area are seriously concerned about the management of their landholdings, as any negligence would make them vulnerable to severe food shortage. In the past, availability of relatively abundant "open access" lands provided an opportunity to expand farmlands in the case of existing farmlands being badly damaged by landslides. With the steady growth of population and the ever increasing state as well as local community control over open access lands, it is virtually impossible to expand agricultural lands. Non-farming activities that offer alternative employment opportunities are still rare. Farmers therefore have to pay serious attention to management of their small landholdings. In this regard, on average a farm household in both areas spends 13 man days of labor per hectare of land on maintenance and repairing farmlands affected by landslides (Table 5. 4). They normally reclaim affected parcels of land in the winter or spring season. In this pursuit, rocks are removed from terraces and soil is leveled uniformly. Farmers can not do anything other than wait for 10-15 years to reclaim farmlands naturally, in case large landslides affect farmlands.

7.2.7 Reinforced Terrace Walls

A landslide, depending on its size, may affect single or several farmers. Where there is the possibility of several farmers' landholdings being affected by a landslide, concerned farmers jointly construct reinforcement walls to protect terrace risers from collapsing (Figure 7. 4). The upper edge of the retention wall is slightly tilted towards the upper slope to reinforce the load bearing capacity of the wall. In the project area, only ten percent of farmers had constructed retention walls in 1975. At the outset of the project they accounted for 42 percent in 1998 (Table 7.1), three years after the termination of the project. In the non-project area, participation of farmers adopting this measure, however, increased marginally from three percent in 1975 to 12 percent in 1998 (Table 7.1), owing to a lack of external support.

7.2.8 Check Dams

To protect their farmlands from landslides and flood related damages farmers have made substantial amounts of labor investment in the construction of check dams ever since the 1960s. In the valley floor, river level and course keep on changing every year, which sometimes inflicts severe damages on fertile *phantkhet*. Even farmlands on hill slopes are destroyed through the process of farmland edge cutting by gullies and associated landslide. Stabilizing river ways, particularly large streams, on a permanent basis is beyond the

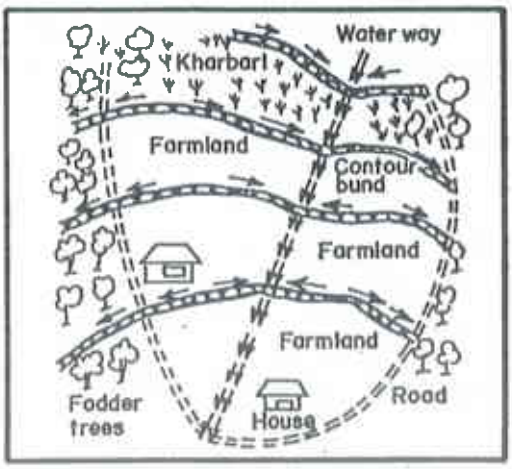


Fig. 7.2 Waterways and contour bunds in the hill slope area

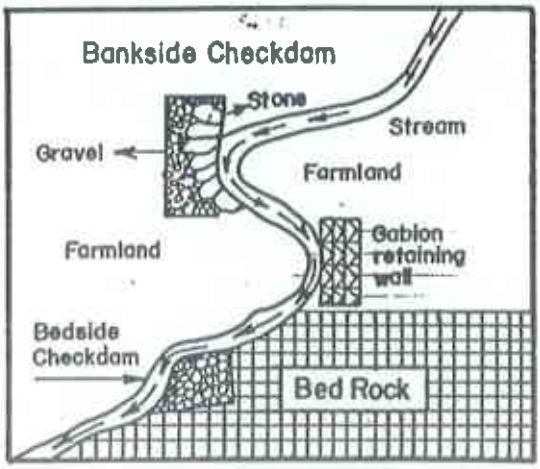


Fig. 7.3 Check dams protecting farmland from flood

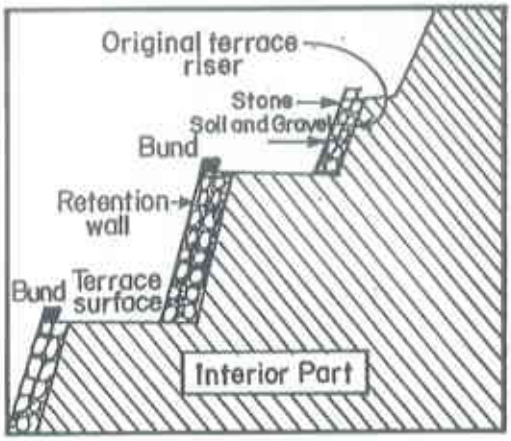


Fig. 7.4 Reinforced terrace walls

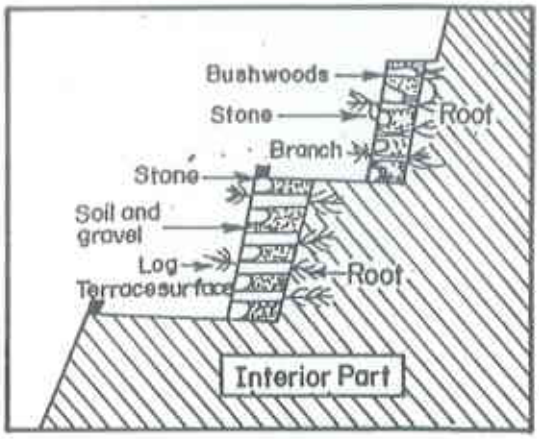


Fig. 7.5 Use of live materials in terrace construction

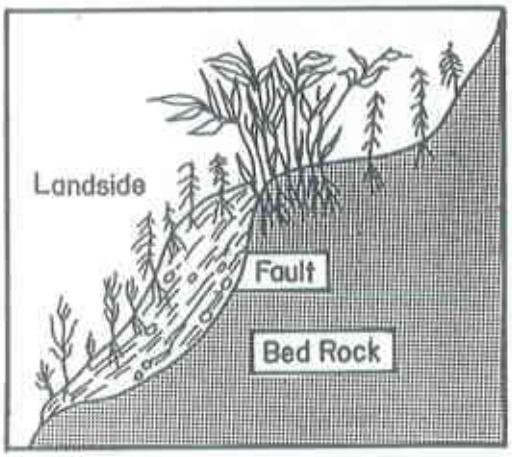


Fig. 7.6 Shrub and trees established to reclaim lands affected by landslide

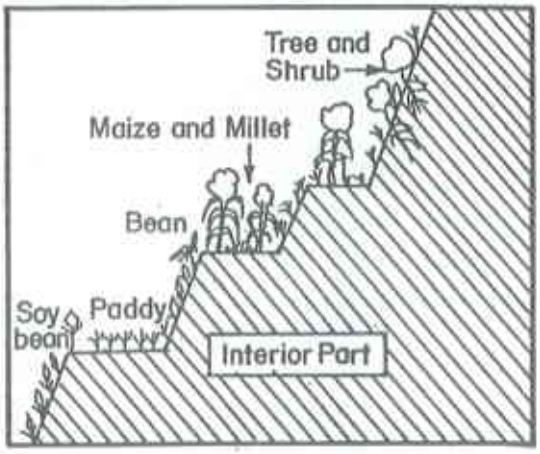


Fig. 7.7 Effective use of terrace risers for legume cultivation

affordability of farmers. However, they are pursuing small-scale work to protect land from possible damage. In this regard they have constructed gabion retaining walls and spurs with launching aprons to control land cutting by streams (Figure 7. 3). These structures are protected by vegetational cover, comprising a mixed formation of trees and shrubs. Six percent of the farmers in the project area had adopted this measure in 1975. Their proportion had increased to 14 percent by 1998. The situation in the non-project area was not much different from the project area (Table 7.1).

7.3 Biological Measures of Land Management

Besides structural measures, farmers in both watersheds have adopted several assorted types of biological measures of land management. These practices evolved over past several centuries have contributed to control land degradation at relatively low cost. They have also played an important complementary role in sustaining farm household economies by providing fuel-wood, fodder and food.

7.3.1 Alley Cropping

As in the case of other mountain areas of Nepal, traditional alley cropping being practiced by farmers in the study area is different from alley cropping developed and promoted by agricultural research centers in which alternative rows of field crops and perennials are grown in a contour pattern. Until a few decades ago, assorted species of fodder and fuel-wood trees as well as shrubs were found grown mostly in *kharbari* together with *Typha angustata,* which is used as fodder as well as thatching material. With the dwindling forest fodder supply caused by deforestation and restriction on free access to forest, farmers started planting fodder trees and shrubs on edge of terrace risers including palatable fodder species like *Artocarpus lakoocha* (badhar), *Ficus auriculata* (nimaro), *Ficus locor* (kavro), *Ficus nemoralis* (dudhilo) *and Ficus glamberrima* (pakhuri). During the 1980s large tree species were gradually replaced by nitrogen fixing, dwarf, high fodder yielding and deeply rooted shrub species, including *Bahuhinia variegata, Leucaneia leucocephala,* and *Morus indica, as* crop yield under the shade of tall trees gradually declined. Farmers found farm edges, foot trail, gullies and terrace risers at higher elevations suitable for tall tree species. In the project area, some exotic species including *Bahuhinia variegata* and *Leucaneia leucocephala,* have been promoted, while in the non-project area mostly indigenous species are found.

Confronted with miniaturizing landholdings and dwindling forest fodder and fuel-wood supply, farmers in both areas have increasingly resorted to alley cropping as an alternative means of fulfilling subsistence requirements. In the project area, only two percent of the surveyed households had practiced alley cropping in 1975. They accounted for 28 percent in 1995 and 30 percent by 1998. In the absence of effective extension service, alley cropping was being practiced by 17 percent of the total households of the non-project area in 1998 (Table 7. 2).

7.3.2 Bamboo Species Plantation in Gullies

Establishing bamboo species, including *Bambussa balloca* (dhanu bans), *Bendrocalanus hamiltonii* (tama bans), *Bambussa spp* (chiple bans) and *Arundinaria raccam* (nigalo) in deep gullies and along stream banks has been a recent practice adopted to minimize soil erosion, river bank erosion and gully expansion. These species propagate rapidly and have fibrous root systems with excellent soil binding capacity. Leaves of these species are used as fodder, stems as fencing, thatching and handicraft materials, and branches as vegetable. Long gullies, with shrub formations, look like green belts interrupted by livestock trails passing through the

intersections of gullies. Bamboo species planted in gullies at the valley bottom occasionally block surface runoff and flood farmlands. To protect land from this hazard, farmers have filled in gaps between bamboo clumps with stone walls. About two fifths of farmers in the project area had established bamboo species in gullies as of 1975. Their relative number had nearly doubled two decades later. The proportion of farmers practicing this method had doubled between 1975 and 1995, even in the non-project area. But, it still accounted for only half of that in the project area (Table 7.2).

Table 7.2: Change in the adoption of biological measures of land management

Measures	Project Area (N=155)				Non-project Area (N=145)			
	1975	1985	1995	1998	1975	1985	1995	1998
	f'	f'	f'	f'	f'	f'	f'	f'
Alley cropping	2.0*	5.0	28.0*	30.0*	0.0*	3.0	12.0*	17.0*
Establish bamboo species in gullies	37.0**	44.0	86.0	87.0	19.0**	40.0	79.0	83.0
Vegetative measures for land slide control	39.0**	45.0**	88.0**	88.0**	17.0**	24.0**	51.0**	55.0**
Adoption of mulching practices	37.0	40.0	68.0*	70.0*	37.0	40.0	46.0*	47.0*

Source: Household survey, 1999

NB: f'= Proportion of N

*Significantly different at 0.01 confidence level (T Test, P≤0.01)

** Significantly different at 0.05 confidence level (T Test, P≤0.05)

7.3.3 Vegetative Measures for Landslide Control

Farmers in both areas use 50-80 cm long logs of fast propagating tree species, including *Erythrina strica* (phadelo), *Vitex negundo* (simali), *Alstonia scholaris* (chhatiwan), and *Salix babylonica* (banis) for the construction of terrace risers, retention walls and check dams. They are staked on a stone foundation. Roots and shoots sprout out of these logs and steadily grow (Figure 7.5). Roots growing vertically and horizontally on the ground reinforce the foundations of terrace risers, retention walls and check dams. Besides providing fodder, leaves and canopies intercept the rain and control erosion of the structure made for soil conservation. Lands affected by landslides are re-vegetated with several tree and shrub species as they facilitate speedy recovery (Figure 7.6). Being aware of its importance for land conservation and fulfilling other household requirements of fodder and fencing materials, farmers in both areas have been increasingly practicing this measure. About two fifths of farmers in the project area had employed this measure in 1975; their relative number grew to nine tenths in 1998. In the non-project area, the proportion of farmers practicing vegetative measures for landslide control grew from 17 percent in 1975 to 55 percent in 1998 (Table 7. 2).

7.3.4 Change in Tree Density in Farm Terrace Risers

Tree density in farmlands increased considerably in project area, as farmers understood its importance. Average tree density in project farmland was 53 trees per hectare in 1988, which grew to 97 in 1998 totaling a growth of 83 percent. While, the tree density in non-project farmland remained constant during same period (Table 7.3).

All types of project farmlands experienced high growth rate, while there was negative change in non-project *tarikhet* and *bari* and slight increase in *phantkhet* and *gharbari*. Total

tree density in farmlands is significantly high (P≤0.01) in the project area compared to the non-project area (Table 7.3)

Table 7.3: Change in tree density

(No/hectare)

Land type	Project Area				Non-project Area			
	Density (1988)	Density (1998)	Change in tree density	Percent change	Density (1988)	Density (1998)	Change in tree density	Percent change
Phantkhet	28*	42*	14*	50.0	2.0*	2.6*	1.0*	30.0
Tarikhet	53	76*	23*	43.0	51	36*	-15*	-29.0
Bari	118	200*	82*	69.0	133	83*	-50*	-38.0
Gharbari	34	169	135	397.0	37	136	99	267.0
Farmland total	53	97*	44*	83.0	49	49*	0.0*	0.0
Kharbari	98	674*	576*	587.0	216	310*	94*	44.0
Jungle	672	2,143*	1,471*	219.0	591	991*	400*	68.0
Total	74	214*	140*	189.0	99	132*	33*	33.0

Source: Household survey, 1999

NB: *Significantly different at 0.001 confidence level (T Test, P≤0.01)

Fodder trees are grown only in *phantkhet, tarikhet bari and gharbari* terrace risers.

Fruit trees are grown both in *bari* and *gharbari* terrace risers and terraces.

Wood and timber trees are grown both in *kharbari* and *jungle* terrace risers and terraces.

However, there was considerable increase in tree density in *kharbari* and *jungle* in both project and the non-project areas, but the change was significantly higher (P≤0.01) in the project area. Farmers in both areas have reduced their dependency gradually on open access forests as they were shrinking on the one hand and they were brought under community control on other hands, which prohibit frequent entry in the forests to collect forest products including firewood, leaf litter, fodder and timber.

7.3.5 Mulching

Farmers considered mulching as an effective means of soil moisture conservation. Farmlands in the hill slopes and ridges are vulnerable to a lot of moisture loss during the winter and early spring seasons. To prevent this, farmers with relatively large household size and small land holdings cover the plowed land with crop residues, leaves and twigs. Mulching is also practiced to prevent seedbeds from getting exposed to the sun and rain, and to protect seedlings from hailstones, which occur in the study area every year. Farmers keep on observing the weather conditions and remove mulch from seedbeds when they feel that seedlings can withstand. About one third of farmers in the project area were practicing mulching in 1975; their relative number grew to over two-thirds in 1998 (Table 7. 2). In the non-project area, the proportion of farmers employing this technology grew from 37 percent in 1975 to 47 percent in 1998.

7.4 Soil Fertility Management

Maintaining or improving soil fertility is the only alternative for minimizing the risk of food shortage in the study area, as so far non-farming employment opportunities are scarce. Therefore, farmers rely on different organic and inorganic fertilizer to maintain soil fertility.

7.4.1 Farmyard Manure (FYM)

Farmyard manure, including manure and livestock bed, is the major source of fertilizer in both areas. FYM is normally dumped in front of the *goth* in a 3-4 feet deep pit, which fills up within four to five months and then continues piling up above the surface. It is left exposed to the sun, rain and wind. Livestock beds comprising waste fodder, tree leaves and crop weeds,

are cleared twice a day to keep the pen clean. Bedding materials mixed with dung are easily decomposed and become part of FYM.

Table 7.4: Application of fertilizer by land type

Fertilizer	Project Area (N=155)					Non-project Area (N=145)				
	PK	TK	BA	GH	Mean	PK	TK	BA	GH	Mean
FYM (kg/hectare)	5,800*	4,200*	19,200*	27,400*	9,300*	2,300*	3,400*	10,100*	16,300*	6,000*
Compost (kg/hectare)	743*	108	352*	916**	321	48*	145	925*	1,580**	444
Green manure (kg/hectare)	35*	56	121*	253**	90*	0.0*	42	15 *	97**	34*
Oil cake/ash (kg/hectare)	0.0	20	0.0	63 *	23**	0.0	18	0.0	17**	10**
Mineral fertilizer (kg/hectare)	42 **	30**	51*	51*	37**	63**	20**	2.0*	7.0*	26**

Source: Household survey, 1999

NB: PK= *Phantkhet*. TK= *Tarikhet*. BA= *Bari*. GH= *Gharbari*

*Significantly different at 0.01 confidence level (T Test, P≤0.01)

** Significantly different at 0.05 confidence level (T Test, P≤0.05)

On average, a farm household in the project area produces six tons of FYM annually, while in the non-project area 4.4 tons are produced. Due to relatively higher amounts of FYM production and small land holdings, farmlands in the project area receive FYM at the rate of 9.3 ton/hectare/year, compared to 6 ton/hectare/year in the non-project area (Table 7. 4). All farmlands in the project area receive significantly high (P≤0.05) amount of FYM compared to non-project farmlands (Table 7.4). In the non-project area, the highest amount of FYM is applied to *gharbari*, followed by *bari*, *tarikhet* and *phantkhet*. In the project area, *phantkhet* receive slightly higher amounts of FYM than *tarikhet*. While FYM is a major source of fertilizer, its supply is steadily declining in both areas. Due primarily to gradually declining livestock herd size, per household production of FYM dropped by 4 percent in the project area and 20 percent in the non-project area during 1988-1998, though the proportion of farmers producing FYM increased over the years (Table 7. 5).

7.4.2 Compost

To cope with declining FYM supply, farmers have been engaged in compost making since the 1960s in an increasing trend. In 1998, one third of farm households in the non-project area had produced compost, compared to one tenth of the farmers in the project area (Table 7. 5). On average, a hectare of farmland in the project area receives 321 kg of compost per year and 444 kg in the non-project area. Relatively less involvement of the project farmers in compost making is attributed to the provision of subsidized chemical fertilizer ever since the implementation of the project in 1975. Being unable to receive such assistance, farmers in the non-project area had no alternative for increasing the supply of fertilizer other than resorting to compost-making using resources at their disposal. In both locations, first priority is given to *gharbari* followed by *bari*, *phantkhet* and *tarikhet* for compost application (Table 7. 4).

7.4.3 Chemical Fertilizers

The application of chemical fertilizer was virtually non-existent in the study area until the mid 1970s. Confronted with declining FYM supply, a considerable proportion of farmers in the project area started using chemical fertilizers provided virtually free of charge by the

Phewatal Watershed Management Project since the late 1970s. Initially chemical fertilizers were applied to millet and paddy seedbeds. Since the early 1980s, they have been applied to wheat, rice and maize. Farmers are fully aware that the regular use of chemical fertilizers accelerate soil acidity. Still the proportion of farmers using chemical fertilizer gradually increased over the years. Particularly in the project area virtually all farm households used chemical fertilizers in 1998 compared to only ten percent in 1975 (Table 7.5). Farmers in the non-project area started using chemical fertilizer in the late 1980s, as they could not receive any external assistance. Still the proportion of farmers using chemical fertilizer increased from two percent in 1975 to 59 percent in 1998 (Table 7.5). Even the intensity of use of chemical fertilizers is significantly high ($P \leq 0.05$) in the project area, 37 kg/hectare, compared to the non-project area, 26/kg hectare (Table 7.4).

Table 7.5: Fertilizer being applied by farmers

Type of fertilizer	Project Area (N=155)				Non-project Area (N=145)			
	1975	1985	1995	1998	1975	1985	1995	1998
	f'	f'	f'	f'	f'	f'	f'	f'
Farmyard manure	81.0	85.0	89.0	90.0	86.0	88.0	91.0	93.0
Compost	2.0	10.0**	12.0**	12.0**	1.0	4.0**	26.0**	34.0**
Green manure	27.0*	30.0*	40.0*	40.0*	5.0*	7.0*	13.0*	13.0*
Legume cultivation	15.0	19.0	33.0	34.0	22.0	25.0	34.0	38.0
Chemical fertilizer	10.0**	65.0*	85.0*	96.0*	2.0**	19.0*	50.0*	59.0*

Source: Household survey, 1999

NB: f'= Proportion of N

*Significantly different at 0.01 confidence level (T Test, $P \leq 0.01$)

** Significantly different at 0.05 confidence level (T Test, $P \leq 0.05$)

Farmers in the non-project area accord priority to *phantkhet* for the application of fertilizers, as they are endowed with good quality soils, with the potential of increasing crop yield substantially using chemical fertilizer. On average, 63 kg of chemical fertilizer is applied to a hectare of *phantkhet*, which is 33 times higher than *bari*, nine times higher than *gharbari* and three times higher than *tarikhet* (Table 7.4). The intensity of use in the project area is higher in *gharbari*, followed by *bari*, *phantkhet* and *tarikhet* (Table 7. 4). Most *phantkhet* in the project area are owned by land speculators pursuing business in the regional town of Pokhara. Therefore, they intensively applied chemical fertilizers to *gharbari* and *bari* which are more fertile than *tarikhet*.

7.4.4 Green Manure

Using green manure species, namely *Adhatoda vasica* (ashuro), *Euphorbia roylena* (siplikan), *Artemisiia vulgaris* (titepati), *Albizia spp* (dhurseli), *Trichilia connoroides* (ankhetari) and ***Stirum insigne*** (khirro), for land fertilizing has been a traditional practice in both project and non-project areas. These wild plant species have more than double NPK content as compared to FYM (Subedi and Gurung, 1991; Joshi, 1997). Some of these species are useful for controlling weeds and pests. Normally green manure is applied to vegetable seedbeds. Despite their awareness of the nutritional value of green manure species, farmers cannot apply it to other field crops, owing to scarcity. Due to their steady use without any promotional efforts, green manure species have become scarce. About two fifths of farmers in the project area and one-sixth in the non-project area are applying green manure to their farmlands (Table 7.5).

In response to diminishing supply of green manure, farmers are applying leaves of *Schima wallichi* (chilaune) and *Castanopsis ssp* (katus) specifically to paddy. According to farmers, these materials have low nutrient contents, but help to prevent soils from being

acidic. Weeds grown in the field are also being utilized as green manure, specifically for millet.

7.4. 5 Goth System

Keeping livestock for a few to several weeks under a makeshift shed built on a parcel of land relatively distant from the farmhouse is locally known as the *goth* system. As practiced in other mountain areas of Nepal (Metz, 1994), this system has been adopted by farmers ever since the 1950s to cope with labor shortage. Carrying FYM to distant farm plots is a highly labor-intensive task. Therefore, farmers build a makeshift livestock shed on a farm plot and one of their household members stays there with livestock during December-April. Livestock are fed on crop residues stocked on the shed. During the daytime livestock graze on the farm plot and are kept under the shed at night. The manure mixed with bedding materials is dumped in front of the shed and applied to puddled *khet* during rice transplantation. Farmers demolish the *goth* and bring the livestock back to the farmhouse when the stock of crop residues is finished. The *goth* system is gradually declining as some of the *khet* are being utilized for winter crops and farmers are increasingly confronting the problem of labor shortage. Still about 12 percent of farm households in the project area and 15 percent of those in the non-project area are practicing this system. Farmers frequently reported that the diminishing *goth* system is one of the major causes of declining farm productivity.

7.4.6 Wrapping Farmlands by First Flood Water

The first flood, which occurs immediately after the first monsoon shower, brings dung dropped by livestock on grazing lands, fallen leaves, decomposed organic materials and other fine and coarse materials from the catchment area. Farmers are well aware that these materials contain high amounts of plant nutrients. Therefore, they channel the first floodwater into their fields through canals and ditches. To facilitate the uniform flow of water throughout the farm plot, they make waterways by cutting bunds and terrace risers, and keep on monitoring the flow of nutrient water. When the amount of fertile materials is observed decreasing, the water is diverted back to canals and streams. This type of practice is common in both watersheds particularly on *khet* lands. Reportedly, 36 percent of the total area of *phantkhet* and 25 percent of *tarikhet* in the project area are fertilized in this way. In the non-project area, one-fifth of *phantkhet* and one-fourth of *tarikhet* receive nutrients through floodwater. However, as mentioned by farmers, the nutrient contents in the water is declining due to shrinking forests and grazing lands, reduced grazing practice, and growing numbers of irrigation canals in the upstream areas.

7.4.7 Legume Cultivation

The need for increasing cropping intensity coupled with maintaining land fertility has increasingly attracted farmers in both areas to legume cultivation, which was not a typical practice until recently. In 1975, only 15 percent of households in the project area had cultivated legume crops; they accounted for 34 percent in 1998. During the same period, legume cultivation practice in the non-project area grew from 22 percent of farm households to 38 percent (Table 7.5). About five percent of the cropped area in the project area and three percent in the non-project area is used for legume crops. Major legumes being cultivated in both areas are cow-pea, pea, black gram, bean, broad bean, pole bean, rice bean, winter bean, French bean, green bean, soybean and peanut. Grown in terrace risers of *khet* and inter-cropped with maize and millet in *bari* and *gharbari* (Figure 7.7), legumes are consumed as side dishes with meals and their residues are palatable to livestock.

7.4.8 Crop Residue and Weed Burning

Burning crop residues and weeds has been a traditional method of land clearing and fertilizing in both project and non-project areas. This is normally practiced in *bari* land. Farmers collect maize and millet stubble, leftover wheat straw, dried weeds, and woody plants grown in *bari* terraces in the dry season. They expose the bio-mass to the sun until it is completely dry. Then they burn it when signs of rainfall appear, so the fire would be confined to the farm plots. The ash is then spread all over the farm plot to enhance soil fertility to some extent and to control pests. This practice is being abandoned gradually in both project and non-project areas, as most crop residues are used as fuel-wood and forage.

7.4.9 Household Ash

In addition to trash burning, household ash produced during cooking of food and boiling of roughage is used in vegetable and crop seedbeds as pest controller and fertilizer. Before the 1960s it was used as cleaning and washing material. It was replaced by chemical after the Siddhartha Highway linked adjoining town with India. Onwards, it is used as organic fertilizer. On average, a farm household in the project area consumes a total amount of 2,300 kg of fuelwood and produces 23 kg of ash per year. Similarly, non-project household consumes 1,575 kg of fuelwood and produce 16 kg of ash. Though, the amount of ash produced at home is relatively small but it is used to fertilize farmlands in both areas.

7.4.10 Oilseed Cake

Use of oilseed cake, as organic manure, is a traditional practice before mineral fertilizer came into practice. Farmers recognized its nutritional value and used it in fertilizing farmlands. They used it rice and millet seedbeds, vegetables and fruit plants, which need fastest growth in short time period. However, the use of oilseed cake is gradually diminishing. The cropped area under oilseed is competing with winter wheat and farmers are gradually curtailing its cultivation. Secondly, it is replaced by mineral fertilizers, and it is diverted to livestock feed. Still limited number of farmers especially who have no ability to purchase high amount of mineral fertilizers are continuing its use. Farmers prefer its use in acid soils. They mixed it with goat and sheep dung and apply evenly in newly germinated seedbeds. About two fifths of farm households in the project area applied oilseed cake in their farmlands and average supply was 32 kg/hectare, while one fifth of farmers in the non-project area applied it to fertilize the farmlands and average amount of supply was 24 kg/hectare.

CHAPTER VIII

FARMERS' STRATEGIES AND PRIORITIES FOR LAND MANAGEMENT

As analyzed in chapter VII, farmers have adopted several types of structural and biological measures to control soil erosion and landslides and to improve soil fertility. This chapter firstly examines as to how management priorities are accorded to different types of land. This is followed by analysis of the major factors influencing land management priority.

8.1 Land Management Priority

A land management priority index is constructed assigning weightage based on the extent and intensity of soil erosion and landslide control measures and amount of farm inputs (Table 8.1). This index indicates that the project farmers assign first priority to *bari* land, as they are being intensively utilized. Second priority is given to *gharbari,* as they are the major source of vegetables, maize and millet. Third priority is given to *phantkhet,* since they are not prone to accelerated soil erosion and landslide and are owned by land speculators. Least priority is given to *tarikhet,* which might be explained by relatively poor soil quality and low crop yield.

Table 8.1: Land management priority

	Measures	Project Area				Non-project Area			
		PK	TK	Bari	GH	PK	TK	Bari	GH
Structural measures	Terraced farming	1	2	4	3	1	2	4	3
	Construction of waterways	4	3	2	1	3	4	2	1
	Gully control	2	1	1	3	2	3	4	1
	Construction of check dams	1	2	3	4	1	2	3	4
	Construction of retention walls	3	4	2	1	3	4	2	1
	Terrace improvement	3	4	1	2	1	3	2	4
	Land slide control	4	3	1	2	1	1	2	3
	Index of structural measures	2.6#	2.7#	2.0#	2.3#	1.7#	2.7#	2.7[illegible]	2.4#
	Priority	**III**	**IV**	**I**	**II**	**I**	**III**	[illegible]	**II**
Biological measures	Trees and shrub plantation	4	2	1	2	4	3	2	1
	Mulching	3	2	1	4	2	4	3	1
	Index of biological measures	3.5#	2.0#	1.0#	3.0#	3.0#	3.5#	2.5#	1.0#
	Priority	**IV**	**II**	**I**	**III**	**III**	**IV**	**II**	**I**
Fertility management	Application nitrogen	3	4	2	1	3	4	2	1
	Application phosphorous	3	4	2	1	3	4	2	1
	Application of potassium	3	4	2	1	4	3	2	1
	Index of fertility management priority	3#	4#	2#	1#	3.3#	3.7#	2.0#	1.0#
	Priority	**III**	**IV**	**II**	**I**	**III**	**IV**	**II**	**I**
Overall priority	Index of overall management priority	2.8#	2.9#	1.8#	2.1#	2.3#	3.1#	2.5#	1.8#
	Priority	**III**	**IV**	**I**	**II**	**III**	**IV**	**II**	**I**

Source: Household survey, 1999

NB: PK= *Phantkhet*, TK= *Tarikhet*, GH= *Gharbari*
The lower the index higher the priority
Please see the end note of this chapter for method employed to construct the index
Not significantly different at 0.05 confidence level (T Test, P >0.05)

In regard to non-project farmers, they accord first priority to *gharbari* and second priority to *bari,* as in the case of project area, these lands are the major source of food crops. Despite the need for intensive care and maintenance, top priority has not been given to *bari* owned by Gurung people, who depend mainly on earnings from remittances and pension to fulfill their requirements. Third priority is given to *phantkhet,* as they are owned by farmers who are utilizing this type of land for cash crop farming. As in the project area, least priority

is given to *tarikhet* (Table 8.1). Overall there is no significant different in land management priority between project and the non-project area.

8.1.1 Structural Measures

Terrace construction and maintenance, construction of waterways, check dams and retention walls are structural measures being adopted by farmers. Overall, they accord first priority to *bari*, followed by *gharbari, phantkhet* and *tarikhet*. In the non-project area, top priority is given to *phantkhet*, followed by *gharbari, bari* and *tarikhet* (Table 8.1).

Phantkhet must have leveled terraces for uniform and regular supply of water for rice cultivation. Therefore, farmers assign first priority to *phantkhet* for terrace construction in both project and non-project areas. Similarly, *tarikhet* also require leveled terraces for rice cultivation during the monsoon season. Hence, the second priority is given to them. *Gharbari* and *bari* can be cultivated without leveled terraces and, therefore, they are given low priority.

Farm terraces require regular repair and maintenance work in each farming season when they are damaged by landslides during the rainy season and livestock grazing during the fallow period in the winter season. On average, two percent of farm terraces are improved annually in the project area three percent in the non-project area depending on farmers' household labor force size. Annually farmers spent about two man-days/hectare in the project area and four man-days in the non-project area for repairing and improving terraces (Table 8.2). Farm households with relatively large labor force size invest more days than households with small labor force size. About three fifths of farm households in both areas have reportedly labor shortage for terrace improvement pursued mainly by males. But the tendency towards out-migration of males has constrained regular repair and maintenance work in both areas. Farmers in the project area assign their first priority to *bari*, followed by *gharbari, phantkhet* and *tarikhet* for terrace improvement. Non-project farm households assign first priority to *phantkhet,* second to *bari,* third to *tarikhet* and lowest to *gharbari* (Table 8.2).

Waterways are constructed to reduce soil erosion in the farmland. Farmers give first priority to *gharbari*, second priority to *bari,* third to *tarikhet* and fourth to *phantkhet* according to their vulnerability to soil erosion. Average density of waterways per hectare of land in the project area is found about two in *phantkhet*, four in *tarikhet*, and ten each in *bari* and *gharbari*. In the non-project area, waterways density is significantly low ($P \leq 0.05$) compared to the project area. The density of waterways is much higher in *gharbari* and *bari* compared to *tarikhet* and *phantkhet* in both areas. Thus, farmers have similar priorities for the construction and maintenance of waterways in both areas. However, the area protected by waterways is considerably high in the project area compared with the non-project area (Table 8.2).

Construction of check dams is another structural measure adopted by farmers to protect farmlands from flooding and stream cutting. Both project and non-project farmers have similar priority for their construction. *Phantkhet* located in the valley floor are flooded when heavy rainfall occurs in the ridges and hill slopes. They are also vulnerable to side cutting by streams during the monsoon season. Therefore, farmers have assigned first priority to *phantkhet. Tarikhet* in the hill slopes are damaged by small streams originating in the ridges. Therefore, farmers assign second priority to protect these lands using check dams. *Bari* and *gharbari* are relatively far from streams and they do not need check dams. Therefore, they are accorded lowest priority.

Table 8. 2 Priority for erosion control measures

Structural measures	Project Area				Non-project Area			
	Phant khet	*Tari khet*	*Bari*	*Gharbari*	*Phant khet*	*Tari khet*	*Bari*	*Gharbari*
Percentage of farm terraces improved last year	1.0	1.4	1.0	2.0	2.5	3.7	3.4	3.0
Workdays invested in terrace improvement/hectare	1.6*	1.0*	3.0	2.3	6.3*	4.3*	2.6	1.6
No of waterways/hectare	1.2	3.6*	9.5*	10.3*	2.0	1.2*	2.5*	6.2*
Percentage of area covered by waterways	15.0	27.0	17.0	12.0	21.0	9.0	6.0	9.0
No of controlled gullies/hectare	0.3*	1.4*	1.0*	1.2 *	1.3*	0.2*	0.4*	0.7*
percentage of area protected by gully control measures	28.0	58.0	58.0	6.0	22.0	11.0	8.0	59.0

Source: Household survey, 1999

NB: * Significantly different at 0.05 confidence level (T Test, P≤0.05)

Retention walls are built to protect terrace risers of *gharbari* and *bari* in both project and non-project areas. *Gharbari* and *bari* terraces are more prone to landslide at the outer edges particularly when heavy rainfall occurs. To prevent it, the concerned farmers jointly built retention walls in *gharbari* and *bari*, which demands for very high labor-intensive work requiring transportation of a lot of stone by farmers. The density of retention walls is sparse in farmlands distant from farm houses like *phantkhet* and *tarikhet.*

Gully expansion has been one of the major land management problems in the hill slope. Farmers have installed preventive structures depending on severity of the problem. In this regard, top priority is given to *bari* and *tarikhet* in the project area and *gharbari* and *bari* in the non-project area. About a half of the total farmlands in the project area and one fourth in the non-project area are protected by different measures preventing the expansion of gullies.

8.1.2 Biological Measures

Farmers have also applied different types of biological measures for their management. Project farmers assign first priority to *bari*, followed by *tarikhet*, *gharbari* and *phantkhet* in managing lands using biological measures, like mulching and shrub plantation. *Bari* terrace risers are relatively high which need sufficient protection from being collapsed during the monsoon season. Besides, being intensively utilized, they need high amount of nutrient to maintain the soil fertility. *Gharbari* are close to farm houses and therefore farmers prefer to grow fodder trees and shrub there. This allows them to collect fodder and other tree products easily. Being far from households, farmers do not grow much trees and shrubs in *tarikhet. Phantkhets* are also distant from the farm household and have very narrow terrace risers constraining tree and shrub growing. Non-project farmers assign first priority to *gharbari*, followed by *bari*, *phantkhet* and *tarikhet* (Table 8.2).

8.1.2.1 Tree and Shrub Growing

Farmers have grown fruit, fodder and timber trees in wide terrace risers and in edges of farmlands. Besides, fulfilling fodder, fuel-wood and timber, trees and shrubs contribute to control soil erosion and landslide, and enhance soil fertility.

Farmers select vegetational species to be grown in farmlands according to their household need, vulnerability of terrace risers to landslide, landholding size, and distance of farm plots from farmhouse. Wherever it be, first priority is given to control gully expansion and repair landslide scars by growing fodder trees. Normally *gharbari* get priority for fruit trees plantation, as being well fenced and located adjacent to farm household, there is no risk of fruits being poached and trees being destroyed by stray livestock. Second priority is given to farm edges to make very efficient use of scarce land resource.

Table 8.3: Priority for tree and shrub growing

(Number of trees)

	Project area					Non-project Area				
Land type	Parcel no without trees	Parcel no with trees	% of land without trees	% of land with trees	Tree density per hectare	Parcel no without trees	Parcel no with trees	% of land without trees	% of land with trees	Tree density per hectare
Phantkhet	38	17	70.0	30.0	42*	154	23	88.0	12.0	2.6*
Tarikhet	144	252	27.0	73.0	76*	222	78	71.0	29.0	36*
Bari	19	75	12.0	88.0	200*	96	73	46.0	54.0	83*
Gharbari	39	122	15.0	85.0	169	53	90	24.0	76.0	136
Farm total	240	466	28.0	72.0	97*	525	264	65.0	35.0	49*
Kharbari	5	99	8.0	92.0	674*	20	91	14.0	86.0	310*
Jungle	0.0	25	0.0	100.0	2,143*	0.0	40	0.0	100.0	991*
All	245	590	25.0	75.0	214*	545	395	56.0	44.0	132*

Source: Household survey, 1999

*Significantly different at 0.01 confidence level (T Test, P≤0.01)

NB: Trees and shrubs are planted only in terrace risers of *phantkhet* and *tarikhet*.
Fodder trees and shrubs are planted in terrace risers and edges of *bari* and *gharbari*.
Fruit trees are grown in *gharbari*..
Kharbari and *jungle* are entirely utilized for growing fodder and fuelwood trees and grass.

Bari terrace risers are normally utilized for growing fodder species of shrubs and trees. Shrubs are grown mainly in high terrace risers and terrace edges susceptible to landslide. Short fodder trees are planted in relatively low terrace risers. Being located relatively close to farm houses, farmers find it easier to collect fodder from *bari*. *Tarikhet* terrace risers are also utilized for fodder and fuel-wood trees, which do not require much care. Normally *phantkhet* terrace risers are not utilized for tree and shrub growing. However, spontaneously grown woody plants are found in relatively wide edges of terraces. *Kharbari* and *jungle,* located in steep slope are utilized for ground grass and timber species of trees. Farmers' priorities for tree and shrub plantation are similar in both project and the non-project areas. However, the project area has significantly high tree density (P≤0.01) compared with the non-project area (Table 8.3).

About three fourths of the total terrace risers in the project area and two-fifths in the non-project area are being utilized for growing tree and shrub species. Tree density in all types of land except in *gharbari* is found significantly higher (P≤0.01) in the project area compared to the non-project area (Table 8.3). This is attributed to the distribution of seedlings and provision of a good extension service by the Phewatal Watershed Management Project.

8.1.2.2 Mulching

Mulching is an effective method of soil erosion control. About one fifth of farmlands in the project area and one tenth in the non-project area are mulched during the spring and pre-monsoon seasons. Farmers give priority to *bari*, *tarikhet*, *gharbari* and *phantkhet* in a

descending order in the project area and *gharbari, bari, phantkhet* and *tarikhet* in the non-project area (Table 8.1). The intensity of mulching depends on availability of mulching materials, distance of land from farmhouse and type of crops cultivated. *Gharbari* are adjacent to farm houses, and cultivated with vegetables and potato which require mulching to conserve soil moisture. Therefore, mulching is intensively practiced there. Despite being distant from farm households, *tarikhet* are also mulched particularly for potato cultivation.

8.1.3 Fertility Management Priority

Farmyard manure (FYM), compost, chemical fertilizer, green manure, and small amount of oilseed cake and ash are the major fertilizers applied by farmers to maintain soil fertility. These fertilizers vary interms of nutrient content and, therefore, all types of fertilizers applied by farmers have been converted into standard macronutrient, like nitrogen (N), phosphorous (P_2O_5), and potassium (K_2O), shortly known as NPK, for analysis using Table A. 10. Then, the management priority has been analyzed by cropping intensity, land holding size, land tenure and the distance between farm plots and farmhouses.

8.1.3.1 Priority by Cropping Intensity

Farmers accord fertility management priority according to the cropping intensity. Normally the application of NPK increases with increasing cropping intensity in both areas. Being most intensively utilized *gharbari* in both areas receive significantly high amount of NPK (Table 8.4) compared to other lands. Second priority is given to *bari* followed by *phantkhet* and *tarikhet*. In both watersheds *bari* lands receive significantly higher amount of NPK compared to *phantkhet* and *tarikhet,* but lower than *gharbari*. The NPK supply is not significantly different between *phantkhet* and *tarikhet*. However, *phantkhet* receive marginally high amount of NPK in both areas.

Table 8.4: Nutrient supply by cropping intensity

Land type	Project area		Non-project area	
	Cropping intensity	NPK supply kg/ha	Cropping intensity	NPK supply kg/ha
Phantkhet	1.4	110*	1.6	66*
Tarikhet	1.3	79	1.4	63
Bari	3.2	278*	2.3	147*
Gharbari	3.3	423*	2.6	247*

Source: Household survey, 1999
NB: * Significantly different at 0.05 confidence level (T Test, $P \leq 0.05$)

Significantly higher ($P \leq 0.05$) amount of NPK application to project *gharbari* and *bari* lands is attributed to the application of chemical fertilizers provided by LAC and the project. The application of such fertilizers is extremely limited in non-project *gharbari* and *bari*. Similarly, the application of NPK is significantly higher in project *phantkhet* ($P \leq 0.05$) than in the non-project *phantkhet*. It is slightly high in project *tarikhet*.

8.1.3.2 Priority by Landholding Size

The size of land holdings has significant influence in determining the amount of NPK applied. In both areas, there is a tendency of decreasing the amount of NPK significantly with the increasing landholding size (Table 8.5). Marginal and medium farmers could apply relatively large quantity of NPK. Contrarily, the large farmers, with relatively large

landholdings could not apply as much amount of NPK as applied by marginal and medium farmers.

Table 8.5: Nutrient supply by landholding size

Land type	Land holding size in hectare	Project area NPK supply in kg/hectare	Non-project area NPK supply in kg/hectare
Phantkhet	< .05	81	122
	0.05-0.10	60	88
	0.11-0.15	197	54
	>0.15	113	45
Tarikhet	< .05	161	163
	0.05-0.10	126	101
	0.11-0.15	106	59
	>0.15	62	32
Bari	< .05	575	315
	0.05-0.10	269	162
	0.11-0.15	242	134
	>0.15	257	131
Gharbari	< .05	758	357
	0.05-0.10	515	206
	0.11-0.15	268	178
	>0.15	211	147

Source: Household survey, 1999

NB: Significantly different within groups in both areas at 0.01 confidence level (F test, $P \leq 0.1$).

8.1.3.3 Priority by Distance of Farm Plots

The proximity of land from farm households is another important factor explaining fertility management. Normally land parcels relatively close to farm households receive more NPK than those relatively distant. The average distance to farm plots from farm houses is 1.5 km in the project area and 2.5 km in the non-project area. Thus, the average distance to farm plots from farm house is significantly high ($p \leq 0.05$) in the non-project area compared to the project area.

Table 8.6: Nutrient supply by distance from farmhouse

Land type	Distance from farm house (in meter)	Project area NPK supply Kg/hectare	Non-project area NPK supply Kg/hectare
Phantkhet	< 600	312 *	95*
	601-1200	306 *	84 *
	1201-1800	83	63
	>1800	34	50
Tarikhet	< 600	107	81
	601-1200	82	63
	1201-1800	73	49
	>1800	34	39
Bari	< 600	339 *	171 *
	601-1200	268 *	160 *
	1201-1800	167 *	116 *
	>1800	102 *	52 *
Gharbari	< 600 meter	423 *	247 *

Source: Household survey, 1999

NB: * Significantly different at 0.05 confidence level (T test, $p \leq 0.05$)

In both watersheds, the amount of NPK applied declines significantly in all types of lands as their distance from farm houses increases (Table 8.6). Compost and FYM are the

major source of NPK for crops. Being bulky, transportation of these fertilizers requires a considerable amount of labor. Therefore, farmers apply more amount of fertilizers to farm plots located relatively close to their houses.

8.1.3.4 Priority by Land Tenure

Land tenure is a legislative regime describing the general rules and conditions for possessing, benefiting, restrictions, responsibilities of ownership and occupation or use of lands (Humphires, 1999:42). Most farmers in the study area have permanent ownership land certificates issued by the District Land Administration Office. This facilitates use and management of land resources without any feeling of insecurity. It also allows farmers to sell and rent-out or mortgage-out their lands.

Table 8.7: Distribution of landholdings by type of land tenure

(Area in hectare)

Type of land	Project Area						Non-project Area					
	Number of parcel			Total area in hectare			Number of parcel			Total area in hectare		
	Owner Operated	Mortgaged and rented	Total	Owner operated	Mortgaged and rented	Total	Owner operated	Mortgaged and rented	Total	Owner operated	Mortgaged and rented	Total
Phantkhet	32 (58)	23 (42)	55 (100)	7.0 (66)	3.6 (34)	10.6 (100)	21.4 (81)	32 (19)	177 (100)	21.4 (76)	6.8 (24)	28.2 (100)
Tarikhet	312 (79)	84 (21)	396 (100)	48.8 (74)	17.2 (26)	66 (100)	237 (79)	63 (21)	300 (100)	35.1 (74)	12.4 (26)	47.5 (100)
Bari	92 (87)	2 (2)	94 (100)	8.0 (97)	0.3 (3)	8.3 (100)	133 (80)	36 (19)	169 (100)	14.3 (83)	3.0 (17)	17.3 (100)
Gharbari	161 (100)	0.0 0.0	161 (100)	15.7 (100)	0.0 0.0	15.7 (100)	143 (100)	0.0 0.0	143 (100)	15 (100)	0.0 0.0	15 (100)
Farmland subtotal	597 (84)	109 (16)	706 (100)	79.5 (78.9)	21.1 (21)	100.6 (100)	658 (83)	131 (17)	789 (100)	85.8 (79)	22.2 (20.5)	108 (100)
Kharbari	102 (97)	2 (3)	104 (100)	13 (99)	0.2 (1)	13.2 (100)	108 (97)	3 (3)	111 (100)	14 (95)	0.6 (5)	14.6 (100)
Jungle	25 (100)	0.0 0.0	25 (100)	3.0 (100)	0.0 0.0	3.0 (100)	40 (100)	0.0 0.0	40 (100)	7.4 (100)	0.0 0.0	7.4 (100)
Total	724 (87)	111 (13)	835 (100)	95.5 (82)	21.3 (18)	116.8 (100)	806 (86)	134 (14)	940 (100)	107.2 (82)	22.8 (18)	130 (100)

Source: Household survey, 1999
NB: Figures in parenthesis indicate percentage

Confronted with lack of savings required for fulfilling subsistence requirement as well as for children's marriage and medical treatment of family members, some farmers have mortgaged-out a few of their farm plots to other farmers who could lend them money. Likewise, some households with small labor force have rented out their land holdings. More than four fifths of land parcels in both project and non-project areas are operated by the owners, while one fifth of them are mortgaged and rented (Table 8.7). Problem with the later type of land tenure is that it prevents tenants from making investment in land management.

Table 8.8: Nutrient supply by land tenure

Land type	Land tenure	Project Area	Non-project Area
		NPK supply kg/hectare	NPK supply kg/hectare
Phantkhet	Owner operated	132*	69
	Mortgaged and rented	67*	57
Tarikhet	Owner operated	90*	72*
	Mortgaged and rented	51*	31*
Bari	Owner operated	290*	157*
	Mortgaged rented	138*	83*
Gharbari	Owner operated	423**	247**

Source: Household survey, 1999
NB: * Means in column within the group are significantly different at 0.05 confidence level (T Test, P ≤0.05)
** Means in row are significantly different at 0.05 confidence level (T Test, P ≤0.05)

According to the Land Reform Act, a formally registered tenant has right to cultivate the land as long as he/she wishs to cultivate. If the owner decides discontinue with current tenant or sell the land, the tenant receives one fourth of the land as his/her share. As landowners do not want to lose their land, most tenancy arrangements are informal type, which allows landowners to change the tenants at any time they want. This constraints investments in farm improvement, including adoption of locationally suitable agricultural enterprises. It is corroborated by the fact that mortgaged or rented farm plots receive considerably low amount of NPK compared to owner operated farm plots (Table 8.8).

8.1.4 Labor Investment Priority

Overall agricultural activities, including land management, highly depend on human labor. Obviously land management practices are considerably determined by land type and household labor force size of farmers. Labor investment in land management, including terrace improvement, landslide treatment and stabilization and application of gully control measures, is highly influenced by the occurrence of landslide and extent of soil erosion. Project farmers accord their first priority to *bari* lands as they are prone to landslide and soil erosion. Second priority is given to *gharbari* followed by *tarikhet* and *phantkhet* (Table 8.9). Non-project farmers assign first priority for *tarikhet* where landslide occurrence is reportedly high than in other type of lands. Second priority is given to *bari* followed by *tarikhet* and *phantkhet*. There is no significant difference in labor investment in land management between project and non-project areas.

Major land management activities, including terrace improvement, landslide treatment, installation of check dams, retention walls and terrace risers scraping are normally pursued during the winter and spring seasons, when farmers are not very busy in crop cultivation. Besides, minor repairing and maintenance works like bund and waterway repairing are also done during crop cultivation in the monsoon season.

Table 8.9: Labor investment priority

Land type	Project Area			Non-project Area		
	Land management (Man-day/ha)	Crop cultivation (Man-day/ha)	Total (Man-day/ha)	Land management (Man-day/ha)	Crop cultivation (Man-day/ha)	Total (Man-day/ha)
Phantkhet	6.0	351	357	8.0	350	358
Tarikhet	12 *	310	322	21*	375	396
Bari	24	616 *	640*	19	477*	496*
Gharbari	17	553	570	14	503	517

Source: Household survey, 1999

NB: Labor investment in crop cultivation is calculated adding total labor input for each crop in a year

Please see Table 8.4 for cropping intensity

* Significantly different at 0.05 confidence level (T Test, $P \leq 0.05$)

Cropping intensity influences labor investment priority. Being intensively utilized, high amount of labor is used in *bari* land followed by *gharbari, phantkhet* and *tarikhet* in the project area. In the non-project area, highest priority is given to *gharbari* followed by *bari, tarikhet* and *phantkhet* (Table 8.9). Labor use in project *bari* is significantly higher ($P \leq 0.05$) than in the non-project *bari* due to higher cropping intensity in the former area. However, there is no significant variation in other types of lands.

Note

Construction of the Index of Land Management Priority

Weighted Priority Index

Computation of weighted priority index

- Priority for terracing was determined based on percentage of area under bench terraces.
- Priority for waterway construction was determined based on density of waterways per hectare and % of land protected by waterway.
- Priority for gully control was determined based on % of area protected by gully control measures.
- Priority for the construction of retention walls and check dams was determined through field observation and discussion with farmers.
- Priority for terrace improvement was determined based on % of improved terraces and number of man-days invested in per hectare of terrace improvement in 1998.
- Priority for landslide control was determined based on number of landslides repaired and number of workdays spent on repairing landslide in 1998 (per hectare of land).
- Priority for shrub and tree plantation was determined based on area under trees and shrubs and tree density per hectare of land.
- Priority for mulching was determined based on the area under this practice in 1998.
- Priority for fertility management was determined based on the nitrogen, phosphors and potassium (NPK) used per hectare of land in 1998. Farmyard manure, compost, green manure, oilseed cakes, and chemical fertilizers used by farmers were converted to NPK based on Table A. 10 and 7.4
- Weight 1 was assigned to first priority, 2 for second priority, 3 for third priority and 4 for the lowest priority

Weighted priority index was constructed to analyze the overall land management priority as follows:

$$Wp_i = \sum_{i=1}^{n} \frac{f_i X_i}{F_i}$$

Where

Wpi = Weighted priority index
fi = Frequency of measures
Xi = Weightage of priority
Fi = Total number of measures

CHAPTER IX

ACTORS AND FACTORS INFLUNCING LAND MANAGEMENT

9.1 Motivation to Adopt Land Management Technologies

Preceeding chapters indicated gradually changing land management practices of farmers. The question arises what are the actors and factors influencing land management. The specific objective of this chapter is to find out the answer of this question.

9.1.1 Agents Motivating the Adoption of Structural Measures

The most important agents motivating farmers in both project and the non-project areas to adopt structural measures of land management, including terraces, were their ancestors. Current structures like bench terraces are ancestral gifts constructed over past several centuries ago. It is extremely difficult to construct such structures by single generation. The present generation of farmers has made additional efforts to expand and consolidate the works done by the preceeding generations. The majority of farm households inherited some terraces as parental property. Additional terraces were constructed through motivation of development agencies and neighbors. Self-motivation through observation in neighboring villages and exchange of ideas with fellow farmers were the second important source of motivation (Table 9.1). In the project area, the contribution of external assistance was vital at the beginning to initiate land conservation works. Later the farmers followed soil conservation methods being promoted by the project. However, large structures like check dams, retention walls and irrigation canals were constructed under the technical and financial support provided by the Phewatal Watershed Management Project in the project area and government line agencies and NGOs in the non-project area (Table 9.1).

Table 9.1: Agents motivating the adoption of structural measures of land management

Structural measures	Project Area (N=155)					Non-project Area (N=145)				
	AN	LA	NE	SM	Total	AN	LA	NE	SM	Total
	f'	f'	f'	f'	f'	f'	f'	f'	f'	f'
Terrace construction	66.0	1.0	10.0	22.0	99.0	52.0	0.0	18.0	28.0	98.0
Waterways construction	42.0	15.0	11.0	24.0	92.0	30.0	1.0	19.0	42.0	92.0
Gully control	2.0	22.0	2.0	4.0	30.0	5.0	1.0	6.0	8.0	20.0
Construction of retention wall	3.0	31.0	4.0	4.0	42.0	1.0	0.0	5.0	6.0	12.0
Construction of check dam	4.0	6.0	0.0	4.0	14.0	2.0	7.0	0.0	6.0	15.0

Source: Household survey, 1999

NB: f'= Proportion of N

AN= Ancestors, LA= Line agencies, NE= Neighbors and SM= Self motivated through observation

9.1.2 Agents Motivating the Adoption of Biological Measures

All farmers in both areas have been practicing several biological measures of land management devised by their forefathers. Particularly in the project area, additional efforts were made by the officials to promote land management through biological methods. This explains why the majority of farmers in the project area mentioned line agencies and NGOs as actors persuading them to adopt biological measures of land management (Table 9.2).

Table 9.2: Agents motivating the adoption of biological measures in land management

Biological measures	Project Area (N=155)					Non-project Area (N=145)				
	AN	LA	NE	SM	Total	AN	LA	NE	SM	Total
	f'	f'	f'	f'	f'	f'	f'	f'	f'	f'
Alley cropping	2.0	22.0	2.0	2.0	30.0	1.0	6.0	4.0	6.0	17.0
Establish shrub species in gullies	26.0	41.0	13.0	7.0	87.0	15.0	4.0	42.0	22.0	83.0
Use of live materials for construction of retention walls	28.0	42.0	10.0	8.0	88.0	14.0	3.0	27.0	11.0	55.0
Mulching	19.0	26.0	20.0	5.0	70.0	27.0	1.0	14.0	5.0	47.0

Source: Household survey, 1999
NB: f'= Proportion of N
Please see Table 9.1 for abbreviations

In the non-project area, relatively higher percentage of farmers learned from farmers in the adjacent project area as a result of spell-over effect (Table 9.2). Some farmers were motivated to adopt biological measures through observation of land management practices being promoted in the project area. This indicates a strong willingness of farmers to adopt cost effective and locally manageable biological measures.

9.1.3 Agents Motivating the Use of Fertilizers

Hill farmers are using farmyard manure for fertilizing their lands since historic time. This is why four fifths of farmers in the project area and more than this in the non-project area said that they are applying manure to farmlands ever since the time of their forefathers. However, a few poor farm households could not use manure due to lack of livestock in the past. Currently these farm households have been able to raise at least one livestock per household. This explains the gradual increment in the proportion of farmers using FYM in both areas (Table 9.3).

Table 9.3: Agents motivating the use of fertilizer

Fertilizers	Project Area (N=155)					Non-project Area (N=145)				
	AN	LA	NE	SM	Total	AN	LA	NE	SM	Total
	f'	f'	f'	f'	f'	f'	f'	f'	f'	f'
FYM	81.0	0.0	2.0	7.0	90.0	86.0	0.0	3.0	4.0	93.0
Chemical fertilizers	0.0	65.0	15.0	16.0	96.0	0.0	20.0	25.0	14.0	59.0
Compost	2.0	5.0	3.0	2.0	12.0	5.0	15.0	1.0	4.0	34.0
Green manure	27.0	5.0	3.0	5.0	40.0	5.0	2.0	8.0	0.0	13.0
Legume crops cultivation	15.0	12.0	3.0	4.0	34.0	21.0	5.0	5.0	7.0	38.0

Source: Household survey, 1999
NB: f'= Proportion of N
Please see Table 9.1 for abbreviations

Regarding the use of chemical fertilizers, more than three fifths of farmers in the project area and one fifth in the non-project area were motivated by government agencies. Particularly the Phewatal Watershed Management Project provided chemical fertilizers to farmers free of charge in the late 1970s and the 1980s. Since then farmers are using chemical fertilizers regularly. About one sixth of farmers in the project area and one fourth in the non-project area said that they were encouraged by their neighbors, while others in both areas applied chemical fertilizers spontaneously (Table 9.3).

Compost application to farmlands was promoted by the Lumle Agricultural Research Center ever since its establishment in 1975 in the villages of adjacent watersheds. This technology was gradually adopted in other villages as farm households confronted with the decreasing supply of FYM. The Annapurna Conservation Area Project (ACAP) working in forest conservation in the non-project area had also provided training on compost making to some farmers. This is why relatively high percentage of farmers are found applying compost in the non-project area (Table 9.3).

About two fifths of farmers in the project area and one sixth in the non-project area use green manure in fertilizing their farmlands. This has been a traditional system practiced since long ago. Some farmers were, however, motivated by government agencies and neighbors (Table 9.3). Similarly, the cultivation of legume crops as a dietary has been a traditional practice. Recently the increasing number of farmers have been attracted to legume cultivation due to their lucrative commercial value.

9.2 Degree of Adoption of Land Management Technologies

In order to determine the degree of adoption of land management technologies, farmers were classified into two groups, high adopters and low-adopters, based on a composite value of fourteen land management practices. Irrespective of the year of adoption, a value of one was assigned to practices adopted by farmers and zero to those practices not adopted. A composite index was calculated by dividing the total value by 14. Accordingly, a composite mean of 0.59 was obtained for the project area and 0.48 for the non-project area. Farmers who obtained mean score above the composite mean value were classified as high-adopters and those with mean score below the composite mean were classified as low-adopters (Table 9.4). Thus, 81 percent of farmers in the project area and 54 percent in the non-project area were identified as high-adopters, while 19 percent farmers in the project area and 46 percent in the non-project area turned out to be as low-adopters.

Table 9.4: Adopters and non-adopters of conservation measures

Type	Measures	Project Area (N=155)			Non-project Area (N=145)		
		Adopters	Non-adopters	Index	Adopters	Non-adopters	Index
		f'	f'		f'	f'	
Structural measures	Terrace construction	99.0	1.0	0.99	98.0	2.0	0.98
	Construction of waterways	92.0	8.0	0.92	92.0	8.0	0.92
	Gully control	30.0	70.0	0.30*	20.0	80.0	0.20*
	Construction of retention walls	42.0	58.0	0.42*	12.0	88.0	0.12*
	Construction of check dams	14.0	86.0	0.14	15.0	85.0	0.15
Biological measures	Alley cropping	30.0	70.0	0.30*	17.0	83.0	0.17*
	Establish shrub and trees in gullies	87.0	13.0	0.87	83.0	17.0	0.83
	Use live materials in construction	88.0	12.0	0.88*	55.0	45.0	0.55*
	Mulching practices	70.0	30.0	0.70*	47.0	53.0	0.47*
Fertility management	Production and use of FYM	90.0	10.0	0.90	93.0	7.0	0.93
	Compost production and use	12.0	88.0	0.12*	34.0	66.0	0.34*
	Cultivate legume crops	34.0	66.0	0.34	38.0	62.0	0.38
	Use green manure	40.0	60.0	0.40*	13.0	87.0	0.13*
	Use chemical fertilizer	96.0	4.0	0.96*	59.0	41.0	0.59*
	Composite mean			0.59*			0.48*

Source: Household survey, 1999

NB: f'= Proportion of N

* Significantly different at 0.05 confidence level (T Test, $p \leq 0.05$)

Such significantly high percentage of high-adopters in the former area is attributed to conservation program implemented by the Phewatal Watershed Management Project. As farmers in the non-project area could not avail of any external support, majority of them appeared as low adopters. In the following section, the socio economic, institutional, spatial and ecological factors influencing the adoption of land management practices are analyzed using logistic regression method.

9.3 Factors Influencing Land Management: Conceptual Framework

The adoption of land management practices are influenced jointly by a set of interrelated socio-economic and institutional factors (Tisdell, 1996:130; Johnson et al, 1999). Farmers decide how to use their land in the light of their objectives, production possibilities and constraints. Farmers' characteristics, their feelings and aspirations considerably influence their decision making (Giampietro, 1997:201). Demographic characteristics of farm households, like number of economically active people at home, number of people involved in farming activities, and labor investment per unit of land are other factors influencing the adoption behavior especially in a situation where all farming activities heavily depend on household labor force (Rauniyar, 1998: 94) (Fig.9.1).

Traditionally Nepali Hindu society has been organized into a caste system based on ethnicity. Accordingly, Brahmin and Chhetri ethnic groups are considered as higher caste, Gurung and Magar as middle and other occupational groups are considered as lower caste. Brahmin and Chhetri follow traditional farm activities, while Gurung and Magar depend considerably on income from pension and remittances (Messerschmidt, 1976:33; Biot et al, 1995:107). Traditionally, these ethnic groups have been working with British, Indian and Nepalese army, and agriculture is their least preferred profession (Vansittart, 1993:25). The occupational caste or lower cast groups are primarily engaged in tailoring, woodcarving, pottery and agricultural equipment making. Thus, the ethnicity is an important factor determining the adoption of land management practices (Mehta and Kellert, 1998:328).

The educational background of household heads is also an influential factor, as they are the one who make most of the household decisions. Farmers who are literate and have relatively better exposure to society and local institutions are more adaptive than the illiterate farmers (Rauniyar, 1998:89; Mehta and Kellert, 1998:325; Johnson, 1999:140).

Resource ownership is another important factor determining the adoption of land management technologies (Savadogo et al, 1998). Increasing population pressure and decreasing per capita farmland creates pressure on household economy, eventually making it essential for farmers to adopt land management practices in order to attain household food security (Meertens et al, 1996:214). Sometimes, the scale of farm economies influences the adoption process. Farm operation at relatively large scale reduces the cost for conservation measures and encourages investment in land management (Raquel, 1985). In a situation like the hills of Nepal, farmers with relatively large livestock herd size find it difficult to follow conservation practices than small herd owners. The large herd owners would be interested in free livestock grazing, which causes land degradation especially when the livestock population exceeds the carrying capacity of land resources (Thapa and Paudel, 2000). Trees grown in farms are sources of household income. Farmers who own large number of trees generate relatively high amount of income by selling fruits and other products, which enables them to make investment in land conservation. Similarly, trees are sources of organic materials required to improve soil fertility and crop yield.

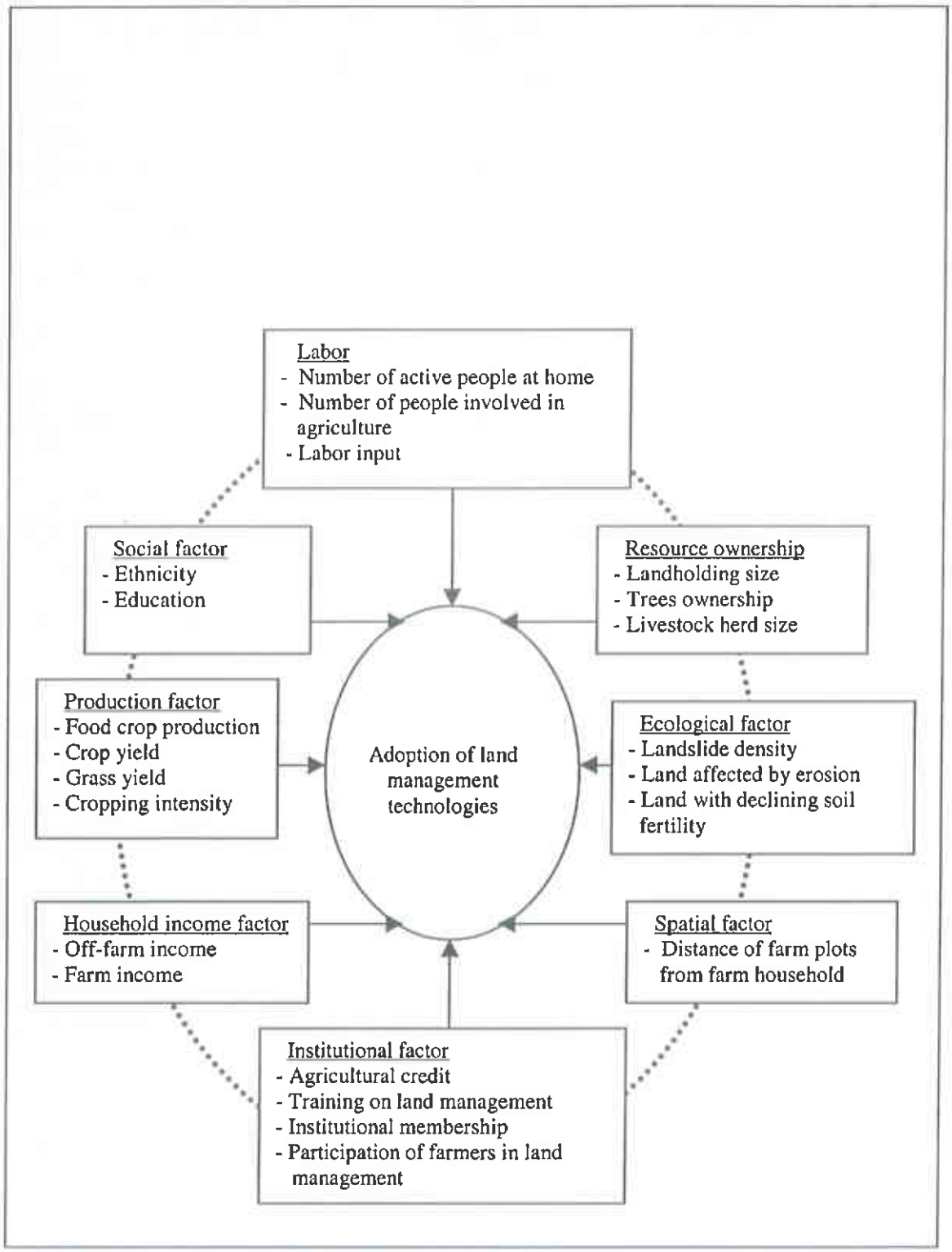


Figure 9.1: Factors influencing the adoption of land management technologies: Conceptual framework

The scale of farm production considerably influences farmers' decision making (Raquel, 1985; Nelson and Cramb, 1998). The amount of farm income which is determined by crop and grass yields enable farmers to make investment in conservation measures (Barker, 1997: 58). Likewise, farmers apply different land management practices when the cropping intensity is high.

Supplementary household income from off-farm sources contributes to land improvement. However, the earnings will not have any influence, if there is no prospect for increasing income from agriculture. This explains why very little amount of cash income is invested by hill farmers in land management including the purchase of fertilizers and terrace improvement (Seddon et al, 1979, Thapa, 1993). Normally farmlands located relatively close to farmhouses receive relatively higher amount of fertilizers than those located distant (Fig. 9.1).

Table 9.5: Explanatory variables

Variables	Specification
Active labor force (X_1)	Active labor force, aged 11-59, at home (no/household)
Agricultural labor force (X_2)	Active people involved in agricultural work (no/household)
Labor input (X_3)	Labor input in land management and crop production (workdays/hectare/year)
Ethnicity (X_4) *	It is a dummy variable please see footnote of this table
Schooling year (X_5)	Schooling period of the household head (no of years studied at a school/campus)
Land ownership (X_6)	Land ownership (hectare/person)
Tree ownership (X_7)	Fruit, fodder, and timber trees (no/person)
Livestock ownership (X_8)	Livestock ownership (head/person)
Food production (X_9)	Food crop production (kg/person/year)
Crop yield (X_{10})	Crop yield (kg/hectare/year) (composite yield of all crops)
Grass yield X_{11})	Grass yield (Kg/hectare)
Cropping intensity (X_{12})	Ratio of gross cropped area under different crops to net available farmland
Farm income (X_{13})	Cash income from farm sources (Rs./person/year)
Off-farm income (X_{14})	Net cash income from off farm sources (Rs/person/year, including remittances)
Distance (X_{15})	Mean distance to farm plots from farm house (in km)
Landslide density (X_{16})	Landslide density in farmland (no/hectare)
Land affected by erosion (X_{17})	Percentage of agricultural land seriously affected by soil erosion
Land with declining fertility (X_{18})	Percentage of agricultural land with declining soil fertility
Credit (X_{19})	Credit obtained for farming activities (Rs/person)
Institutional membership (X_{20})	Number of family members affiliated with local institutions (no/household)
Training (X_{21})	Land management training attended by the household head (no during 1988-1998)
Extension service (X_{22})	Frequency of visits by extension workers/during 1988-98)
Participation (X_{23})	Participation in joint land management activities (workdays/household during 1988-98)

NB: * According to their social hierarchy weight 4 was assigned to Brahmin and Chhetri, 3 for Gurung and Magar, 2 for minority ethnic group and 1 for occupational cast group.

Land resources undergo degradation due to landslide, accelerated soil erosion and declining fertility. Most often farmers adopt new land management technologies when they realize the effect of land degradation on crop production (Lutz et al, 1994:276). Declining

crop yield creates food security problem. In response, farmers react in a number of ways and adopt several land management technologies (Gafsi and Brossier, 1997:71) (Fig 9.1).

Provision of support services including agricultural credit, training and extension services is essential to enable farmers to adopt conservation measures. Effective services are essential especially during the initial phase (Gafsi and Brossier, 1997:92). Line agencies and NGOs can play an important role in providing information to farmers about new technologies (Versteeg et al. 1998:276). Normally adoption rate would be high, if farmers are regularly advised by competent extension agents, with adequate support materials provided in a coordinated way (Barker, 1997:62; Adesina et al, 2000:264) (Figure 9.1).

9.4 Factors Influencing Land Management

As conceptualized in preceeding section adoption of land management practices is influenced by a set a factors which is analyzed using logistic regression as follows:

9.4.1 Logistic Regression

Probit and logistic regression methods can be employed for the construction of adoption model when the dependent variable is binary (Raquel, 1985). Like in the linear probability model, the predicted probabilities of both logistic and probit regression model always approach 0 and 1 and yield similar result (Hair et al, 1998). Hence, the logistic regression is an appropriate statistical tool to determine the influence of independent variables on dependent variables, when the dependent variable has only two groups e.g., adopters and non-adopters (Neupane, 2000; Mehta and Kellert, 1997; Mardia et al, 1982). This analysis has a straightforward statistical test, with high ability to incorporate non-linear effects and wide range of diagnostic power (Hair et al, 1998). To pursue the logistic regression analysis, the dependent variable, adoption of land management practices, is hypothesized of being influenced by a set of independent variables (Table 9.5). The independent variables other than ethnicity are self-explanatory expressed numerically. Whereas the ethnicity is a dummy variable created through weighted score method (Table 9.5).

9.4.2 Model Specification

To construct the logistic regression model, the dependent variable, adoption of land management practices, was converted into a dichotomous-binary variable stating high and lower level of adoption (Table 9.4). Value one was assigned to high adopters and 0 to low adopters. Then the variable was analyzed in association with other independent variables using logistic regression method. The variables listed in Table 9.5 were considered as independent variables influencing the adoption of land management practices. In view of the possibility of variation in influencing factors, separate logistic regression models were constructed for project and non-project areas.

The model is specified as follows:

$Ln\ [P_i/(1-P_i)] = \beta_o + \beta_1 X_1 + \beta_2 X_{2i} + \ldots \beta_k X_{ki}$

Where,

The subscript $_i$ is the ith observation in the sample

P is the probability of the outcome

β_o is the intercept term

$\beta_1, \beta_2 \ldots\ldots \beta_k$ are the coefficients of explanatory variables $X_1, X_2 \ldots\ldots X_k$.

In this logistic model of adoption of land management practices, the coefficients are compared with the probability of an event occurring with or not occurring. The estimated (β) coefficients do not directly indicate the effect of change in the corresponding explanatory variables on probability (P) outcome of the occurring. The coefficients demonstrate the effect of each explanatory variable on log of odds as follows:

$\{ Ln[\ P/(1-P)\ ]\}$

A positive coefficient increases the probability of where as the negative value decreases the predicted probability. The coefficients in the model are estimated in an interactive manner through the maximum likelihood procedures.

The mathematical equation for estimation is formulated as follows:

$$P_i = Prob\,(Y_i = 1) = \frac{1}{1+e^{-(\beta_o \beta_1 X_{1i} + \ldots + \beta_k X_{ki})}} = \frac{e^{(\beta_o + \beta_1 X_{1i} + \ldots + \beta_k X_{ki})}}{1+e^{(\beta_o\ \beta_1 X_{1i} + \ldots + \beta_k X_{ki})}} \quad \text{(i)}$$

Similarly,

$$\Pr ob\,(Y_i = 0) = 1 - \Pr ob\,(Y_i = 1) = \frac{1}{1+e^{(\beta_o + \beta_1 X_{1i} + \ldots + \beta_k X_{ki})}} \quad \text{(ii)}$$

Dividing (i) by (ii) we get

$$\frac{\Pr ob\,(Y_i = 1)}{\Pr ob\,(Y_i = 0)} = \frac{P_i}{1-P_i} = e^{(\beta_o + \beta_1 X_{1i} + \ldots\ldots + \beta_k X_{ki})} \quad \text{(iii)}$$

Where P_i is the probability that y_i takes the value 1 and then $(1-P_i)$ is the probability that Y_i is 0 and e is the exponential constant.

Now taking the natural log in both sides of equations (iii) we get

$$Ln\ [P_i/(1-P_i)] = \beta_o + \beta_1 X_1 + \beta_2 X_{2i} + \ldots \beta_k X_{ki} \quad \text{(iv)}$$

Holding the rest of the variables constant, odds{P/(1-P)} and probability (P) of the outcome given k^{th} independent variables is equal to $e^{\beta}k$ and $1(1+e^{-\beta}k)$, respectively. Therefore,

$\beta_k = 0 \Rightarrow$ odds = and probability (P) =0.5 (v)

$\beta_k > 0 \Rightarrow$ odds > 1 and probability (P) >0.5, and

$\beta_k < 0 \Rightarrow$ odds < 1 and probability (P) <0.5

9.4.3 Interpretation of the Results

The maximum likelihood estimates of parameters of explanatory variables in the logistic regression models of the adoption of land management practices demonstrate the effects of independent variables on odds and probability of the land management practices. The log likelihood ratio tests show that the data set of explanatory variables fit into the model including the constant in both project and the non-project households. It indicates that there is a significant relationship between log of odds and hence odds and probability of adoption of land management practices and the explanatory variables included in the model. These variables contribute significantly in a group to explain the changing behavior of the respondents, though several coefficients are not significant individually. Nagelkerke R^2 value is 0.61 in the project area and 0.52 in the non-project area. The percentage of the correct prediction is 87 percent in the project area and 79 percent in the non-project area. These values suggested that the estimated adoption of land management models have high explanatory power in both project and the non-project households (Table 9.6). The overall models of chi-square values for the adoption of land management practices are highly significant at 0.01 confidence level in both project and the non-project areas, indicating that the models are statistically significant.

9.4.4 Determinants of Land Management in Project Area

Out of 23 variables included in the logistic regression model, five variables including economically active people involved in agricultural work, schooling period of the household head, tree ownership, grass yield and percentage of land seriously affected by soil erosion significantly explained ($P \leq 0.05$) the adoption of land management practices (Table 9.6).

Farmland seriously affected by soil erosion is the most important determinant of the adoption of land management practices (Table 8.6). Possessing of small landholdings, farmers have to face food shortage with increasing area seriously affected by soil erosion. Therefore, they have a tendency towards adoption of more conservation practices in both project and non-project areas.

The number of economically active people involved in agricultural activities appeared as another variable explaining the adoption of conservation measures significantly (Table 9.6) Land conservation measures ranging from terrace repair to grass growing in terrace risers are highly labor intensive. Naturally farm households with relatively high number of members involved in agricultural activities adopt more land management technologies.

Households with high degree of adoption of conservation measures have relatively large number of household members involved in farm activities. In the project area, the number of household members involved in conservation activities significantly influenced the adoption of conservation technologies, which is not the case in the non-project area.

Farmers' educational level significantly influences the adoption of land management practices. The reason for significant positive contribution of the level of education in the project area is that the literate farmers are more aware of the long term advantages of conservation practices and have maintained good personal contacts with line agencies and NGOs, who are engaged in promoting land management technologies (Table 9.6). In the non-project area, educational level could not influence the adoption of land management technologies significantly due mainly to lack of a project engaged in technology promotion.

Table 9.6: Factors influencing in the adoption of land management practices

Variables	Project Area (N=155)				Non-project Area (N=145)			
	β	T Ratio	Exp (β)	Prob (p)	β	T Ratio	Exp (β)	Prob (p)
Active labor force (aged 11-59)	-0.047	0.11	0.948	.48	-0.362 ***	1.69	-0.695	.40
Agricultural labor (no/household)	0.633 ***	1.71	1.883	.65	0.239	1.10	1.271	.56
Labor input (work days/hectare)	0.001	1.00	1.001	.50	0.001*	1.00	1.007	.50
Ethnicity	0.290	1.00	1.748	.63	0.675*	3.10	1.964	.66
Schooling year of the household head	0.184***	1.70	1.202	.55	0.991	1.40	1.104	.53
Land ownership (hectare/person)	15.740	0.78	68.01	.98	2.212	0.32	1.134	.53
Tree ownership (no/person)	0.052 *	2.50	1.949	.66	-0.001	0.10	0.999	.49
Livestock ownership (head/person)	-0.105	0.55	0.900	.45	-0.100	1.00	0.904	.47
Food production (kg/person)	0.010	1.00	1.004	.50	0.001	0.55	1.996	.67
Crop yield (kg/hectare)	2.170	0.23	1.000	.50	0.001	1.00	1.001	.50
Grass yield (kg/hectare)	0.001***	2.00	1.020	.50	0.001	0.50	1.001	.50
Cropping intensity	0.366	0.68	1.693	.63	0.157	0.58	1.170	.54
Farm income (Rs/person)	0.001	0.80	1.999	.67	2.301	11.55	1.000	.50
Off-farm income (Rs/person)	-1.711	0.20	0.999	.49	-1.781	0.94	0.999	.48
Distance to farmland (in km)	0.562	0.20	1.755	.63	0.545	1.59	1.725	.63
Landslide density (no/hectare)	0.010	1.00	1.006	.50	0.030	1.20	1.031	.51
Percentage of farmland seriously affected by soil erosion	16.750*	2.50	18.00	.95	3.107***	1.80	1.045	.51
Percentage of farmland with declining soil fertility	0.558	0.18	1.572	.61	1.506	1.30	4.507	.82
Credit (Rs/person)	6.410	6.40	1.001	.50	2.605	2.20	1.000	.50
Institutional membership (no of household member affiliated)	0.085	1.30	1.088	.52	0.646***	1.80	1.908	.66
Training (no attended by respondent during 1988-98)	0.621	1.30	1.859	.65	0.216	1.10	1.241	.55
Extension visit (Frequency of visit made by extension worker 1988-98)	3.901	3.50	1.000	.50	0.233**	2.10	1.262	.56
Participation (workday contributed in joint land management activities)	0.010	0.45	1.009	.50	0.130	0.65	1.013	.50
Constant	3.189 **	3.01			5.615 *			
Cox and Snell R^{2a}	0.57				0.49			
Nagelkerke R^2	0.61				0.52			
Likelihood ratio test [b]	87 (p≤0.01)				71 (p≤0.01)			
No of correct prediction	135 (88%)				115 (79%)			

NB: [a] The higher Cox and Snell R^2 value indicates greater the model fit. However, this value can not reach to maximum value of 1, so Nagelkerke proposed a modification that had the range of 0 to 1 (Hair et al, 1998).

[b] Likelihood ratio test is used to test the null hypothesis stating that there is no relationship between the log of odds of adoption of land management practices and the set of independent variables included in the model (i.e., H_o: $\beta_1=\beta_2=.....=\beta_{23}=0$). ***, ** and * denotes 0.10, 0.05 and 0.01 levels of significance

Regarding the role of tree ownership, farmers in the project area were made well aware of the economic and environmental benefits of tree growing in marginal land by the Phewatal Watershed Management Project. By virtue of relatively easy access to the regional city of Pokhara, farmers could increase their household income by selling tree products. Particularly the plantation of fodder trees facilitated commercial dairy buffalo raising, eventually increasing the supply of organic fertilizers to land and enhancing farmers' ability for investment in land management. Therefore, tree ownership significantly influenced the adoption of conservation measures in the project area. This variable could not influence significantly in the non-project area, as tree growing could not promote commercial dairy farming due to lack of transportation facility.

Grass yield in farm terrace risers is also an important variable influencing land management positively (Table 9.6). This is partly because of that increased grass yield contributed to increasing supply of milk which has been one of the main sources of household income required for investment in land management.

9.4.5 Determinants of Land Management in the Non-project Area

As in the case of the project area, 23 explanatory variables were included in the logistic regression model to examine their influence in the adoption of land management practices. Out of the total, five variables, including the percentage of land seriously affected by soil erosion, ethnicity, labor input in land management, institutional membership and frequency of contacts with extension workers had significantly ($P \leq 0.05$) positive influence on the adoption of land conservation practices. Notably all explanatory variables except the percentage of farm area under serious soil erosion were different from the project area (Table 9.6).

Ethnically Brahmin and Chhetri farmers invest more time and resources in farmland management compared to other ethnic groups including Gurung, Magar, minority ethnic groups and occupational caste group as land is the primary source of household earning. This is why it explained significantly the adoption of conservation practices in the non-project area. Irrespective of ethnicity, majority of farm households in the project area have adopted land management practices, with project support. Therefore, this variable could not explain significantly there.

Labor input per unit of land is an indirect indicator of effort being made for land management which is highly labor intensive. This is why it had significantly positive influence on the adoption of conservation practices in the non-project area (Table 9.6). There is no considerable variation in labor input per unit of land in the project area. As a result, this variable has no significant influence in the adoption of land management practices.

Regarding the significantly positive influence of farmers' affiliation with local organizations, the institutional membership influenced significantly, as line agencies and NGOs organized training to farmers on land management (Table 9.6). Besides, making them aware of land conservation technologies, the training had facilitated individual contacts with officials who provided services for land management. In the project area, majority of farmers are affiliated with local organizations, resulting insignificant influence of institutional affiliation on land management.

Farmers' contact with extension workers is another important variable influencing the adoption of land management practices significantly (Table 9.6). Extension agents provide information on better land management technologies to farmers and explain them about the need for proper management of land resources, thereby motivating farmers to take care of their farmlands. In the project area, there was no variation interms of access to extension service, as most farmers were provided extension services by the Phewatal Watershed Management Project. Thus, farmers' contact with extension workers could not reveal significantly positive influence.

Different from other variables, family size has significant negative influence in the adoption of land management practices in the non-project area (Table 9.6). It is attributed to relatively higher number of out-migration of people from large families. In the project area, the rate of out migration of active labor force from large farm households is considerably low. This is why family size has no influence in the project area.

CHAPTER X

ROLE OF FORMAL AND INFORMAL INSTUTIONS IN LAND MANAGEMENT

Various national acts (*aiyan*), rules (*niyam*) and regulations (*biniyam*), and area based informal rules evolved over past several decades have influenced farmland management in one way or other. The government enforces these rules and regulations through its local line agencies, and informal organizations operate under their legal framework desired by themselves. The local organizations are the local actors and play key role in development and conservation, as they interface between the government and farmers in implementing the formal and informal rules and regulations. The purpose of this chapter is to analyze as to how various acts, rules and regulations have influenced land management, and as to how the intermediary local organizations implement and regulate land management activities.

10.1 Role of Formal Rules and Regulations

The acts related to land evolved over past years based on the policy of the contemporary governments and their desire to change served for the benefit of rulers at large and the farmers to a lesser extent (Regmi, 1974:15). Several acts were promulgated ever since the 1950s to increase agricultural production through tenancy reform. However, any effort was not made to implement a scientific land use and management plan (Biot et al, 1995:109).

Until 1951, a large proportion of land was concentrated in the hands of a few feudal landlords affiliated with ruling families and top level bureaucrats, priests and military officers. There was limited land with farmers. Lands were divided into five categories, including *birta, guthi, jagir, kipat* and *raikar* (K.C, 1986). *Birta* land was granted free of cost by the state to the warriors, priests and politicians to secure stable income for their families. *Guthi* land was granted to the religious and charitable institutions to generate income for their operation. *Jagir* land was assigned as emolument to the government employees. *Kipat* land was granted to 17 small ethnic groups of Mongoloid tribal origin, including Limbu and Rai living in the eastern and western hills (Regmi, 1974). *Raikar,* defined as private property, was given to the individuals on payment of tax. Except *raikar,* all other lands were tax free and government was loosing substantial amount of revenue.

Birta, guthi and *jagir* lands were rented out to farmers with arbitrarily fixed rent and insecure tenancy rights, which led to exploitation of peasants by intermediaries, like revenue collectors, merchants and money lenders. Such unfair and insecure land tenure systems discouraged farmers to make investment in land management. Realizing the problem, the government promulgated several acts, rules and regulations since 1951 (Table 10.1) to abolish the feudal land tenure system and to protect the tenants from exploitation, so as to encourage them to increase production through proper management of land resources.

10.1.1 Rent Control Act, 1958 and Tenancy Reform Acts

Until the 1960s, farmers were forced to cultivate *birta* lands owned by feudal lords. In addition to rent, tenants were obliged to provide free labor to *birta* owners whenever they demanded for it. In 1958, the government enacted the *Birta* Rent Control Act and fixed the land rent up to 65 percent of the total farm production for the *birta* owners. The act also imposed ban on forced and unpaid labor imposed by the *birta* owners. This act could be considered as a pioneering effort towards land reform.

Table 10.1: Major acts and their role in farmland management

Act	Year introduced	Major role in land management
Private Forest Nationalization Act	1957	• Reduced the amount of farmyard manure, as private forests were converted into open access forest. • Discouraged tree growing in private land, as farmers were not sure whether they could get benefit from it.
Rent Control Act for *Birta* Land	1958	• Fixed land rent to protect tenants from the exploitation by *birta* owners. • Banned forced and unpaid labor imposed on tenants by landlords.
Birta Abolition Act	1959	• Special privilege of tax exemption to bureaucrats, military officials, priests and Rana families was withdrawn. • All types of land were brought under one taxation system.
Land Consolidation Act	1962	• Agricultural lands were classified into five groups: *abbal, doyam, sim, chahar* and unproductive land, based on soil quality, irrigation facility, water holding capacity and productivity for taxation. • Priority is given to *abbal* land for investment, specifically for irrigation development.
Land Act and Land Reform Program	1964	• Fixed ceiling on landholdings. • Caused massive land fragmentation, as the landlords transferred their land rights to their clans in order to hide the land, which was over the ceiling. • Provision of secure and fair land rights.
Land Administration Act	1967	• Distributed land certificates to farmers, stating land type, parcel number and area. • Encouraged investment in land management.
National Park and Wildlife Act King Mahendra Trust for Nature Conservation Act	1973 1982	• Restriction on killing any type of wild animals. • Farmlands near the national park or conservation area are left barren, as the crops are damaged by wild animals.
Kharka Nationalization Act	1974	• Reduced livestock pressure on farmlands, as all *kharka* lands become free for grazing.
Watershed Management Act	1982	• Encouraged adoption of structural and biological measures of land management in watersheds.
Private Forest Code	1984	• Encouraged tree growing in private land.
Water Resources Act	1993	• Facilitated to the transfer of irrigation management system from government to the farmers.
Forest Act	1993	• Devolution of forest ownership from the government agency to local communities. • Recognized forest user groups as an autonomous and corporate institution, with rights to acquire and sell of forest products.
Forest Code	1995	• Encouraged tree growing in private lands, thereby increasing the supply of organic fertilizers.
Environment Protection Act	1996	• Emphasized on environmentally suitable land use practices.

Source: Analyzed from: Ministry of Law and Justice, 1998a, 1998b, Makalu Books and Stationers, 1999

The *Birta* Rent Control Act was not sufficient to protect the interest of the tenants. On the other hand, the *birta* owners could not manage their land properly, which led to declining productivity. To cope with this problem, the government promulgated a *Birta* Abolition Act in 1959 and withdrew special privilege of tax exempt provided to *birta* owners. Since then, the *birta* lands were converted to *raikar* land to generate national revenue. This act made an attempt to minimize the discrimination between tax paying peasants and tax exempted landlords by bringing all lands under one taxation system (Table 10.1).

Besides, the government enforced Princely States Abolition Act, 1961 and New Civil Code, 1963 to abolish the *Kipat* system. It also introduced *Ukhada* Tenure Act 1964, Land Acquisition and Distribution Act, 1967 and *Jhora* Tenure Act, 1971 to protect tenants interests. These acts declared that the land tilled by tenants would be registered in their names which promoted strong sense of security among tenants and helped to increase investment in land management.

Despite some achievements, the Rent Control and Tenancy Reform Acts could not bring desirable change in land use and management due to the lack of firmness and clarity in government policies and considerable influence of landlords in government and authorities.

10.1.2 Land Consolidation Act, 1962 and Land Administration Act, 1967

Land Consolidation Act, 1962 facilitated the cadastral survey during the early 1960s and 1970s required to prepare land inventory containing information on land type and area. Accordingly, lands were classified into five categories: *abbal, doyam, sim, chahar* and unproductive land (Table A. 56) to determine the land tax and prioritize investment in irrigation and other infrastructure development programs. *Abbal khet* were given priority for irrigation development.

Land Administration Act, 1967 was promulgated to update the land inventory and to generate revenue from the private land. Farmers were issued permanent land title or *lalpurja* as per the land inventory prepared by the Land Administration Office. These two acts contributed to build a strong sense of security among landowners, thereby encouraging investments in land management.

10.1.3 Land Reform Act and Program, 1964

The Land Act was introduced with three major objectives. The first objective was to divert the inactive capital and surplus labor from land to other sectors to accelerate economic development. The second objective was to improve living standard of farmers through equitable distribution of land, and the third was to increase agricultural production through the provision of production services.

The Land Reform Program implemented in 1964 imposed ceiling on land ownership and tenancy holdings. The maximum amount of farmland that a farmer or farm household could own was fixed at 17 hectares in *tarai*, 4.11 hectares in the hills and mountains, and 2.67 hectares in Kathmandu valley. Additional 2 hectares in *tarai*, 0.8 hectare in the hills and mountains, and 0.4 hectare in Kathmandu valley could be owned as *gharbari*. Regarding the ceiling of tenancy holding, it was fixed at 2.7 hectares in *tarai*, 1.5 hectares in hills and mountains, and 1.1 hectare in Kathmandu valley.

The land reform program achieved little success in its implementation. About 600,000 hectares of land was estimated above the ceiling in the entire country, actually 66,380 hectares of land was found to be above the ceiling (K.C, 1986). Out of this, 33,825 hectares was legally confiscated and 23,588 hectares was distributed to tenants in *tarai*. About 1.8 million tenants were identified and 1.5 million certificates of tenancy rights were distributed. The land rent was suppose to be not more than 50 percent of the main annual crop in *tarai* and one-third to one-fourth in the hills and mountains. Debt reduction was at a minimal point. Out of Rs. 199 million debts of the tillers, only 40 million was scaled down under the debt

reduction program. Large number of tenants were left behind under heavy debt of the landlords.

The Land Reform Program was implemented without proper preparation. The agency in-charge of program implementation did not precisely know the amount of land owned by individuals. The 'family' was not clearly defined as every son above 16 years and unmarried daughter above 35 were identified as separate unit of family and entitled to hold same amount of land. This provided enough opportunity to landlords to transfer the ownership of land to his/her family members. Landlords with large amount of lands transferred the ownership of some of their land to their relatives. Even the program could not provide security to the tenants.

The effect of Land Act and Land Reform Program in the equitable distribution of land was minimal in the study area, as *Jamindar* and *birta* owners, with landholdings above the ceiling, transferred the ownership of some of their landholdings to their relatives to avoid confiscation. This led to more fragmentation of landholdings, which constrains their efficient use and proper management.

10.1.4 Forest Act 1957, 1961 and 1993

Several forest acts promulgated over the past years have also influenced land management. The Private Forest Nationalization Act, 1957 and the Nepal Forest Act, 1961 nationalized all private forests, eventually making them open access forest, as the government could not manage them effectively. To prevent from nationalized, some of the private forests were converted into farmlands by their owners. As a consequence, forests adjacent to farmlands were gradually converted into farmlands. This led to reduced supply of forest fodder and leaf litter, constituting a large proportion of the farmyard manure required for maintaining soil fertility.

Realizing the problem caused by the nationalization of forests, a community forestry program was implemented in 1978, and this program was reinforced by the Private Forestry Code, 1984. However, the program could not bring expected change, as the community forest management was not fully delegated to the local user groups. Thus, the government promulgated a new Forest Act, 1993 and Forest Code, 1995 which recognized the forest user group as an autonomous and corporate institution with rights to acquire, sell and transfer forest products. Such provision has encouraged tree plantation in both public and private lands.

10.1.5 National Park and Wild Life Act, 1973 and Protected Area Act, 1982

The National Park and Wildlife Act, 1973 and the King Mahendra Trust for Nature Conservation Act, 1982 were introduced for biodiversity conservation, including wildlife protection. These acts have also influenced agricultural land use and management particularly in the non-project area. The Annapurna Conservation Area Project (ACAP) implemented since 1988 under the King Mahendra Trust for Nature Conservation Act, prohibits farmers from killing wild animals which are destroying crops adjacent to forests. In some areas, the damage was so severe that the farmers could not get any return from crops, despite substantial amount of labor and cash investments. As a result, some farmlands adjacent to forests have been left fallow permanently, and farmers are not pursuing any effort for repair and maintenance of terraces.

10.1.6 *Kharka* Nationalization Act, 1974

*Khark N*ationalization Act, 1974 prohibits encroachment of public grazing land or *kharka.* While this act has contributed to alleviate the livestock pressure on farmlands, though *kharka* are undergoing accelerated soil erosion and landslide due to lack of proper management.

10.1.7 Watershed Management Act, 1982

The Watershed Management Act, 1982 was the first effort with direct bearing on land conservation. This act authorizes the Department of Soil Conservation and Watershed Management (DSCWM) to undertake appropriate conservation activities in both public and private lands. The Department, according to this act, can even force farmers to practice suitable land use in areas considered fragile and prohibit farming practices in areas susceptible to natural hazards.

The Phewatal Watershed Management Project was implemented in accordance with the Watershed Management Act. Following this Act, farmers were advised to pursue environmentally compatible land use and management activities. In the project area, it also encouraged farmers to adopt biological measures of land management.

10.1.8 Water Resources Act, 1993

Water Resources Act, 1993 recognizes the role of water user groups in the project development, implementation, maintenance and repair activities. User groups formation and their involvement in water resources development and management have been made indispensable specifically for irrigation projects. The Act clearly states that all irrigation projects should be handed over to user groups after their completion for sustainable utilization and management of water resources.

In addition to the acts discussed above, the Environment Protection Act, 1996 emphasizes environmentally suitable land use practices. However, this Act has little influence in land management, as it is not enforced due to the lack of a comprehensive land management plan.

10.1.9 Problem of Integration

The acts, rules and regulations reviewed above were introduced by several line agencies to serve their interests. This has resulted lack of a well coordinated effort for environmentally suitable land use and management. Instead each act and rule considers the concerned line agency as a supreme authority responsible for land use and management, and overlooks the complementary roles of all agencies. This partly explains why the government agencies have not been able to enhance environmental and socio-economic conditions in mountain watersheds.

10.2 Role of Informal Rules and Regulations in Land Management

Customary rules and regulations developed and practiced since the historic period have considerably contributed to land management. They have undergone some modifications according to the changing socio-economic condition and natural resources status.

10.2.1 *Jhara* System

Jhara is a social system being practiced for several decades in both project and non-project watersheds. According to this system, one member from each household is obliged to participate voluntarily in land management activities that require collective efforts like construction and maintenance of irrigation canals, check dams and retention walls, gully control, landslide treatment, and river bank stabilization.

Whenever the contribution is required, the community leader calls a village meeting to estimate required amount of labor contribution by each household. If some one informs in advance about his/her inability to make contribution during the stipulated date, he/she is exempted from the work. Those who do not participate without prior notice have to pay fine at the rate of 4 kg of rice per day.

The *jhara* system is also applicable to construction and maintenance of check dams, retention walls, and landslide stabilization, depending on the magnitude of natural hazards like landslide, mass wasting, torrent flow and gully expansion. When the land of several farmers is affected by these natural phenomena, all affected farmers act collectively as per the rules set by the *jhara* system.

10. 2.2 *Sanad*

Sanad is an informal rule prepared in consensus of one to several villages to prevent livestock grazing in *phantkhet* from the second half of May to the end of November until paddy is not harvested. Until the 1940s, livestock intensively grazed in the farmlands during the winter season. Livestock grazing particularly in *khet* destroyed paddy and millet seedbeds and farmers had difficulty in transplantation of paddy and millet following the occurrence of monsoon rain. To overcome this problem, farmers in some of the villages gathered in 1935 and prepared a *sanad,* which imposed ban on livestock grazing in *phantkhet*. This system is being practiced even at present, with some modification in penalty to offenders. Initially the penalty to the offender was fixed at Rs 0.04 per livestock per day, and it was increased to Rs. 50 per livestock per day in 1999.

10.3 Investment in Land Management

Investment priority at national and local levels reflects as to how the national and local governments think about land resources which have been the major source of livelihood of most people. Therefore, the public sector budget allocation to agricultural sector in general and land management in particular is analyzed at national, district and village levels.

10.3.1 Public Sector Investment at the National Level

In Nepal, a systematic development planning through periodic plans began since 1956. The First Five-year Plan, 1956-61 and the Second Three-year Plan, 1962-64, did not specify any priority area. Since the Third Five-year Plan, 1965-1970, investment priorities were clearly specified. Particularly the agricultural sector received high priority in the public sector budget allocation from the Fifth Plan, 1975-1980 to the Eighth Plan, 1992-1997 period (Table A. 57). As the school education was made free at the end of the Eighth Plan, the social sector budget exceeded the agriculture sector budget during the Ninth Plan period, 1997-2002.

The agricultural sector has received more than one fourth of the total development budget during 1965-2002, which was higher than the budget allocated to industrial and infrastructure sectors and marginally low compared to the social sector budget (Table A.57). Despite high priority given to the agricultural sector, farmers particularly in the non-project area could get little benefit. In view of environmental fragility and biophysical conditions, mountain watersheds need small-scale development projects conducive to tap locational potentials. Contrarily, the priority for investment in agricultural sector was given to large scale projects located in *tarai* and selected accessible areas in the hills. As a result, the farmers in the non-project area could not get much benefit from the development programs. Moreover, the national investment in agricultural sector was always directed towards the production promotion and due attention was not given towards investment in farmland management.

10.3. 2 Investment at the District Level

Time series information on public sector investment at the district level was not available. However, the budget allocation of line agencies in 1998 indicates that about a half of the investment was made in the agricultural sector, followed by the social, road and communication, and industry and electricity sectors (Table A.58). Despite the high investment priority given to the agricultural sector, there were nominal support programs for land management. Most of the budget allocated to the agricultural sector was for irrigation projects and little attention was given to land management.

10.3.3 Investment at the VDC Level

VDCs are the lowest level of the local government. They prepare and implement local development plans using fund available from different sources. Each VDC receives Rs. 0.5 million of development budget annually from the central government. The Local Governance Act promulgated in 1998 authorizes VDCs to collect tax and seek external funding support for implementation of development activities. These sources accounted for one fifth of the total budget in the project area and one fourth in the non-project area (Table A.59).

About seven percent of the total budget in the project area and 13 percent in the non-project area was allocated to land management, including gully control, check dam construction, training for farmers and plantation in landslide prone areas (Table 10.2). Rest of the budget was allocated to other sectors.

Table 10.2: Sectoral development budget allocation by VDCs during 1995-1999

Rs. Million

Activities 1995-1999	Project Area (5 VDCs)	Percent	Non-project Area (6 VDCs)	Percent
Agricultural land management	0.98	7.4	2.20	13.0
Industry and electricity	0.00	0.0	0.90	5.0
Road and communication	3.62	27.0	4.57	26.0
Social services	3.37	25.1	5.29	30.0
Administration and miscellaneous	5.44	40.5	4.52	26.0
Total expenditure	13.41	100.0	17.48	100.0

Source: VDCs, 1999

Occupational background of the VDC executives has great influence in budget allocation to different sectors. More than two thirds of the VDC executive members in the project area and more than four fifths in the non-project area were elected from among farmers (Table A. 60). However, the VDC chairpersons were ex-army, retired teachers and

bureaucrats, businessmen and lawyers who gave priority to non-agricultural activities, despite farmers' demand for increased budget allocation to land management. However, in Rivan VDC of the non-project area, where both the VDC chairman and vice-chairman were farmers, about a half of the budget was allocated to land management, including construction of irrigation canals and check dams, and gully control. VDC chairmen with teaching background in both areas had made high amount of investment in upgrading local schools, while those with backgrounds like businessman and ex-army gave priority to road construction and provision of electricity.

10.4 Role of Formal and Informal Local Organizations in Service Delivery to Farmers

Formal organizations, like government line agencies, VDC and DDC and informal organization, like NGOs and user groups have been pursuing conservation and development activities in the study area. The number of informal local organizations facilitating land management activities is steadily growing in both watersheds (Table 10.3). Such growth of local organizations was facilitated by the restoration of democracy in 1990. Before 1990, there were only 64 local organizations in the project area, which grew to 514 by 1999. During same period their number in the non-project area grew from 29 to 417 (Table 10.3). The number of user groups and NGOs is significantly high ($P \leq 0.05$) in the project area due to local organizations strengthening program launched by the Phewatal Watershed Management Project.

Table 10.3: NGOs and user groups in the study area

Year of establishment	Project Area		Non-project Area	
	Number	Percent	Number	Percent
Before 1990	64*	12.0	29*	7.0
Between 1991-1995	234*	46.0	128*	31.0
After 1995	216	42.0	260	62.0
Total	514*	100.0	417*	100.0

Source: Institutional survey, 1999

NB: Significantly high at 0.05 confidence level (T Test, $P \leq 0.05$)

More than half of the user groups in both areas are promoted by line agencies (Table 10.4). About one fourth of user groups in the project and one third in the non-project area are promoted by NGOs. Around one-tenth in the project area and five percent in the non-project area are promoted by VDCs, while a few user groups are self-organized. Only nine percent NGO and user groups in the project area and nearly two percent in the non-project area are formally registered with the Chief District Officer's Office (CDO), while rest of them are working informally (Table 10.4). About 73 percent farm households in the project area 43 percent in the non-project area are member of the user groups.

Table 10. 4: Legal status of NGOs and user groups

Legal status	Project Area		Non-project Area	
	Number	Percent	Number	Percent
NGO and mother groups registered at CDO's office	45*	9.0	8.0*	1.5
User groups promoted by line agencies	279	54.0	237	57.0
User groups promoted by NGOs	116	23.0	141	34.0
Spontaneously formed user groups without registration	27*	5.0	11*	2.5
User groups promoted by VDCs	47*	9.0	20*	5.0
Total	514*	100.0	417*	100.0

Source: Field survey, 1999

NB: Significantly high at 0.05 confidence level (T Test, $P \leq 0.05$)

Formal local organizations, including line agencies, VDC and DDC play intermediary role between government and local farmers. The government provides support services and facilities, including technology, credit, training, extension services, and development budget to farmers through these organizations based on request made by farmers. Informal local organizations, specifically NGOs, receive technology and resources from the external aid agencies, including INGOs, for the provision of support services and facilities for farmers. The user groups implement small scale land management activities using local and externally supported resources.

The line agencies and NGOs provide support services to farmers and their role in training, credit and extension services is analyzed in following sections.

10.4.1 Training

Training is one of the major support programs undertaken by line agencies and NGOs to help farmers. During 1988-1998, they had trained about one fourth of the total surveyed farmers in the project area on terrace improvement, soil fertility management, livestock development, agroforestry and crop management (Table 10.5).

Table 10.5: Farmers trained during last 10 years

Training	Project Area (N=155)			Non-project Area (N=145)		
	NGO	Line agency	Total	NGO	Line agency	Total
	f'	f'	f'	f'	f'	f'
Terrace improvement	0.0	15.0	15.0	0.0	0.0	0.0
Soil fertility	2.0	2.0	4.0	2.0	0.0	2.0
Livestock development	3.0	5.0	8.0	2.0	0.0	2.0
Agroforestry	1.0	2.0	3.0	2.0	0.0	2.0
Crop management	0.0	4.0	4.0	3.0	7.0	10.0
Exchange visit	1.0	3.0	4.0	3.0	0.0	3.0
Total *	4.0	24.0	28.0	5.0	7.0	12.0

Source: Household survey, 1999
NB: f' proportion of N
* A few cases of multiple attendance of the same type training were considered as single event cases.

Exchange visits were also organized to make them aware of improved land management and agricultural practices in other areas. In the non-project area, only seven percent of the farmers could get opportunity for training through line agencies. NGOs have been playing complementary role in arranging training. They had trained about four percent of farmers in the project area and five percent in the non-project area on different aspects of land management (Table 10.5).

The trained farmers attended three trainings during 1988-1998 and the average duration of the trainings was only two days in the project area. The trained farmers in the non-project area had attended two training during the same period and the duration of the training was for two days. Farmers frequently complained that line agencies and NGOs have either weak capacity for or are reluctant to organizing training for them. About half of the farmers in the project area and more than two-thirds in the non-project area expressed their interest in training on land management. However, the concerned line agencies have allocated only one percent of their total budget to the training program, which is not adequate to arrange training for all interested farmers. The NGOs have allocated 10 percent of their total budget to the training but the total amount of budget is very small, which prevents them from providing effective service.

10.4.2 Institutional Credit

Farmers need adequate amount of credit for investment in agricultural activities, including land management. In the project area, there are three organizations providing credit to farmers. The Women Development Program implemented by DDC provides credit to farmers in two VDCs. The Small Farmers Development Program is lending credit specifically to women farmers in one VDC. The Agricultural Development Bank provides credit to interested farmers who can offer land as collateral. Altogether eight percent of farmers received credit from these organizations to purchase dairy cattle and buffalo. These institutions charge interest at the rate of 17 percent for the credit for one year and 18 percent for the long term credit. About six percent of farmers who could not offer collateral had received credit from moneylenders at the interest rate of 31 percent to purchase seed and fertilizers (Table 10.6).

Table 10.6: Use of the institutional credit during last 10 years

Purpose	Project Area (N=155)			Non-project area (N=145)		
	f'	Interest rate (Percent/year)	Average amount (Rupees)	f'	Interest rate (Percent/year)	Average amount (Rupees)
Seed and fertilizer	6.0	31.0	6,089*	9.0	17.0	23,554*
Land management	0.0	0.0	0.0*	4.0	18.0	22,000*
Livestock raising	8.0	17.0	18,231*	9.0	17.0	23,077*
Total	14.0	23.0	13,264*	22.0	17.0	23,069*

Source: Household survey, 1999.
NB: f' = Proportion of N
* Significantly different at 0.05 confidence level (T Test, $P \leq 0.05$)

In the non-project area, two Small Farmers Development Programs and one *Gramin Bank* are providing credit to farmers. Particularly, the Small Farmers Development Programs offer loan to farmers in only two VDCs. Other farmers can get credit from *Gramin Bank* located at Hemja village. These institutions have disbursed agricultural credit to 22 percent of the total farmers (Table 10.6). The average amount of credit was Rs 23,069 per household, which is significantly higher than the amount in the project area ($P \leq 0.05$).

The formal financial institutions in the study area could not provide credit to all farmers seeking it. About one third of farmers in the project area and one fourth in the non-project area could not get credit due to lack of collateral and lengthy administrative procedure required to obtain credit. Remarkably, about 55 percent of farmers in the project area 51 percent in the non-project were not interested in obtaining institutional credit, as they had enough amount of savings required for buying agricultural inputs.

10.4.3 Extension Service

The provision of extension service is essential to enable farmers to adopt technologies conducive to improving production and land management. Farmers want to know about locationally suitable improved technologies and their costs and benefits, so as to select technologies suitable for their areas.

Line agencies and NGOs are involved in disseminating information on agricultural technologies in the study area. The Agricultural Development Office and Livestock Development Office have established one each of the service center and sub-center in the project area, and two sub-service centers in the non-project area. Both agencies have deputed two extension workers at the service center and one worker at the sub-center. On average, a

service center provides service to eight VDCs, with a total population of 36,000, and the sub-center provides service to three VDCs, with a total population of 18,000. Thus the extension workers cannot visit all farm households, despite their willingness. Alternatively, they have adopted a group approach to extension service. Accordingly, 12 crop production groups, comprising 240 farm households have been formed in the project area and 33 groups, comprising 396 farm households, in the non-project area. Agricultural extension workers have been able to provide their services to only four percent of the total farm households in the project area and eight percent in the non-project area. Similarly, the livestock extension workers have formed 12 livestock development groups, covering three percent of the total farm households, in the project area and three groups, covering two percent of farm households, in the non-project area. Farmers organized in group are expected to adopt recommended practices and transfer them to other farmers. About one fifth of farmers in the project area and nearly half in the non-project area received advice from extension workers during 1988-1998 (Table 10.7).

Table 10.7: Provision of extension services (1988-1998)

Service	Project Area (N=155)						Non-project Area (N=145)					
	Line agency		NGO		Total		Line agency		NGO		Total	
	N	f'	N	f'	N	f'	N	f'	N	f'	N	f'
Technical advice	25	16.0	8	5.0	33	21.0	30	21.0	38	26.0	68	47.0
Fruit, fodder and tree saplings	62	40.0	0	0.0	62	40.0	5	3.0	12	8.0	17	11.0
Subsidy for land improvement	51	33.0	0	0.0	51	33.0	1	1.0	6	4.0	7	5.0
Total	138	89.0	8	5.0	146	94.0	36	25.0	56	38.0	92	63.0

Source: Household survey, 1999

NB: N = Frequency of respondents

f' = Proportion of N

Farmers who were not group members have not been able to get any advice from the extension workers. There is ever widening gap between farmers' expectations and extension services offered. All farm households expect a good extension service, while the extension workers meet these groups occasionally and discuss about their problems and agricultural technologies. According to officials, budget and manpower available at the disposal of District Agricultural Development Office and Livestock Development Office were not adequate to satisfy farmers' demand. Farmers frequently complained that the extension workers lacked knowledge required to address their problems due to lack of opportunity for refresher training courses. In view of these constraints, NGOs are being considered by top level policy makers as an alternative for providing effective extension services. Accordingly, the government policy is to encourage NGOs to provide agricultural extension service to farmers.

NGOs, including ACAP, have made considerable contribution to the non-project area for dissemination of information among farmers. However, farmers are not quite sure how long these organizations will continue providing their services, as they depend primarily on international agencies for funding support.

Besides technical advice, about two fifths of the farmers in the project area and one tenth in the non-project area have received fruit, fodder and tree saplings free of cost from line agencies and NGOs (Table 10.7). Particularly farmers in the project area received considerable number of saplings from the project nursery until 1995. Farmers in the non-project area are provided seedlings by ACAP, though the proportion of farmers receiving such support is considerably low compared with the project area.

About one third of farmers in the project area have collectively or individually received subsidy from the Phewatal Watershed Management Project for terrace improvement, gully control, foot trail improvement, *goth* improvement and check dam construction. In the non-project area, only six percent of farmers could receive such assistance from ACAP and other NGOs (Table 10.7).

About six percent of farmers in the project area and 37 percent in the non-project have not received any extension services from line agency and NGO during last 10 years.

10.5 Role of User Groups in Land Management

There are eight types of user groups, locally known as *samuha* in the study area. Forest user groups are involved in forest and fodder tree management; water user groups are managing irrigation water; crop production groups are taking care of cash crop farming; livestock groups are promoting fodder and forage production; mothers groups are involved in small infrastructure and women development activities; farmers cooperative are handling vegetable and dairy production; saving groups are engaged in land and livestock based income generation; and small farmers group have been pursuing crop production related activities. The activities undertaken by these groups are directly and indirectly contributing to land management.

About nine tenths of farmers in both project and non-project areas consider the activities pursued by user groups are conducive to land management. Some of the executive committee members of the user groups were trained by line agencies and NGOs, and they are expected to disseminate information on new technologies to the respective group members. Some farmers in both areas expect technical advice from the user groups (Table 10.8).

Table 10.8: Farmers' expectation from user groups

Expectation	Project Area (N=155)		Non-project Area (N=145)	
	N	f	N	f
Technical advice on land management	22	14.0	12	8.0
Assist line agencies and NGO to construct structural measures of land management	94	61.0	58	40.0
Contribute to conduct on farm research	8	5.0	14	10.0
Contribute to promote agroforestry	5	3.0	3	2.0
Contribute to cash crop promotion	0	0.0	19	13.0
Develop new land management technologies through experiment	11	7.0	22	15.0
Total	140	90.0	128	88.0

Source: Household survey, 1999
NB: N= Frequency of respondents
f = proportion of N

Farmers cannot construct individually large structures like check dam, irrigation canal and retention wall to protect their land from flood and landslide. However, about three fifths of them in the project area and two fifths in the non-project area mentioned that they can build such conservation structure in cooperation with line agencies and NGOs. User groups can mobilize required labor and locally available materials, if line agencies and NGOs provide some support. They also can contribute to on farm research, agroforestry promotion, cash crop farming and generate new technology through their own experiment.

10.5.1 Role of Forest User Groups in Agricultural Land Management

There are community initiated and government initiated forest user groups in both project and non-project areas. There are 12 community initiated forest user groups in the project area and 10 in the non-project area. In regard to the later type of group, there are 59 community forest user groups in the project area and 37 in the non-project area. Besides management of community forests, forest user groups in both project and the non-project areas have planted vegetation in gullies, landslide prone areas, landslide scars, flood prone areas and critical slopes to protect soil erosion. They are also promoting fodder and fuel-wood tree plantation in farm boundaries, terrace risers and marginal lands. Some of the group members in the non-project area have utilized their marginal lands for non-timber forest products (NTFP) which contributes to control land degradation and enhance household income. The group leaders, were trained by the District Forest Office have played a catalyst role in the promotion of sustainable land use by disseminating information on fast growing, dwarf, high yielding and nitrogen fixing tree species.

Forest user group members have not been adequately trained on sustainable use and management of land resources. They can play very effective role in the promotion of environmentally sustainable land use and management, provided the groups members get opportunity to attend appropriate training courses and to visit areas where lands are being effectively managed.

10.5. 2 Role of Water User Groups

There are eight water user groups in the project area and 14 in the non-project area promoted by the District Irrigation and Drinking Water offices. But they are not legally recognized like forest user groups, though the Water Resources Act, 1993 fully recognizes their potential role in water resource management. Executive committees are either selected or elected from among the users who govern these groups and rules and regulations are in written form which have to be followed by the members.

Water users have been able to mobilize local resources in the form of cash, labor and kind for construction of irrigation canals in both project and the non-project areas. Their contribution ranges from 0.5 percent to 10 percent of the total cost of construction. These groups are responsible for repair and maintenance of canals. They have constructed sub-canals at their own initiatives and established retention walls to protect canals.

10.5.3 Role of Crop and Fruit Production Groups

There are 12 crop and fruit production groups in the project area and 33 in the non-project area promoted by the Agricultural Service Center and NGOs. The executive committee members are selected from among the group members, and they have responsibility to play leadership role. They also have their own rules and regulations regarding membership, meeting, and utilization of the saving fund. However, they have not been as effective as forest user groups due to weak support from the line agencies.

In some instances, crop and fruit production groups have contributed to change the cropping systems. A few farmers at Hemja village in the non-project area have shifted from millet cultivation in *bari* and wheat in *phantkhet* to vegetable cultivation through the initiative made by these groups. In some of the locations in the project area, maize crop in *tarikhet* has been replaced by potato for higher income. Some farmers in the lower hill slopes have planted fruit trees in *gharbari* which were traditionally utilized for maize and millet cultivation. These groups can make significant contribution to promote locationally suitable land use, if

their capacity is upgraded through the provision of training programs and required support services.

10.5. 4 Role of Livestock Development Groups

There are 12 livestock development groups in the project area and 4 in the non-project area promoted by the Livestock Service Sub-centers. These groups are involved in dairy buffalo and goat raising activities. Their executive committee members are selected from among the members who govern these groups. They work for the benefit of the group members and encourage non-member households to raise economically attractive livestock.

As a part of their livestock promotion task, livestock development groups are also actively engaged in promotion of plantation of palatable, high yielding and nutritious varieties of fodder and forage trees in terrace risers and marginal lands. In the project area, farmers have planted high yielding forages like *Napier, Desmodium intortum, Cymbopogon microtheca, Mlasis,* and other *Stylosanthes* species, using the knowledge that they gained from the Phewatal Watershed Management project. According to farmers, the yield of these species is four times higher than the yield of local varieties of forages. Besides providing forage to livestock, these species have been useful to control soil erosion in farmlands with steep slope gradients. While the livestock groups could not get advice from experts in the non-project area, they were supplied with *Thysanolena maxima* (amriso) seedlings by ACAP since 1992. Normally utilized for making brooms, this has been increasingly planted in marginal lands, farm edges, gullies and areas affected by landslide because of its commercial value. It is a multipurpose plant, which is consumed by livestock, provides cash income to farmers and helps to control soil erosion particularly in terrace risers. A few farmers at Koleli village in the non-project area have completely replaced cereal crop in their *bari* lands with *Amriso* and are securing ten times high income compared with cereal crops. Livestock raising groups can play more effective role in the promotion of locationally suitable land use practices, provided their members get opportunity to attend related trainings.

10.5. 5 Role of Mothers Group

There are spontaneously formed and government initiated mothers groups in both project and non-project areas. The former type of groups were formed by Gurung and Magar women during the First and Second World Wars to carry out the social works when large number of adult male household members were forced to join the British army. The group members used to be assigned social works by elderly women who served as group leaders. These groups have contributed to social works like construction of parks, temples, schools, child centers, small irrigation canals and foot trails. Similarly, they have mobilized local resources for providing drinking water. They are also mobilizing women for protest against production and sale of alcohol in villages, gambling, domestic violence against women and polygamy. They are generating income from membership fee, voluntary donation from high remittance earners, financial support provided by line agencies and NGOs, and cultural programs. They have no written rules and regulations. The account is kept by the group leaders based on their merits. The group members have strong feeling of solidarity and excellent sprit of work.

Second type of mothers group are being promoted by political parties since 1990. Out of 105 mothers group in the project area, more than two fifths are promoted by political parties. Similarly, out of 54 groups in the non-project area, one third are promoted by them.

Besides social activities, mothers group in both the project and the non-project areas are also involved in selected land management activities, like construction and maintenance of small irrigation canals and plantation of trees and shrubs in public land. Though trees and

shrubs are planted in public land, it helps to reduce soil erosion and siltation in downstream farmlands. Construction of bunds along the foot trails also helps to control soil erosion and siltation. During the group discussion, the group members complained that the line agencies and NGOs did not arrange training on land management. They are willing to be involved in dissemination of information on improved land use and management technologies in the future, if they are provided opportunity to attend training.

10.5. 6 Role of Small Farmers Group

There are 10 small farmer groups in Sarangkot VDC of the project area and 129 in Hemja and Lwang Ghalel VDCs of the non-project area. These groups were promoted by the Small Farmers Development Program of Agricultural Development Bank to distribute credit and mobilize saving. So far these groups have not been involved in land management. They are, however, interested to pursue activities for improved land management, if they are provided some assistance.

10.5. 7 Role of Saving Groups

Saving groups are being promoted by the Women Development Program implemented of DDC and NGOs in the project area, and by the UNDP supported Participatory District Development Program, ACAP, *Gramin Bank* and NGOs in the non-project area. Their primary objective is to mobilize local resources and to develop saving habit among local women. Altogether there are 255 saving groups in the project area and 119 in the non-project area. They have their own rules and regulations formulated with the assistance of agencies that supported them.

Women involved in saving groups are generating small amount of income by selling vegetables, fruits, dairy products, and some of the income is deposited in their accounts. About five percent of the groups were trained on vegetable farming by NGOs in the project area. In the non-project area, 20 percent of the groups were trained. Currently they are involved in the promotion of vegetable and high value cash crop farming, and in fruit tree growing in the foothills. In the future, they can make a good contribution to agricultural land use and management by promoting environmentally and economically suitable agricultural enterprises and land management practices in both areas.

10.5. 8 Role of Farmers Cooperative

Farmers cooperative have spontaneously developed in the study area since the 1990s. In 1976, two government supported cooperatives were established in the project area. One of them was closed in 1996, as it incurred a heavy loss. Another cooperative was also at the verge of being collapsed. Frustrated with the failure of government supported cooperatives, farmers organized themselves and established new dairy cooperative at Naudanda village in 1992, with 600 members and 300 shareholders. Another cooperative was established at Guntechour village in 1993, with 200 shareholders. Every year the first cooperative sales 9,200 liters of milk to Pokhara Dairy and earns Rs. 1.5 million. The second cooperative sales 8,988 liters of milk and earns Rs. 1.4 million annually. These cooperatives have their own milk collection centers, pathological laboratories and technical staff to take care of livestock diseases, veterinary medicine shops and feed depots.

Livestock raising has been a financially attractive activity particularly in the project area. These cooperatives are involved in promotion of land use activities which help to increase the supply of fodder and forage required for livestock. In this regard, they have distributed fodder seedlings to the members in collaboration with the Forest and Livestock

Development Offices and NGOs. They also encourage both members and non-members to grow additional fodder trees in terrace risers and marginal farmland. Likewise, they have arranged plantation of fodder trees in community land, established shrub species along gullies, foot trails and landslide areas. They are also promoting locationally suitable dwarf, nutritious and high lopping tolerance varieties of fodder trees, and have discouraged livestock grazing in community land.

In the non-project area, two cooperatives were established in 1976. One of the cooperative disappeared in 1997 due to heavy loss and debt. However, another cooperative is functioning well and earns reasonable amount of profit. In 1998, 50 farmers in Lahachock VDC established a new cooperative, with aims to promote cash crop production and to arrange marketing of products. Similarly, 32 farmers in Hemja VDC have established Vegetable Farmers Organization for vegetable marketing. So far both of the cooperatives are not involved in land management due to lack of adequate training and weak technical capability.

CHAPTER XI

CAPABILITY OF LOCAL ORGANIZATIONS ASSOCIATED WITH LAND MANAGEMENT

Preceeding chapter indicated that there is a widening gap between farmers' expectation and provision of support services by local organizations. This chapter analyzes the capability of local organizations directly and indirectly involved in land management, so as to strengthen their capability for improved land management.

11. 1 Analysis of Local Organizations

Local organizations that work in close cooperation with farmers are intermediaries facilitating the local development. Formal line agencies have a bureaucratic orientation who implement the government policies and regulate actions in a rigid manner. Non-governmental organizations (NGOs) have flexible structure and contribute development and conservation activities including land management. A lot of studies have been pursued on local organizations' role in development and common pool resources management (Uphoff, 1986; Gibson et al, 1998; Nair et al, 1998a). However, very little is known about their existing capacity and contribution to farmland management. Factors determining their performance need to be explored through empirical studies which would contribute to formulate appropriate policies for strengthening local organizational capacity in improved land management (Gueye and Laban, 1994: 21-22; Cousins, 1997: 61, Chamber 1993:15, Uphoff, 1990:1403).

In the study area, three types of local organizations are pursuing land management related activities. They are government organizations (GOs), including line agencies and local government, NGOs and farmers group, including forest and water user groups, crop and vegetable production groups, livestock development groups, mothers group, saving and credit groups, and farmers cooperative hereafter referred to as "user groups." However, it is not known which of these organizations have been effective, under what condition and how they can help farmers in land management? SWOT analysis of GOs, NGOs and user groups helps to get answer of these questions.

The acronym "SWOT" denoting the strength, weakness, opportunity and threat is a standard method of capacity analysis used to size up the situation of organizations in the public domain (Duncon and Gross, 1995:21). Strengths and weakness are factors internal to the organizations and opportunities and threats are external factors. SWOT analysis serves as a basis both for analysis and development of an appropriate policy for action. It is a useful means to assess the functional capacity of organizations and finding hidden issues that constrain in their effective functioning (Hutanuwatr, 1998:12).

11.2 Farmers' Satisfaction with Local Organizations

There are many local organizations engaged in providing different types of support services to farmers. These organizations provide technical advice, credit and high yielding varieties of crops. The preceeding chapter discussed activities pursued by local organizations.

It is essential to examine farmers' satisfaction with these organizations so as to enhance their institutional capacity for better services. Farmers have mixed type of reaction to support services provided by local organizations in both project and the non-project areas. Farmers in both areas revealed low level of satisfaction with government organizations (Table

11.1). However, particularly in the project area, they expressed significantly higher degree of satisfaction ($p \leq 0.05$) with the Soil and Water Conservation and Watershed Management Office, which is attributed to the Watershed Management Project implemented by this organization during 1975-1995. Overall, farmers are more satisfied with local NGOs, including the aid project like LAC than with GOs. Among GOs, local governments including DDC and VDC could satisfy farmers better than other government agencies (Table 11.1). This suggests that the efforts made by local organizations have not been able to meet farmers' demand for required services. According to farmers, NGOs and other organizations working outside government bureaucracy offered relatively better services. While the services provided by government organizations, like Agricultural Inputs Corporation, Land Administration and Land Survey Offices were worst.

Table 11.1: Farmers' satisfaction with local organizations

Name of local organizations	Project Area (N=155)		Non-project Area (N=145)	
	Index	Rating	Index	Rating
District Agriculture Development Office	0.63	Medium	0.70	Medium
District Land Administration Office	0.53	Low	0.56	Low
District Land Survey Office	0.53	Low	0.52	Low
District Livestock Development Office	0.57	Low	0.59	Low
District Forest Office	0.58	Low	0.58	Low
District Irrigation Development Office	0.66	Medium	0.58	Low
District Soil and Water Conservation Office	0.91*	High	0.56*	Low
Local governments (DDC/VDC)	0.74	Medium	0.67	Medium
Agricultural Input Corporation	0.57	Low	0.53	Low
Lumle Agricultural Research Center (LAC)	0.70	Medium	0.66	Medium
Small Farmers Development Programs	0.61	Medium	0.65	Medium
Non-governmental organizations (NGOs)	0.69	Medium	0.65	Medium
Annapurna Conservation Area Project (ACAP)	0.59	Low	0.66	Medium
Aggregate index of satisfaction	0.64	Medium	0.61	Medium

Source: Field Survey, 1999

NB: The statements were weighted assigning value 1 for "highly satisfied", 0.80 for "satisfied", 0.60 for "don't know", 0.40 for "unsatisfied" and 0.20 for "highly unsatisfied" to construct the index of satisfaction.

The index below 0.60 is rated as "low", 0.61 - 0.80 as "medium" and above 0.80 as "high".

* Significantly different at 0.05 confidence level (T Test, $p \leq 0.05$)

11.3 Farmers' Participation in Joint Land Management Activities

Besides individual efforts made for land management, farmers have also participated in management activities that require joint efforts. It is essential to examine the nature and process of participation in the pursuit of designing a comprehensive land management strategy.

In a broad perspective, participation is understood as an involvement of individuals who share an action for the accomplishment of common goals. Participation in land management is defined as a process, which enables farmers to organize themselves, prepare joint action, identify appropriate technologies and undertake necessary actions. Recently there is growing emphasis on public participation in resource management and development programs. Still there is tendency to implement programs with little or without farmers' involvement. This explains conservation and development programs initiated by GOs could not achieved stated objectives (Sastry and Rao, 1997; Burkey, 1993; Chamber, 1993). In

this context, it is plausible to examine farmers' involvement in different land management activities requiring joint or community action.

11.3.1 Innovative Participation

A few farmers who were concerned about the on going land degradation caused by landslide and gully formation discussed this matter, and requested line agencies for support. Whenever they received some support, the farmers made additional contribution spontaneously, as they could get direct benefit from this. This type of participation was normally found in tree and shrub plantation in gullies, landslide scars and foot trails, and in waterway and bund construction in both areas (Table 11.2).

11.3.2 Community Leader Guided Participation

Some ethnic groups like Gurung, Magar and Tamang participate in social, cultural and development activities following their group specific tradition which authorizes the concerned group leaders to mobilize and provide guidance to fellow villagers. In villages with these ethnic groups, the development agency officials approach the concerned leaders for their contribution to development and conservation activities. If the leaders are convinced that the proposed activity is beneficial for their community, they ask villagers for participation. Sometime they call meetings for discussion then make contribution according to the decision made at the meeting. This type of guided participation is reportedly high in construction activities mentioned under innovative participation. The proportion of farmers under this type of participation is relatively high in the non-project area (Table 11.2).

11.3.3 Direct Active Participation

Some farmers have played active role in the promotion of land management activities among fellow farmers. They involved themselves in activities whenever opportunities were available. In this pursuit, they attended the meeting organized to prepare the plan, and asked fellow villagers to express their needs in the meetings and requested village representatives to discuss their problems with the concerned authorities. They also involved themselves actively in project implementation. The proportion of farmers under this type of participation was relatively high in the project area than in the non-project area (Table 11.2). The major activities pursued were shrub and tree plantation in the former area and gully control in the latter area.

11.3.4 Direct Passive Participation

Some farmers who did not have leadership character attended the meeting and listened others, but did not put forward personal views or offered suggestions to their representatives until they were asked if they had some point to make comment. Sometimes they agreed whatever was done by the representatives and did not pass any personal comment, rather they helped the representatives whenever supports were requested during the planning phase. However, they actively contributed their labor to activities executed in their villages. Relatively small proportion of farmers were under this type of participation in the project area. In the non-project area, only a few farmers participated in gully control in this way (Table 11.2).

11.3.5 Coercive Participation

The Phewatal Watershed Management Project followed highly centralized system for implementation of its activities. At the beginning, the project was directly implemented

without any consultation with the local people. The contractors responsible for structural conservation works were working under the supervision of the project staff. There were frequent resistances and demonstrations by local farmers against the project. Farmers were against the plantation in public grazing land fearing that they might be ultimately nationalized. The protest was so serious that even some local leaders were arrested. Some farmers however, took part in project activities because of the fear that their non-involvement would lead to punishment. Mid-term evaluation of the project conducted in the late 1980s strongly recommended for implementation of project activities in cooperation with local farmers. Since, then public participation was emphasized.

Table 11.2: Type of participation

Type of participation	Project Area (N=155)				Non-project Area (N=145)			
	A	B	C	D	A	B	C	D
	f'	f'	f'	f'	f'	f'	f'	f'
Innovative	8.0	7.0	7.0	13.0	8.0	6.0	6.0	10.0
Community leader guided	16.0	14.0	11.0	18.0	26.0	23.0	20.0	52.0
Direct active	5.0	5.0	6.0	8.0	3.0	4.0	2.0	2.0
Direct passive	2.0	4.0	4.0	4.0	0.0	3.0	0.0	0.0
Coercive	15.0	14.0	11.0	19.0	2.0	0.0	4.0	4.0
Elite pressure	4.0	5.0	4.0	8.0	0.0	0.0	0.0	2.0
Politically guided	2.0	4.0	3.0	2.0	0.0	0.0	0.0	0.0
Social and cultural	8.0	6.0	5.0	12.0	2.0	2.0	1.0	1.0
Full flagged	4.0	2.0	0.0	4.0	3.0	5.0	3.0	5.0

Source: Household survey, 1999
NB: f'= proportion of N
A = waterway and bund construction B: Gully control C: Landslide prevention D: Shrub and tree plantation

In the non-project area, the Annapurna Conservation Area Project (ACAP) has implemented a centralized forest conservation program in four VDCs since 1989. It has formed Conservation Area Management Committee (CAMC) in each VDC, with responsibility for program implementation. Besides, ACAP has also implemented small-scale land management activities like gully control, foot trail improvement and plantation. According to its organizational policy local people are required to make 40 of the total value of contribution in project activities. Some farmers who were not willing to make contribution voluntarily were forced by CAMC to make labor contribution. The proportion of farmers representing this type of participation was relatively low compared with the farmers in the project area (Table 11.2).

11.3.6 Elite Pressure Participation

Some farmers in the project area contributed their lobar to different land management activities according to request made by local elite (Table 11.2). Similarly, about two percent farmers in the non-project area contributed to tree and shrub plantation in gullies under the pressure of the local elite. Interestingly all farmers who had attended the group discussion reported that such elite pressure was diminishing gradually in all sectors of local development.

11.3. 7 Politically Guided Participation

Politically guided participation is a recent phenomenon evolved since the 1990s after the establishment of a multiparty political system. In this regard, people affiliated with different political parties are organizing land management activities in order to enhance respective party's popularity among farmers. About two percent of farmers participated in each

waterways and bund construction and shrub as well as tree plantation, four percent in gully control, and three percent in landslide prevention in the project area (Table 11.2). This type of participation was not reported in the non-project area.

11.3.8 Social and Cultural Participation

Traditionally, voluntary contribution of cash, kind and labor for the benefit of large number of farmers is considered as the contribution for god. Relatively better off farmers have made contributions to the construction and maintenance of irrigation canals, paving stone in foot trails and check dams construction with believe that such contribution would make god happy. Based on this belief, some farmers in both areas participated in land management activities organized by line agencies, NGOs, and VDCs (Table 11.2)

11.3. 9 Full Flagged Participation

Overall implementation of the land management activities assisted by the line agencies is top down and participation of farmers is relatively coercive in nature. However, some farmers participated voluntarily in all processes, including problem identification, decision making, implementation and benefit sharing. This type of participation occurred when the farmers themselves initiated small-scale land management activities without any outside assistance. About two percent of farmers participated in gully control and four percent each in waterway and bund construction and shrub and tree plantation in the project area. Similarly, three percent of farmers participated each in waterway and bund construction and landslide prevention, and five percent each in gully control and shrub and tree plantation in the non-project area (Table 11.2).

11.4 Participation by Project Phase

Farmers often complained that line agencies and even NGOs are not fully democratic and transparent which prevent their participation in all project cycle, including planning and decision making. It is only a few local leaders who are involved in the planning and decision making. Most activities of the Phewatal Watershed Management Project were prepared by the officials without consultation with the target group. The project staff went with their programs and local farmers were asked for their part of contribution to conservation actions. Most of the participation in land management activities occurred during the program implementation (Table 11.3). As a result, the project experienced poor performance in its first phase. Realizing this problem, farmers' participation was emphasized during the second phase. At the final stage, the project involved some local people in discussion on repair and maintenance of the completed works. Some farmers were also involved in the project monitoring and evaluation. All other development agencies followed the same system adopted by the project. Clearly immediate objective was to pursue targeted activities without any due concern about their sustainability.

Participation of farmers in land management activities was relatively low in the non-project area compared with the project area. Most participation occurred during the implementation phase as in the case of project area (Table 11.3). While so far any comprehensive support package has not been provided to farmers in the non-project area, some VDCs, NGOs and ACAP have initiated small-scale land management works.

Table 11.3: Participation by project phase

Land management activity	Project Area (N=155)				Non-project Area (N=145)			
	Project phase				Project phase			
	Planning	Decision-making	Impleme-ntation	Monitoring and evaluation	Planning	Decision-making	Impleme-ntation	Monitoring and evaluation
	f'	f'	f'	f'	f'	f'	f'	f'
Waterway and bund construction	2.0	1.0	52.0	9.0	4.0	4.0	33.0	3.0
Gully control	1.0	2.0	49.0	9.0	2.0	2.0	35.0	4.0
Land slide prevention	1.0	3.0	40.0	8.0	2.0	2.0	27.0	3.0
Shrub and tree plantation	2.0	4.0	68.0	14.0	3.0	3.0	66.0	4.0

Source: Household survey, 1999
NB: f' = proportion of N

11.5 Labor Contribution to Land Management

Farmers are seriously concerned about the condition of their landholdings. Besides efforts made to manage their individually owned agricultural land, they have made labor contribution to community and development agencies initiated land management works. On average, a farm household in the project area contributed three workdays per year for group based land management activities (Table 11.4). A farm household in the non-project contributed two workdays of labor annually. Relatively low contribution in the non-project area compared to the project area is attributed to a few land management activities undertaken there. However, there is great variation in contribution among farm households.

Table 11.5: Labor contribution in land management

Labor contribution (Workday/household)	Project Area (N=155)		Non-project Area (N=145)	
	During 1988-1998	Per year	During 1988-1998	Per year
Average workdays	27	2.8	19	1.9
Standard deviation	24	2.3	18	1.8
Maximum days	138	14	165	17
Minimum days	5.0	1.0	2.0	1.0

Source: Household survey, 1999

11.6 SWOT Analysis of Line Agencies

Analysis of support services provided by line agencies, including local governments in preceeding chapter and farmers' satisfaction with these organizations in preceeding section indicated that they have week capability to provide required services to farmers. Thus, it has been essential to analyze their strengths, weaknesses, opportunities and threats so as to understand their existing capacity and figure out the prospect of institutionalizing the land management activities through their enhanced capacity.

11.6.1 Strengths

Well-trained bureaucrats head the district level line agencies. They are supported by competent sub-ordinates who are quite familiar with problems faced by farmers that constrain better land management. These agencies have well-structured, vertically organized network. All employees have a strong sense of job security, as they get regular salary and fringe benefits during the service period and pension after retirement. The majority of them have

their own office premises at district level and are moderately equipped with necessary equipment. Each agency generates its own information for planning. The District Development Committee (DDC) coordinates the line agencies at district level. GOs prepare their annual programs and submit to the district council for approval. The District Council approves the programs based on their merits. Similarly, the Village Development Committee coordinates the village level programs and the VDC Council approves VDC level programs. These procedures have given enough opportunities to people's representatives to scrutinize and select the appropriate programs that suit the local conditions (Table 11.5).

11.6.2 Weaknesses

The government services are fragmented into different line agencies. There is no one-door policy and service outlet for farmers. Farmers have to contact different line agencies for technical advice and other assistance. The line agencies can independently implement the programs once they are approved by the District Council. They are compartmentalized and each of them function without any coordination with other agencies. They are located in different parts in district headquarters and farmers have to visit individually for required services. Farmers often lose their patient to visit all agencies, as they require a comprehensive package of extension services for new crop. There are very limited number of staff deputed for extension services at the service centers. They are unaware of location specific land management technologies owing to lack of regular training. The amount of budget allocated to training, extension materials, travelling and daily allowance is very small which accounts for one percent, half percent and two percent of the total budget respectively. On average, an agricultural extension worker has to provide service to 3,677 households. Similarly, a livestock extension worker is assigned 16,515 livestock of 3,371 households, and a forest extension worker has to take care of 1,586 households, 6 forest user groups and 1,574 hectares of forest. Besides, there is no regular supervision and monitoring system in each line agency, to check the work progress and remove constraints being confronted. All these factors combinely impair extension workers' capability. Unwritten job descriptions, weak accountability and transparency, skepticism, rivalry among sectional heads, compulsion to get directives from central departments for major decisions and late decision are other weaknesses of GOs. They collect information in an old-fashioned manner as a result errors, discrepancies and duplication of information have been common problems. Coordinated collection and synchronization of information at district level is essential for better planning, but no such initiative has been taken (Table 11.5).

11.6.3 Opportunities

Line agencies receive funds from the government that provides an opportunity for continuation of their activities, though not in an effective way. The government promulgated four acts in the last three decades, i.e., the Local Administration Act 1971, Decentralization Act 1982, DDC and VDC Acts 1991 and Local Governance Act 1998, to enable local organizations to carry out their developmental and conservation responsibilities effectively. The provision of training for staff in foreign countries, a growing number of experienced staff, and the growing catalyst role of DDC to integrate all sectors under one umbrella are other opportunities for the line agencies. The Agriculture Perspective Plan (1995-2015) aimed to increase agricultural production from 0.5 percent in 1991/92 to 5 percent by the end of the plan period, averaging 3 percent growth. It has emphasized enhancing functional capacity of local organizations, which is expected to offer better training opportunities for staff. Following the plan, the District Agricultural Program Implementation Committee has been formed under the DDC including key line agencies, NGOs, farmer groups and private

entrepreneurs. The committee would initiate institutional reform to make them service-oriented (Table 11.5).

Table 11.5: SWOT analysis of GOs

Issues	Strength	Weakness	Opportunity	Threat
Governance	• Well established organizational set up • Well developed vertical network and functional hierarchy • Approval of district level program and projects by District Council • Approval of local level programs by VDC Council	• Compartmentalized line agencies • Weak horizontal coordination and duplication of work • Fragmented service out lets and absence of comprehensive extension package • Poorly integrated service and sub-service centers	• Increasing emphasis on local governance • Promulgation of: - Local Administrative Act, 1971 - Decentralization Act, 1982 - DDC and VDC Acts 1991, and - Local Governance Act, 1998	• Politicized bureaucracy • Power influence in financial decisions • Central departments control the vital decision making power • Growing rivalry and competing attitude among line agencies
Resources	• Regular funding from central government • Moderately equipped office premises at the district level • Each agency has its own information system for planning	• Under financed • Poorly equipped field offices • Budget shortfall for repair and maintenance works • Unsynchronized information system	• Long term funding assurance by donors for watershed management • Continued bilateral and multilateral support • Prospect of information computerization	• Dependency on donors for development projects • Insufficient and delayed release budget from central departments • Data gap and overflows of information
Manpower	• Well educated and trained office in-charges • Competent subordinates at district level	• Limited and poorly trained extension workers • No regular training for staff to upgrade their knowledge and skill	• International training opportunity for staff • Gradually growing capacity of Regional Agricultural Training Center	• Frequent transfer of personnel • Dominance of old age bureaucrats in decision making who hardly adjust with changes
Motivation	• Strong sense of job security • Salary and fringe benefit during service and pension after retirement	• Extension workers have no incentive for field works • No mechanism for reward and punishment	• Recent change in the Civil Service Act has made provision of work evaluation for promotion	• Nepotism and favoritism in appointment and promotion in key posts
Accountability	• Quarterly report to central departments stating achievement and shortfall • Annual progress review meeting	• No job description for employees • Intersection rivalry • Weak monitoring and supervision of field level activities	• Agriculture Perspective Plan aims to make local organizations more accountable to implement stated programs	• Competition with NGOs/INGOs • Political interference
Transparency	• Line agencies present program and budget before peoples' representative for approval once a year	• Lower level staff and farmers don't know the financial strength of line agencies	• Preparation of the district development plan by combining annual programs of line agencies	• Corruption and manipulation of resources

Source: Institutional survey, 1999

10.6.4 Threats

The Nepalese bureaucracy has been politicized since 1990 after the restoration of the multi-party political system. The non-officer bureaucrats openly organized under the two unions, namely the "Civil Servant Association" and the "Civil Servant Organization" aligned as sister organizations of two large political parties, the United Marxist-Leninist and the Nepali Congress respectively. The law prohibits gazetted officers from being involved in such unions. However, they have maintained stable and strong relationship with the preferred political parties. This type of relationship with political parties has increased the influence of politicians in technical decision making. The politicians are interested to depute their own supporters in key posts who could work in their interest. The central government has changed nine times during the last ten years and congruently, civil servants were transferred frequently according to the interest of politicians in charge of the government. Civil service has been plagued with nepotism and favoritism particularly in deputation and promotion in key posts. This phenomenon has aggravated mistrust of farmers to the bureaucrats on their neutrality and service motive. Besides, under-funding, delayed budget release, competition with NGOs, dependency on donors for large projects, poor infrastructure, and growing rivalry among line agencies have constrained delivery of prompt services for farmers (Table 11.5).

11.7 SWOT Analysis of NGOs

Proliferation of NGOs since 1990s has made some contribution in land management at village level. According to farmers, the services provided by NGOs are relatively better compared to line agencies. It is known about their capability and effectiveness. Thus, SWOT analysis would help to understand their functional capacity and organizational structure to devise strategy for their development as local partner in land management.

11.7.1 Strengths

An NGO functions under the leadership of an executive committee, formed by people with common interest in conservation and development issues. NGOs' programs are implemented by volunteers and staff. They have flexible structures and decision-making systems which help them adjust according to situations. They have little bureaucratic procedures and the staff promptly take action on programs approved by the committee. Local NGO staff are recruited from respective area as who are well aware of farmers' needs and preferences. They have keen interest in local resources mobilization to ensure the sustainability of their organization and to achieve the stated objectives. The field based office maintain regular direct contact with farmers. Similarly, the office bearers maintain close relations with funding agencies. A strong supervision and monitoring system is established to redirect the field staff and to overcome pitfalls. They work as active agents and demonstrate a good impact in the target area (Table 11.6).

11.7.2 Weaknesses

The NGOs operate in a closed system. Most of the executive committees comprise seven persons, including a chairperson which is mandatory to be recognized as NGO. There is no opportunity for entry to new members. The founding members control/make all important decisions and there are no immediate successors in the leadership. There is under-representation of poor and marginalized people in leadership. The employees have low competence and are poorly trained. There is a high degree of salary discrepancy between the upper and lower level staff. Low-paid field staff are least motivated to their responsibilities. The employees have no sense of job security as they are hired on contact basis and little

chance of career development. Funds are collected from different sources, but there is no commitment for long-term support. While they are receiving substantial amounts of funding support from external agencies.

Table 11.6: SWOT analysis of NGOs

Issues	Strength	Weakness	Opportunity	Threats
Governance	• Executive committee is formed by local people who are aware of land management issues • Executive committee members are elected	• Closed membership • No immediate successors to take over the leadership • Concentrated in urban and semi- urban areas • Dominance of educated elite, retired bureaucrats and politicians in executive committees who can manipulate program and impose decisions	• Strong government support as NGOs contribute to national development programs • Recognized by development and aid agencies	• Change in regulatory law • Mobilization Of NGOs for political purpose
Resources	• Direct funding from aid agencies • Mobilization of local resources	• Short term funding • Uncertainty in program continuation • Poor office infrastructure	• Recognized as local development partner by aid agencies and INGOs • Independent to seek fund from any source	• Prone to collapse after loosing the outside funds
Manpower	• Local staff are aware of needs and preferences of farmers • Working in a team comprising volunteers and staff	• High salary gap between upper and lower level staff • Poorly trained field staff • Less competent staff • No job security • No career development opportunity	• Training opportunity in developed countries • Attraction of retired governments' officers	• High turn out of employees • Shortage of skilled manpower
Motivation	• High incentive to field workers • Good internal monitoring and supervision system	• Allowance driven field workers • Confined to a small area	• Increasing involvement of women and under privileged groups	• Growing influence of urban elite
Accountability	• Field office • Flexibility to adjust plan and programs • Close contact with donors and farmers	• Lack of periodic plan and guaranteed contribution in national program • Weak coordination with line agencies and VDCs	• Enough freedom to advocate for hidden issues	• Overlapping and duplication of programs particularly in accessible area
Transparency	• Program and budget approved by the general assembly	• Lack of external auditing of income and expenditure • Financial situation is not transparent	• Growing interest of people	• Corruption and manipulation of resources by elite in the name of poor

Source: Institutional survey, 1999

Farmers often complain of the uncertainty of the programs implemented by NGOs. As a consequence of short term commitment to funding support, they always pursue activities on the project basis. They are mainly confined to small urban and semi-urban areas. They have neglected the rural hinterlands, which are in dive need of external support. Farmers often accuse them as being non-transparent, because they don't disclose their income and expenditure (Table 11.6).

11.7.3 Opportunities

The government has invited NGOs to make contribution to its conservation and development programs since 1990 by mobilizing local and external resources. They have been recognized as development partners by both government and development aid agencies. They are free to establish direct contacts with aid agencies, INGOs and other institutions for funding support. The aid agencies have identified them as reliable development partners. NGOs address hidden issues which are often neglected by the government (Table 11.6).

11.7.4 Threats

Educated elite, retired bureaucrats and politicians who can manipulate decisions have occupied key posts in most NGOs. High turnover of employees is another threat to local NGOs. Field staff keep looking for better job opportunities and they quit their jobs as soon as they get better offer. According to GO officials, NGOs duplicate their activities in accessible areas. There is no in-built mechanism to avoid the duplication of development projects for efficient utilization of scarce resources. Most NGOs are funded from external sources and they are prone to collapse after the withdrawal of the support (Table 11.6). Besides, changes in government policy affect NGOs. As the government is likely to introduce an NGO Regulation Act, which envisages channeling NGO funds through government agencies to minimize the duplication of activities and to monitor their financial system. It is likely to have considerable impact on the scope and intensity of NGOs involvement in conservation and development pursuits (Table 11.6).

11.8 SWOT Analysis of User Groups

User groups formed spontaneously or promoted by line agencies, NGOs and VDCs are peer local actor in land management. SWOT analysis of these groups would help to devise the strategies and programs to enhance their technical and managerial capability for the promotion of locationally suitable land management practices.

11.8.1 Strengths

The user groups have strong unity among members and motivation for self-governance. A few of them, specifically mothers' group, have continued functioning for a long time with modifications and adjustments. They have their own formal or informal rules and regulations. They have maintained solidarity and a cooperative mind among the members. Decisions are made by consensus with consultation, and benefits gained by the group are distributed equally among the members. They trust their leaders for financial management based on the merits of the leaders. Internal disputes among members are managed based on consultation and dialogue through coordination by the leader. The participation of women is encouraged in mothers group (Table 11.7).

Table 11.7: SWOT analysis of user groups

Issues	Strength	Weakness	Opportunity	Threat
Governance	• Strong unity among members and motivation for self governance • Change in leadership based on consensus • Cooperative members • Decision making based on consensus of the member • Negotiation to settle internal disputes among members	• Majority of them are formed and mobilized according to the interest of line agencies and NGOs • Absence of long term vision • All members are not certified as member • Dominance of local elite in executive post capable of maneuvering the decisions • Involvement of same influential person in different groups	• Growing relationship with line agencies, NGOs, INGOs and aid agencies • Recognized as local partner by Forest and Water Resources Acts • Federated organizational structure	• Migration of young people to towns and cities • Manipulation and mis-utilization of resources due to dominance of influential persons
Resources	• Fair benefit sharing among the members • Mobilize local and external resources	• Lack of the account auditing system • Financial management controlled by leaders	• Rule and regulations are respected by line agencies • Free to establish direct contact with aid agencies for funding	• Conflict between members and non-members over benefit sharing
Manpower	• Group expertise	• All members are not trained • Lack of trained manpower • Insufficient follow up and refresher training	• Hire technical manpower	• Expert are not interested to work as hired labor due to their weak affordability to pay
Motivation	• Some promotional program and activities are implemented by GOs and NGOs	• Irregular support services to attract them in program implementation	• Growing number of member	• Limited support services provide by line agencies and NGOs are captured by a few elite
Accountability	• Program and budget are approved in consensus of all members • Group accountability	• Weak record keeping system • Limited contact of group member with support agencies	• Line agencies, NGOs, INGOs and donors are interested in their capacity strengthening • Growing involvement of women	• Lack of long term plan • Difficult to continue after phasing out the external support • Male dominance in decision making
Transparency	• Income and expenditures accounts are open for all members concerned	• Most of the account is kept by affluent person	• Increasing number of meetings	• Misuse of fund by local elite

Source: Institutional survey, 1999

11.8.2 Weaknesses

Majority of user groups are formed and mobilized by line agencies and NGOs as an entry point to the community to attain their objectives with the exception of the forestry sector, user groups have no long-term plan for the future. A few saving groups have collected large amounts of money up to Rs 0.5 million. The money was kept ideal in the bank due to their weak entrepreneurial skills. Neither the group nor the supporting agencies could prepare an investment plan that would yield reasonable profit. Local rich males have taken a leadership role in many user groups, and their wives have been leaders of women groups. The line agencies and NGOs prefer working with the rich farmers as they are influential which makes it easier to implement programs. This has constrained the role of the poor in user groups. Local elite capable of manipulating the decision have dominated the user groups. Influential leaders may manipulate actions and mobilize user groups according to their vested interest. Besides, the groups are dominated by males, and women who are making significant contribution to land management, have little role in decision-making. The extension workers have contacts mostly the leaders. Large proportion of members are not trained on related activities due to limited training capacity and broad vision of support agencies. User groups have no formal audit and record keeping system due partly to lack of training (Table 11.7).

11.8.3 Opportunities

The role of user groups in development and conservation is well recognized by all line agencies, NGOs and donor agencies. User group involvement has been considered essential for effective resource management and small-scale development works to replace the contractor system. The Forest Act 1993 and Forest Regulation 1995 have recognized forest user groups as autonomous and corporate institutions with right to acquire, sell and transfer forest products to generate income. A national forest user group federation was established in 1996, integrating 1,323 groups (FECOFUN, 1998), of which 59 were from the project area and 37 from the non-project area, to protect their rights and enhance their capacity in forest management. It has strengthened and widened the role of the user groups. Following the forestry sector, water user groups have been formally recognized by the Water Resource Act 1993 for the construction, operation and maintenance of irrigation canals.

From the experience in user groups' effective role in forest and irrigation water management, other agencies including the Departments of Agriculture and Livestock Development have also learn and started promoting the user group management system. Accordingly, line agencies, NGOs, INGOs and aid agencies have been pursuing efforts to strengthen user groups (Table 11.7).

11.8.4 Threats

There is a risk of power influence within the group. User groups are formed based on geographical proximity to and traditional affiliation with local resources. Still so-called low caste households have not been allowed to join groups. This has lead to conflict between member and non-member households over benefit sharing. The introverted nature of a few farmers and preference of the young to work in towns and cities are other constraints to maintain user groups. The privatization policy of the government has curtailed subsidies gradually for chemical fertilizers and other support services due to increasing emphasis on the privatization policy. As a result relationship between user groups and line agencies has been weakened (Table 11.7).

CHAPTER XII

STRATEGIES FOR LOCATIONALLY SUITABLE LAND MANAGEMENT

The analysis of the status of farmlands indicated that the current management practices have not been able to control land degradation effectively. Farmers have changed land management practices considerably over last three decades in response to shrinking landholding size and undergoing land degradation. However, these changes have not been able to cope with these problems. Therefore, formulation of locationally suitable land management strategies which would enhance farmers' economic condition and promote farmland conservation has been necessary. Change in land management system requires even change in the mode of current farming system accompanied by strengthening local institutional capability for land management (Fig 12.1).

Promotion of environmentally suitable, economically profitable and socially acceptable land management practices requires a strategic land management plan. Farmers' land management practices in both areas have evolved over past several decades in response to changing socio-economic situation. Land management decisions are made to attain food security and to secure some income required to fulfilling basic subsistence requirements. At the national level, land are considered as source of food supply and means of absorbing growing labor force. But their connotation has not been a matter of concern for policy makers. However, some appreciable changes have been taken place in land management in selected areas of both watersheds, though the scale of change is relatively small.

Improvement in land management and change in farming system is required to improve the status of farmlands. The current land use policy emphasizes the promotion of the traditional farming system instead of promotion of new agricultural enterprises and land management practices conducive to harness economically attractive land use potentials and prevent lands from degradation. The major portion of the agricultural lands in both areas are located along fault lines, comprising bed rocks like phylite, schist and slate. Farmlands near such highly vulnerable geological structure are prone to leaching, landslide, and accelerated soil erosion. Frequent occurrence of landslide has increased the cost of terrace maintenance in both areas. Therefore, a gradual change in cropping system is necessary for sustaining the local livelihood system.

The Land Resource Mapping Project (LRMP, 1984) has broadly classified lands into seven classes based on slope gradient, soil depth and soil characteristics (Table A.53). Based on these criteria, lands between 5 to 30 percent slope gradient are recommended for crop cultivation with terracing; lands above 30 percent slope gradient are suitable for forestry and pasture. This classification provides some basis for examining land suitability. However, a strategy for change in land management and cropping system should also take into consideration for slope stability, geological condition and comparative advantage. Generally lands located in geologically weak areas, including lands located near fault and thrust lines, steep hill slope and ridge should be prioritized for multipurpose tree plantation. Farmlands in the hill slopes should be utilized for tree-crop mixed farming and lowland area for crop production.

12.1 *Bari* Land Management

Bari lands in both watersheds are located in steep hill slopes and ridges. In the non-project area, most of these lands are characterized by outward facing terraces, which are vulnerable to accelerated soil erosion especially during the rainy season. *Bari* terraces in the project area

have been changed from outward facing to inward facing. Still they are prone to landslide due their location along fault lines and steep slope combined with the intensive cultivation.

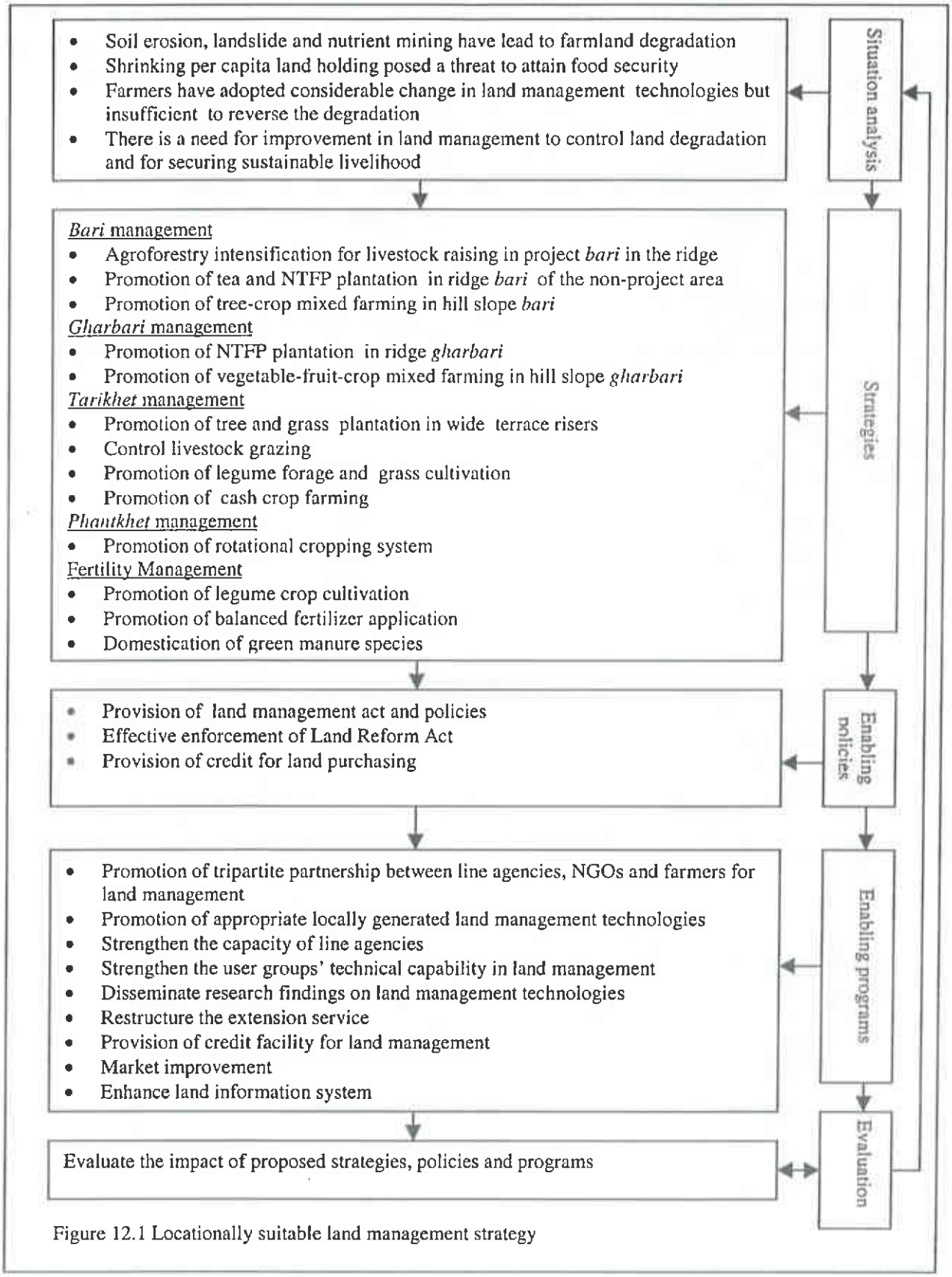


Figure 12.1 Locationally suitable land management strategy

12.1.1 Agroforestry Intensification for Livestock Raising in Ridge *Bari* of the Project Area

The productivity of *bari* lands in the ridge is declining gradually due to soil erosion and nutrient loss. As a consequence, farmers need to apply a substantial amount of labor for terrace improvement and fertility management. Considering the labor shortage, cereal crop cultivation has been a difficult and economically unattractive for farm households. Despite marketing opportunity, fruit farming is not possible in the ridge due to frequent occurrence of hailstone during the pre-monsoon season.

The ridge environment, however, offers opportunity for livestock raising, which can contribute to improve farm household economies, particularly in locations accessible to market centers (Thapa and Paudel, 2000:223). In the adjoining Andhikhola watershed, livestock raising had contributed 39 percent of the total household income (Paudel, 1997:59).

After the construction of the Pokhara-Baglung highway in 1990, stall-fed dairy livestock raising has emerged as an attractive economic activity in the eastern part of the Phewatal watershed. Farmers have been selling diary products including fresh milk, in the regional town of Pokhara, which has been economically more attractive than the cereal crop cultivation. It is essential to promote this activity in view of the ever increasing demand for dairy products through the implementation of a fodder and forage production improvement program.

Fodder tree growing in farm terrace risers was promoted in the project area since the 1980s with the external assistance. However, all *bari* and *kharbari* in the ridges are not intensively utilized for this purpose. Therefore, some promotional activities are required to intensify the agroforestry to increase the supply of forage and fodder and to enable farmers to fed livestock on stall. Besides, farmers should be encouraged growing *Thysanolena maxima* (amriso) and other non-timber forest products in terraces considered being relatively infertile by farmers.

Agroforestry can be promoted even in the western part of the project area. Traditionally, livestock have been raised in the northwestern part. If a milk collection depot is opened at Thulakhet, near Baidam-Ghantichhina road head, farmers would be able to sell fresh milk and secure increased amount of farmyard manure required for fertilizing farmlands. Tree and grass species found to be suitable by LAC should be considered for promotion which would require a systematic trail and demonstration on farmers' field through the provision of an efficient extension service.

Most fodder grown in the study area, including *Artocarpus* (badhar), *Ficus locor* (kahuro), *Erythrina spp* (phadelo), *Bambosa ssp* (bans), Ficus clavata (bedulo), *Listea monopetala* (kutimro), *Celtis australis* (khaniyo), *Ficus nerifolia* (dudhilo), *Ficus roxburghii* (nimaro) and *Ficus hispida* (totne), are deciduous type changing their leaves in February and become ready for lopping in May. Only *Ficus glaberiria* (pakhuri) is an evergreen fodder tree which can not meet the fodder demand during the dry summer season. Farmers are not aware of other species which could provide fodder during this season. Mulberry (*Morus alba)* locally known as *kimbu* is a multipurpose tree. Its foliage can be used as fodder as well as for silkworm raising and it can be lopped in dry season. It is widely grown to offset fodder deficit during the dry summer season in Dhading District (Neupane, 2,000). This type of technology should be promoted even in the project as well as the non-project areas. Besides, extensive propagation of *Ficus glaberiria* (pakhuri) in gullies and landslide area should be encouraged,

as its extensive root system stabilizes gully expansion and the tree provides higher amount of fodder.

Plantation of non-forest timber product (NTFP) species should be promoted under shade of fodder trees for effective utilization of ground space. This would help to enhance household income, and to promote land conservation.

12.1.2 Promotion of Tea and NTFP Plantation in Ridge *Bari* of the Non-project Area

Ridges in the non-project area suffer from hailstone during the pre-monsoon season. This constraints fruit tree growing there. According to farmers, cereal crop cultivation is not economically attractive. Therefore, a few farm households with large amount of income from remittances are reluctant to invest their labor and cash resources in *bari* and have left them fallow for several years. This entails promotion of alternative land use to prevent lands from degradation and to improve farm household economy.

Agroforestry based livestock raising might be considered as an alternative farm enterprise suitable for this area. But due to the lack of transportation facility, there is no immediate prospect for this activity. Annapurna Conservation Area Project (ACAP) has introduced tea plantation in barren *bari* lands in the ridges of Lwang Ghalel VDC, as biophysical environment is suitable for this activity. Impressed with its outcome, farmers in neighboring Rivan and Lahachock VDCs have also planted tea in their community lands under shrub formation, though the scale of cultivation is very small at the moment. Therefore, it is plausible to suggest promotion of tea plantation in *bari* and *kharbari* located in the ridge, as it offer opportunity to increase the farm household income as well as to control land degradation.

Since tea processing industries are located in the eastern part of Nepal, it is necessary to establish a small-scale tea processing industry in order to enable farmers to adopt a large scale. As farm households with income from remittances are interested making investment in the tea processing industry, concerned agency has to make concentrated effort to tap this potential.

NTFP promotion is another alternative in ridge *bari* of the non-project area. Farmers who are not willing for tea plantation should be encouraged for this practice for effective utilization of land and to reduce land degradation.

12.1. 3 Promotion of Tree-crop Mixed Farming in Hill Slope *Bari*

Building food self sufficiency through cereal crop cultivation is impossible in both watersheds, as most farmers have small land holdings normally unsuitable for cereal crops. However, the food security can be attained to a considerable extent through the cultivation of high value cash crops, including NTFP, which have high demand in Pokhara town.

Farmers have been practicing tree-crop mixed farming in *bari* land. But so far it has not been practiced at extensive scale. Therefore, tree-crop mixed farming should be intensified in both project and non-project areas. In this endeavor, domestication of suitable NTFP should be promoted in marginal lands; cardamom, ginger, herbal and other high value cash crops under trees in sloping land.

12.2 *Gharbari* Management

Gharbari constitute a small proportion of farmlands in both watersheds. These lands have been intensively utilized for cereal crop production and fodder and fruit trees growing. Still there is opportunity to make efficient use of these lands through some modification in land use and management systems.

12.2.1 Promotion of NTFP in Ridge Terrace Risers

Gharbari terrace risers in the ridges are utilized for fodder trees and terraces for cereal crop cultivation. Since the occasional occurrence of hailstone constrains fruit tree growing in this area. There is prospect for promotion of locationally suitable non-timber forest products, including *Bambussa ssp* (bans) and *Thysanolena maxima* (amriso), in the edges of farm plots and terrace risers. These trees will have multiple advantages for farmers, as they provide fodder for livestock, generate cash income from the sale of broom, and reduce soil erosion and landslide through their extensive root systems. The climatic condition in the study area is also suitable for *Swertia chirata* (chiraito), *Picrohiza* (kudki) *Valeriana jatamasi* (sugandahawal) which are used to make several homeopathic medicine. These NTFPs have high market value and can be grown under fodder trees.

Promotion of NTFP needs awareness creation on its economic and environmental benefits. In addition, farmers need technical know how on NTFP species and their propagation and marketing. Forest and Agricultural Development Offices and NGOs should promote NTFPs through the provision of necessary support services.

12.2.2 Promotion of Vegetable-Fruit Tree Mixed Farming in Hill Slope *Gharbari*

There is growing demand for vegetable in Pokhara. So far the major proportion of demand is being fulfilled by vegetables imported from *tarai* and India. According to vegetable traders, daily about 25 tons of vegetables are being consumed in the town. Out of this amount, about 30 percent is supplied from kitchen gardens in the city, peripheral villages and neighboring districts, and rest is imported from *tarai* and India. It is estimated that about 6,200 tons of vegetables are imported from India and *tarai* annually. Similarly, there is also growing demand for fruits in the city which can be fulfilled through the promotion of locationally suitable fruit trees in lower hill slopes. Given these opportunities, there is need for the promotion of vegetable-fruit tree mixed farming in the hill slope *gharbari.*

Fruit tree growing requires a wide range of management techniques including, lopping, browsing and pruning to modify their shape and growth pattern. In view of farmers' unawareness of these techniques, there is need for provision of training on different aspect of fruit farming.

In the non-project area, some farmers have been practicing vegetable-cereal crop mixed farming in *gharbari.* They are producing vegetable seeds for sale and earned about 80 times higher amount of cash income compared to income from cereal crops. Similarly, a few farmers have also practiced vegetable-fruit tree mixed farming and earned 10 times higher amount of income from same unit of land compared to cereal crop. As so far, this is being practiced by a few farm households in selected accessible areas, efforts should be made to promote vegetable-fruit tree mixed farming in hill slope.

12.3 *Tarikhet* Management

Tarikhet, constituting about two thirds of the total farmlands in project area and more than two fifths in non-project area, are undergoing declining soil fertility problem due to nutrient mining. Therefore, immediate attention should be given to improve soil fertility and farm productivity.

12.3.1 Tree and Grass Plantation in Wide Terrace Risers

Normally wide terrace risers and edges of *tarikhet* remain unutilized in both areas. Therefore, farmers should be encouraged to plant NTFP and fodder trees in wide terrace risers and edges of *tarikhet.* Besides, increasing the supply of biomass required for improving soil fertility, this practice, would contribute to increase the farm household income.

In view of declining grass yield in terrace risers, some improved grass varieties including, *Pennisetum purpureum* (napier grass) *Sargum sudaneses* (Sudan grass) and *Desmodium canum* (pega pega grass), *Macroptilium atropurpurem* (sirato grass) should be promoted. These grasses are very effective in reducing landslide and soil erosion.

12.3.2 Control Livestock Grazing

More than two thirds of surveyed *tarikhet* in the project area and about three fifths in the non-project area are left fallow during the winter and spring seasons. Livestock grazing is intensive during these seasons, as the farm terraces are not utilized for crop cultivation. This practice destroys the terrace risers made from clay by hoof traffic during the dry season and triggers landslide and soil erosion when high amount of rainfall and thunder occur during the monsoon season. Besides, destruction of vegetative cover by hoof trampling and nabbing is making land vulnerable to nutrient loss. Therefore, farmers should be educated to control excessive livestock grazing in *tarikhet* to maintain the farm structure and soil fertility. They should be educated on stall fed livestock raising and promotion of fodder tree and grass plantation in wide terrace risers.

12.3.3 Promotion of Legume Forage and Grass Cultivation

Legume forage cultivation during the winter season utilizing the residual moisture could help to increase soil fertility in *tarikhet.* Farmers are interested in forage cultivation in *tarikhet.* They are constraining due to unavailability of seed. Some leguminous drought resistant forage species, including, *Trifolium alesandrium* (berseem grass), *Resupinatum* (Persian clover), *Pisum arvense* (field pea), Melilotus indica (sweet clover) *Cenchrus, ciliaris* (buffalo grass), *Chloris gayana,* (rhodes grass), *Melinis minutiflora* (molasses grass), *Paspalum dilatum* (dallis grass), *Setaria anceps* (setaria grass) and *Eragrosties curvula* (weeping love grass) are suitable for *tarikhet* during the winter season. Therefore, concerned line agencies and NGOs should provide seed and technical know how about their propagation.

Grass cultivation instead of cereal crop cultivation in *tarikhet* is another alternative farm enterprise to increase household income and environmental conservation in both areas. It would help to promote stall fed commercial dairy livestock rising in the ridge and valley floor of the project area as they have road access for transporting dairy products to town. It can be promoted in the valley floor of the non-project area, if feed became available for this enterprise. This type of enterprise requires less labor and tillage practice which could alleviate pressure on household labor as well as reduce soil erosion and landslide associated with

regular hoeing and plowing of land. However, farmers are not sure about the profitability of grass cultivation, as it is not practiced before in both areas. Therefore, it must be promoted on trail basis and farmers would adopt spontaneously, if it demonstrates reasonable profit.

12.3.4 Promotion of Cash Crop Farming

There is enormous potential to increase household income through cash crop farming in *tarikhet*. This type of land has high potential for seed production of bean, bitter gourd, bottle gourd, brinjal, asparagus, board leaf mustard, christophine, coriander, cowpea, cress, okra, fenugreek and cucumber during the summer season. They have high demand in the adjoining town of Pokhara. Thus, farmers should be encouraged to change their cropping system from cereal crops to such high value cash crops.

Besides, *tarikhet* in both areas are suitable for potato cultivation in the dry summer season. A few farmers have introduced this type of crop enterprise for higher income, but the scale and intensity is relatively low. Therefore, the farmers who have sufficient labor force should be educated towards this crop enterprise.

12.4 *Phantkhet* Management

Declining soil fertility has been the major problem even in *phantkhet* management. As these lands have year round irrigation facility, there is prospect for cropping intensification with balanced application of fertilizers. Regular cereal crop cultivation with inadequate fertilizer input has made them vulnerable to declining soil fertility. Promotion of rotational cropping system with cereal crop cultivation in the summer season, grain legume cultivation in the winter season and commercial vegetable cultivation in the spring season will help to maintain soil fertility and improve household economies.

12.5 Fertility Management (All Types of Land)

Regular crop cultivation with low fertilizer input has led to nutrient mining in *tarikhet* and *phantkhet* of the project area, and *tarikhet, phantkhet* and *bari* of the non-project area. Immediate attention should be given to fertility management in these lands.

12.5.1 Promotion of Legume Crop Cultivation

So far *tarikhet* are being utilized for only rainfed rice during the monsoon season and their fertility is going down gradually due to application of inadequate amount of fertilizers. To some extent, these problems can be addressed by promoting legume crop cultivation in these lands during the winter season immediately after the harvest of rice crop. Normally soils in *tarikhet* have reasonable amount of moisture for 8-10 weeks after rice harvest. This allows cultivation of legume crops, which would help to enhance soil fertility, increase household income and livestock feed.

Phantkhet have year round irrigation facility and there is good prospect for promotion of legume crop cultivation during the winter season. This would help to enhance soil fertility and yield of cereal crops. Considering declining soil fertility, this practice should be intensified during the winter season.

Farmers have been inter-cropping legume crops with maize and millet in *bari* and *gharbari*. However, the intensity is not so high. Therefore, intensification of this practice in these lands would help to maintain soil fertility and increase the yield of cereal crops.

12.5.2 Promotion of Balanced Fertilizer Application

Irrespective of land type, a standard dose of NPK 100:60:40 kg/ha was recommended for high yielding varieties and 60:40:30 kg/ha for local varieties in the 1980s (Joshi and Khatiwada, 1986). The District Agricultural Development Office was then instructed by the Department of Agriculture to identify location specific nutrient requirement for the hill farming system and inform farmers through its extension workers. But this instruction is not implemented yet. Due to lack of information, farmers apply farmyard manure, compost, green manure and chemical fertilizers from their own judgement and experience. Therefore, immediate attention should be given by concerned agency to educate farmers on balanced application of chemical and biological fertilizers based on soil quality and cropping intensity.

Particularly in the project area, some of the farmers applied a large amount of chemical fertilizers made available by LAC at highly subsidized price. For a few year, according to farmers, cereal crops yield considerably increased. But later they had to gradually increase the amount of fertilizer to maintain crop yield. As a result, such haphazard use of fertilizer, soil fertility in some of their farmlands has gone down considerably.

Tarikhet are likely to face severe fertility decline problem in the future, if the current tendency of neglecting them continues. Therefore, besides legume cultivation, use of different degradable organic materials including leaf litter, green manure, weeds and waste materials should be increased immediately to increase organic matter content in the soils to prevent them from acidity problem.

12.5.3 Domestication of Green Manure Species

Some green manure species, including *Adhatoda vasica* (ashuro), *Euphorbia roylena* (siplikan), *Artemisiia vulgaris* (titepati), *Albizia spp* (dhurseli), *Trichilia connoroides* (ankhetari) and *Stirum insigne* (khirro), found in the farm and forest, have been traditionally utilized to fertilize farmlands. These green manure species are considered to be better than compost and farmyard manure in terms of nutrient content. They are getting scarce due to their regular use without any domestication and conservation efforts.

Farmers in both watersheds are reluctant to grow green manure species in their farmlands, which are very small in size. However, there is prospect to integrate useful species with the agroforestry and plant them in terrace risers and edges, and in lands kept fallow. There is also prospect for plantations of these species in community lands. Farmers are keenly interested to utilize their community lands, including the gullies, landslide, and grazing areas for growing green manure species.

Farmers are not much aware of the technical knowledge required to prepare saplings of green manure species and have not taken any initiatives towards their plantation. Concerned GOs and NGOs should, therefore, encourage farmers to initiate domestication of green manure species. This would require provision of technical support, including establishment of nurseries for sapling production.

12. 6 Enabling Polices and Legal Arrangement

Government policies, institutional arrangements and legal structures facilitate the adoption of locationally suitable land management practices. The following policies, rules and regulations should be considered in order to enable farmers to manage their farmland effectively.

12.6.1 Provision of Land Management Act and Policies

According to the Department of Land Administration, Ministry of Land Reform, there are about 58 active acts, rules and regulations regarding the use of agricultural land. However, as mentioned earlier, land management has not been matter of their concern. There is need for provision of a land management act to promote locationally suitable land management practices. The act should provide broad guidelines for land use and management. It should be supported by conducive land management polices.

12.6.2 Effective Enforcement of Land Reform Act

About one fifth of the total farmlands in both watersheds are cultivated by tenant farmers. According to Land Reform Act 1964, a formally registered tenant has a right to cultivate the land as long as he/she wishes to do so. If the landlord decides to discontinue with the tenant or sell the land, the tenant is eligible to receive one fourth of the land as his/her share. Since the landlords do not want to loose their lands, most of the tenancy arrangements are informal type, which allows landowners to change the tenants at any time according to their wish. This constrains investment in land management on the part of tenant cultivators. Therefore, there must be effective enforcement of Land Reform Act to protect the rights of the tenants.

12.6.3 Provision of Credit for Land Purchasing

There is growing tendency of keeping land fallow by wealthy households with non-farm earnings, which has accelerated the pace of land degradation. Despite their willingness, the concerned households have not been able to sell their lands due to lack of cash with other farmers, who are willing to purchase their lands. By making the provision of credit the interested farmers have to be enabled to purchase land, which will help to improve the use and management of land being kept fallow.

12.7 Enabling Programs

Implementation of land management strategies suggested in section one supported by policy in section two requires appropriate institutional arrangement and implementation of several programs in a coordinated way by line agencies, NGOs and use groups.

12.7.1 Promotion of Tripartite Partnership for Land Management

There must be strong partnership between farmers, line agencies and NGOs for land management. In this regard, line agencies should provide required services and facilities, including technical know how and institutional credit. NGOs can play important role in awareness creation and in providing complementary support services and facilities. NGOs are better than GOs in terms of service delivery, still they have to build their technical capability for land management activities which have not been pursued by them yet. Farmers are the service recipient and real land managers. The suggested tripartite partnership would help to implement the land management programs effectively on cost sharing basis without any duplication of effort and resources.

12.7.2 Promotion of Appropriate Locally Generated Land Management Technologies

Managing farmland is a complex task, which requires systematic and scientific efforts, with emphasis on improving and promoting indigenous technical knowledge. The concerned line agencies and NGOs should promote locally generated land management technologies like shrub formation in gullies, nitrogen fixing tree plantation in terrace risers and farm edges, mulching, and construction of reinforced walls and bench terraces to control soil erosion. Similarly, emphasis should be given to increase the production of farmyard manure, compost and green manure to enhance soil fertility.

12.7.3 Strengthen the Capacity of Line Agencies

Local organizations have very limited capability for promotion of locationally suitable land management practices. Therefore, the concerned government department should pay attention to upgrade technical capability of extension workers and district level staff so as to enable them to provide require technical service to farmers.

The Local Governance Act of 1998 authorizes local governments to prepare and implement local development plans. However, the central departments receive the major proportion of the development budget. As a result, local organizations have not been able to pursue their responsibility effectively. Central departments play a major role in sectoral program formulation and budget allocation. Such programs do not address local needs and aspirations. Therefore, the local governments should be fully authorized to prepare an integrated local development plan, with the provision of appropriate amount of budget.

Local level line agencies have weak capability for organizing training on land management due to limited budget allocation. Each line agencies have small training program component and the training are conducted without any coordination. The target groups are not properly specified and the training participants are randomly selected. The duration of the training is often too short and farmers cannot gain desirable benefit. To strengthen the training capacity of the line agencies, budget allocation should be increased substantially from the current one percent of the total budget to five percent, and adequate attention should be paid to produce relevant training materials for different target groups. Besides, a team of trainers combing livestock, forestry, agriculture, cooperative, irrigation, land administration and soil and water conservation specialists should be formed, and they should have full responsibility to conduct the training courses.

The line agencies and NGOs need manpower capable to formulating and implementing land management plans. Their need can be fulfilled by academic institutions, who have not been able to meet the need due to lack of linkages with the government line agencies. A formal link needs to be established between academic institutions and line agencies to produce technicians required for planning and execution of land management plan.

12.3.4 Strengthen User Groups' Technical Capability in Land Management

The user groups promoted by line agencies or formed spontaneously have been instrument . in local resource mobilization, technology transfer, and use and management of natural resources. They are interested to participate in land management activities, but have been constrained due to weak technical capability. Therefore, emphasis should be given to build local user groups' technical capability for land management through training, demonstration and observation tour programs.

Farmers cooperative can make important contribution to the promotion of better land management practices. Spontaneously formed dairy cooperatives in the project area are involved in the marketing of dairy products, livestock health care and promotion of agroforestry. Similarly, farmers cooperative in the non-project area are involved in vegetable production and marketing. They can also motivate farmers to pursue economically attractive and environmentally suitable land use practices. It is necessary to encourage cooperatives to promote land management activities through the provision of appropriate training courses on different aspects of land management.

12.7.5 Disseminate Research Findings on Land Management Technologies

While very little attention has been paid to developing locationally suitable land management technologies for hill farming system, and result of researches pursued so far have not been disseminated to farmers. In view of the major proportion of farmlands under *tarikhet*, research should be conducted on developing land use and management appropriate for this type of land. There is a pressing need for greater coordination between agricultural research institutes, extension workers and farmers in order to generate locationally suitable technologies and then disseminate the information to target areas. Extension workers, NGOs, user groups, and farmers cooperative should be mobilized to disseminate the information.

12.7.6 Re-structure the Extension Service

There is weak coordination between line agencies in delivering extension services, which has created confusion among farmers. A forest extension worker advises farmers to plant trees in the farmland; livestock extension worker recommends livestock grazing to fulfill feed deficit; agricultural extension worker recommends to give up the fodder trees plantation and emphasizes on cash crop cultivation; and soil and water conservation extension worker advises them to stop livestock grazing in fields.

An efficient extension service enables farmers to enhance their production and conservation activities. The integration of different extension services into a single system of command would help to improve use and management of farmlands, as this type of system has demonstrated good result in India, Turkey, Indonesia, and most Sub-Saharan African countries (Feder and Slade, 1986). There should be enough number of field staff under an officer who will provide guidance, supervision and training. At the bottom of the hierarchy there should be provision of at least one extension worker. Each extension worker should cover 300 farm households divided into 13-15 groups. Training and visit system would be appropriate in delivering the extension services. The extension worker should visit each group once a month on a specified day. A well-structured schedule of visit provides opportunity to field officers to supervise the extension workers and also to enhance farmers' confidence in the advice provided by the workers.

The extension service at the VDC level should be provided in a package form comprising agriculture, livestock and forestry by an extension worker. At present each sub-service center has to look after three VDC and they have not been able to provide service to all households. To provide effective services, each VDC should have a sub-service center and extension worker should be directly accountable to the VDC (Fig. 12.2).

The extension workers should promote farmers-to-farmers extension system and informal networking among the groups to create self-reliance and closer collaboration between them. Extension workers should act as facilitators and information should be

transformed through school teacher, community leader, demonstration plots, field visits and other media.

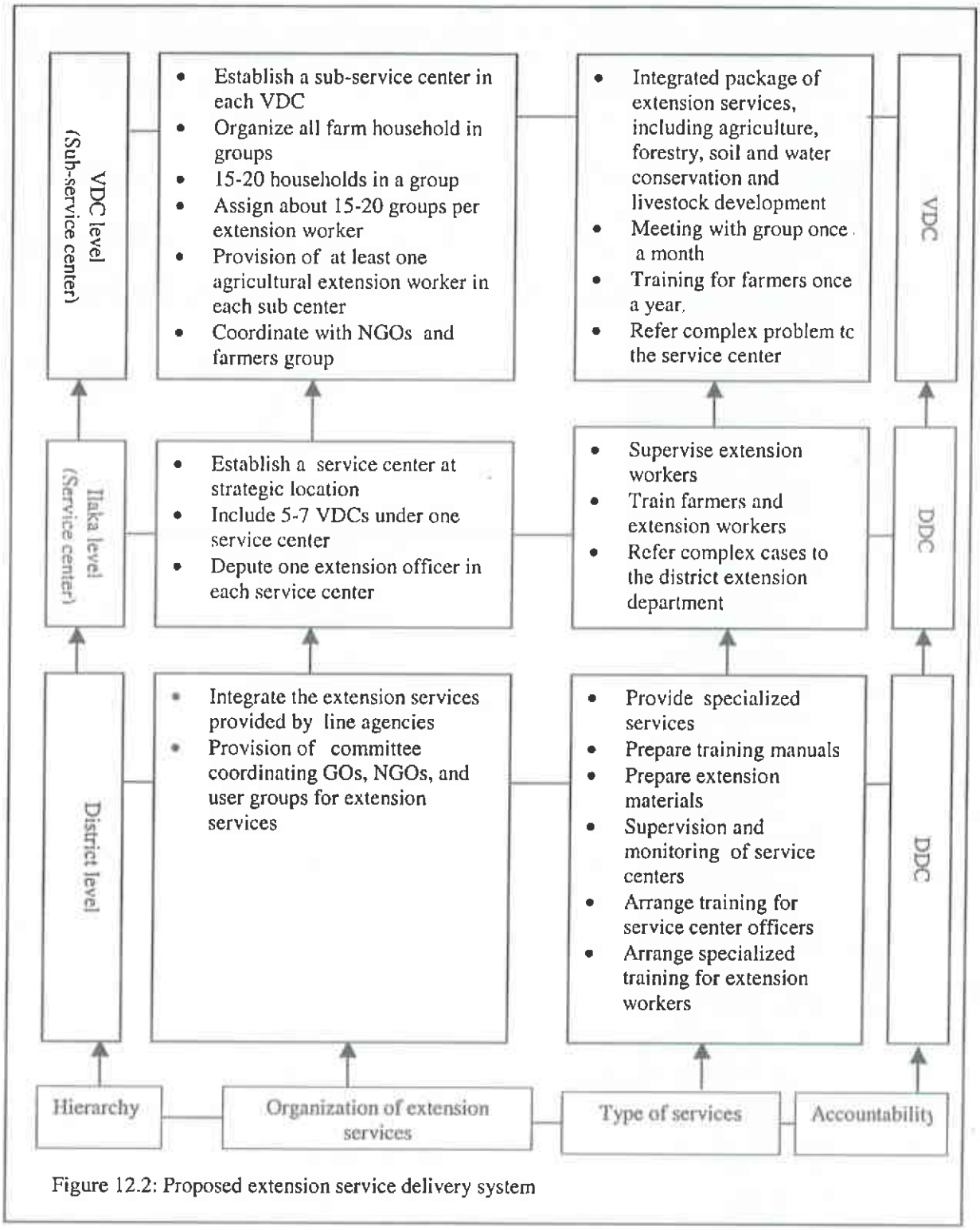


Figure 12.2: Proposed extension service delivery system

The existing service centers located in each Ilaka, should be upgraded by providing required manpower and necessary infrastructure. At least one extension officer should be deputed at the service center with responsibility of supervising the extension workers. Besides, he/she should help to solve problems which cannot be addressed by the extension workers (Fig. 12.2).

An integrated cell of extension service should be established at the district level through coordination between existing line agencies. It should provide training to officials deputed at the service and sub-service center (Fig. 12.2).

12.7.7 Provision of Credit Facility for Land Management

The proposed intervention in land management requires a change in farming system which demands for additional investment for purchasing land, equipment, sapling production and tree plantation. Particularly the small farmers need institutional credit. During field survey, about one third of farmers in both watersheds were seeking formal credit for agricultural improvement, but they could not receive it due to lengthy administrative procedure and requirement of collateral. Provision of an easily accessible credit facility should be made to enable farmers to pursue activities that they want.

User groups and farmers cooperative have implemented saving and credit schemes among their group members, which is not adequate for investment in land management. Agricultural Development Bank and NGOs should provide additional support to user groups and cooperatives, so as to enhance their lending and saving mobilization capacity.

12.7.8 Market Improvement

Agricultural marketing includes assembling, grading, sorting, packing, storage, transportation and distribution of farm produces. Marketing channels involves a number of market intermediaries including government, private sector, user groups and farmers cooperative. Government involvement is required for policy support and for provision of market infrastructure to encourage farmers to adopt land use and management practices conducive to control land degradation. User groups and cooperatives can play important role in securing higher amount of benefit from the sale of produces. The private intermediaries and business organizations can also make contribution to collection, storage and distribution of farm produces. But so far these intermediaries are exploiting farmers and consumers. As a result, farmers have not been able to get appropriate price of their produces.

Marketing of agricultural produces has been constrained by unavailability of storage, packaging and processing facilities, price instability due to seasonality of production, and lack of market information dissemination system. Farmers have to be assisted to sell their produces at reasonable price through the provision of appropriate support services and facilities, including the provision of market price information dissemination system, and group marketing of produces. Local user groups and cooperatives can play important role in pursuing these tasks.

12.7. 9 Enhance Land Information System

Promotion of locationally suitable land management program should be supported by an integrated land information system. Current information system serves only for land revenue collection. There is no information on how the lands are being utilized. In order to improve land use and management, it is necessary to know about the characteristics of land, which is not available at present. Creation of comprehensive computerized land information system would help to formulate and implement a scientific land use and management plan.

12. 8 Priority for Implementing Strategies, Polices and Programs

All of the strategies, policies and programs, as suggested above can not be implemented at a time, therefore, following priorities are suggested for implementation.

Table 12.1 Priority for implementation of suggested strategies, policies and programs

Strategies	Project Area	Non-project Area
Bari management		
• Agroforestry intensification for livestock raising in project *bari* in the ridge	***	-
• Promotion of tea and NTFP plantation in ridge *bari* of the non-project area	-	***
• Promotion of tree-crop mixed farming in hill slope *bari*	**	**
Gharbari management (Both areas)		
• Promotion of NTFP-annual crop mixed farming in ridge *gharbari*	*	**
• Promotion of vegetable-fruit crop mixed farming in hill slope *gharbari*	*	**
Tarikhet management (Both areas)		
• Promotion of tree and grass plantation in wide terrace risers	***	***
• Control livestock grazing	***	***
• Promotion of legume forage and grass cultivation	***	***
• Promotion of cash crop farming	***	***
Phantkhet management (Both areas)		
• Promotion of rotational cropping system	**	**
Fertility management (All land in both areas)		
• Promotion of legume crop cultivation	***	***
• Promotion of balanced fertilizer application	**	***
• Domestication of green manure species	**	***
Enabling policies (All land in both areas)		
• Provision of land management act and policies	***	***
• Effective enforcement of Land Reform Act	**	**
• Provision of credit for land purchasing	**	***
Enabling programs (All land in both areas)		
• Promotion of tripartite partnership for land management	***	***
• Promotion of appropriate locally generated land management technologies	*	**
• Strengthen the capacity of line agencies	**	**
• Strengthen user group's technical capability in land management	**	***
• Disseminate research findings on land management technologies to farmers	*	**
• Restructure the extension services	**	**
• Provision of credit facility for land management	**	***
• Market improvement	**	**
• Enhance land information system	*	*

NB: *** High priority
** Medium priority
* Low priority

CHAPTER XIII

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS FOR FURUTRE RESEARCH

13.1 Summary of Findings

This study examined the status of farm lands, farmers' awareness of and attitudes towards land management technologies, farmers' changing land management practices and priority, actors and factors influencing land management, role of formal and informal organizations in land management and institutional capacity of local organizations involved in land management in watersheds "with" and "without" external intervention.

13.1.1 Status of Farmlands

The status of farmlands is examined based on three indicators, including the proportion of farm land seriously affected by soil erosion and landslide, nutrient balance and change in crop and grass yields.

Both natural and accelerated soil erosion are active in the study area. Accelerated soil erosion is high in outward facing *bari, gharbari* and puddled *tarikhet* as the soil structure is regularly disturbed by ploughing and hoeing activities. Soil erosion is high in the pre-monsoon season when farm lands have no vegetative cover and heavy rainfall washes away a lot of soil and plant nutrient from the farm lands. About 18 percent of the total farmlands in project area and 21 percent in non-project area are seriously affected by soil erosion. By land type, soil erosion is more severe in *bari* land in both areas. About two fifths of *bari* land in the project area and about a half in the non-project area are seriously affected by soil erosion. Outward facing *gharbari* are also affected by soil erosion. However, the intensity of soil erosion is relatively low in *phantkhet* and *tarikhet* as they are bench terraced with bunds at the outer edge, which helps to reduce soil erosion.

Occurrence of landslide is mainly a natural phenomenon in the study area. Natural factors including, location of farmlands in steep hill slopes, high intensity of rainfall during the summer monsoon season, frequent thunderstorms, fault lines and weak geological structure are largely responsible for landslide occurrence. Landslide occurrence is most frequent during the monsoon season. Normally the landslide density is found higher in areas along the fault and main central thrust lines, areas with bed rocks like phylite, schist and slate, and over 20 percent slope gradient. About 10 percent of farm lands in both areas have been affected by landslide every year. The occurrence of landslide is relatively high in the project area as there are several fault lines running across this area. *Bari* lands are most severely affected by landslide in both areas.

Gully formation caused by an interaction of natural and cultural factors is another factor contributing to land degradation. This process is most active in areas with phylite, schist and weathered slate which are highly erodable. Overgrazing common lands by livestock initiates the process of gully formation which expands vertically and laterally into adjoining farm lands.

Regarding the soil nutrient balance, the removal of nitrogen (N) exceeds its supply in *tarikhet, phantkhet* and *bari* of both areas. Similarly, in both areas the supply of potassium (K) is negative in *phantkhet* and *tarikhet.* Regarding the phosphorus (P) supply, it is

replenished in all lands except *tarikhet* of the non-project area. *Gharbari* has balanced supply of NPK in both areas.

Regular crop cultivation with low fertilizer supply has lead to nutrient mining in *phantkhet*, *tarikhet* and *bari* lands in both areas. *Tarikhet* in both areas are most severely affected by nutrient mining. According to farmers, about one third of *tarikhet* in the project area and nearly three fifths in the non-project area have been facing declining soil fertility problem due to nutrient mining. This is reinforced by declining crop yield in *tarikhet.*

In *bari* and *gharbari* of the project area, maize and millet yield had increased due to improvement of terraces combined with adoption of HYV crops and application of chemical fertilizers subsidized by the Phewatal Watershed Management Project. Contrarily, the rice yield had dropped in *tarikhet* and *phantkhet,* as they were not targeted for intervention by the project. In the non-project area, millet, wheat and maize yield had decreased over last 23 years as farmers could not get any external assistance. However, there was no change in the rice yield due to the completion of several small-scale irrigation projects.

Grass available from terrace risers has considerably facilitated livestock raising in the study area. However, the alarming fact is that its yield was also declining as a result of soil erosion, landslides and nutrient mining.

Overall, there is an indication of farm lands undergoing degradation in both areas, though it varies by land type. According to farmers, *bari* and *gharbari* have been affected by soil erosion and landslide while *tarikhet* are confronting with nutrient mining. The degree of degradation is relatively high in the non-project area compared to project area.

13.1.2 Farmers' Awareness of and Attitude towards Improved Land Management

Farmers have been using and managing land resources to fulfill their subsistence requirements for several centuries. However, they have been increasingly constrained in fulfilling their subsistence requirements due to gradually increasing population pressure on limited land resources and scarce non-farming employment opportunities. Moreover, the on going land degradation has threatened undermining their food security.

Farmers in both project and the non-project areas are well aware of the advantages of the land management technologies suitable for their areas. To a considerable extent, they understand the advantages and disadvantages of tree-crop mixed farming, alternative crop rotation, legume cultivation, perennials tree growing in marginal land, alley cropping in sloping land, domestication of green manure species, compost making, mulching and reduced tillage system. Despite being aware of their proven efficiency in land management, farmers are finding it difficult to practice conservation measures intensively due to some problems. Shade effect of trees on cereal crops and difficulty in land preparation are the major constraints preventing farmers from intensive tree-crop mixed farming and alley cropping in sloping land. Small and fragmented land holdings have been constraining the adoption of alternative crop rotation at extensive scale, which requires a collective decision making by several farmers possessing of landholdings at a place. As some farm plots are away from homesteads, it is difficult to protect crops from livestock and wild life, if only few plots are cultivated with crops especially during the period when traditionally lands are kept fallow. The high demand for labor and scarcity of materials have been the major constraints of increasing compost making and mulching practices. Small landholdings and technical know how are factors determining the domestication of green manure species. Reduced tillage

system has not been widely practiced by farmers in both areas since they believe that it would reduce crop yield. However, there is ample opportunity to overcome these constraints through provision of effective extension service and marketing facilities.

13.1.3 Farmers' Changing Land Management Practices

Consistent with findings of studies carried out elsewhere, the findings of this study justify Boserup's postulate (1970) that farmers devise alternative technology for increasing land productivity, as they are exposed to the risk of food scarcity due to diminishing per capita landholdings. Farmers have innovated and adopted several land management technologies as they found their land being affected by erosion, landslide and declining soil fertility.

Based on the traditional knowledge and personal experiences, most farmers in the study area have pursued efforts to enhance land productivity through several land management practices. In this regard, they have intensified the use of *gharbari* and *bari*, cultivated HYV of crops and shifted gradually from a cereal-based to cash crop-based cropping system. The opening of the Pokhara-Baglung highway has offered opportunity to sell farm produces in the regional town of Pokhara. The farmers especially in areas adjacent to the highway in the project area are shifting to dairy farming. Likewise, farmers in the non-project area have started cultivating cash crops in their land along the river.

Farmers have also converted outward facing terraces to inward facing terraces, intensified agroforestry practice and contributed to gully control, landslide stabilization and waterway construction activities to control land degradation. They also have adopted alley cropping and mulching, and applied chemical fertilizers, farmyard manure, compost and green manure to improve land productivity. To some extent, farmers in the project area have learned about these practices from the Phewatal Watershed Management, while some of the changes in the non-project are spell-over effect of land management implemented in the project area. Overall change in land management has been positive in both areas, though the degree of change is relatively high in the project area due primarily to technical and financial assistance extended to farmers. Relatively high degree of change has occurred specifically in regard to the construction of inward facing terraces, retention walls, waterways and check dams, and stabilization of landslides. Similarly, relatively high degrees of change occurred in alley cropping, mulching, and application of chemical fertilizers, farmyard manure and green manure. In the non-project area, relatively high degree of change has been experienced in the application of compost and legume cultivation due to diminishing supply of farmyard manure.

13.1.4 Land Management Priority

Farmers accorded priority to different types of lands based on their vulnerability to soil erosion and landslide, cropping intensity, distance from farm household and household labor force size. Normally the top priority is given to *bari* followed by *gharbari*, *phantkhet* and *tarikhet* in the project area. In the non-project area, the first priority is accorded to *gharbari* followed by *bari*, *phantkhet* and *tarikhet*.

The priority for the application of structural and biological measures varies by land type. Project farmers give first priority to *bari*, followed by *gharbari*, *phantkhet* and *tarikhet* for their management through structural measures. Non-project farmers accord first priority to *phantkhet* followed by *gharbari*. *Bari* and *tarikhet* are given third priority. Regarding the biological measures, project farmers give their first priority to *bari*, followed by *tarikhet*, *gharbari* and *phantkhet*. Non-project farmers give their first priority to *gharbari* followed by *bari*, *phantkhet* and *tarikhet*.

Soil fertility management is the major effort pursued by farmers to sustain crop production for meeting their basic subsistence requirements. The amount and type of fertilizers applied to farm plots depends on cropping intensity, landholding size, land tenure and distance of farm plots from farm house. In both areas, the application of NPK is high in intensively used, small and owner operated farm lands. Likewise, farm plots located near to farm house receive relatively high amount of NPK. The supply of NPK decreases sharply as the distance of farm plots increases from the farm household. The owner-operated farm lands receive significantly higher amount of NPK compared to rented and mortgaged lands. Overall, the first priority is given to *gharbari*, followed by *bari, phantkhet* and *tarikhet* in both areas, which is partly reflected in labor allocation to land management. Notably, *tarikhet*, which constitutes about two thirds of the total farm land in the project area and more than two fifths in the non-project area, are given least priority and, therefore, they are vulnerable to declining soil fertility.

13.1. 5 Actors and Factors Influencing Land Management

Farmers' decisions as to how use and manage their lands have been influenced by different actors and factors. Bench terraces were ancestral gifts constructed over past several centuries. The present generation of farmers has made additional efforts to expand and consolidate the works done by their preceeding generations. Farmers partially in Phewatal watershed were assisted by the watershed management project for terrace improvement. Assorted types of vegetative measures being practiced by farmers in both watersheds were devised by their forefathers, while line agencies as well as NGOs had contributed to enhance and intensify these technologies. Farmers applied farmyard manure to their lands since past several centuries, the use of compost and chemical fertilizer was promoted by several GOs and NGOs.

Regarding the socio-economic, institutional and ecological factors influencing the adoption of land management technologies in the project area, the logistic regression analysis predicted five variables namely, the number of economically active people involved in agricultural activities, schooling period of the household heads, tree ownership and grass yield, as statistically significant. The percentage of farm land seriously affected by soil erosion is another important factor influencing the application of land management technologies. In the non-project area, percentage of land seriously affected by soil erosion, labor input, ethnicity, institutional membership and number of extension services were found significantly influencing the adoption of land management technologies. Particularly labor force size had negatively influenced land management, which is explained by out-migration of household labor force.

13.1.6 Role of Formal and Informal Institutions in Land Management

Formal and informal rules and regulations play important role in land management. A series of acts and regulations have been promulgated in Nepal, with the main aim at increasing the land revenue. Formal rules and regulations have consistently neglected land management. Some of the acts, for example the Forest Act, Land Administration Act, and Watershed Management Act have created conflict over land administration by making three government departments equally important for this matter.

The Private Forest Nationalization Act of 1957 and Nepal Forest Act of 1961 discouraged tree growing in farm lands, eventually reducing the supply of farmyard manure required for maintaining land productivity. Realizing the problem arisen from these acts, tree

growing in private land was legalized again through the promulgation of the new Forest Act, 1993. This act also encourages devolution of resource management responsibility from Department of Forestry to local communities which contributed to promote forestry. The Land Act and Land Reform Program of 1964 had aggravated land fragmentation. The Land Administration Act, 1967 facilitated the distribution of permanent land title deeds which encouraged farmers to increase investment in land management. Contrarily, the National Park and Wild Life Act, 1973 and King Mahendra Trust for Nature Conservation Act, 1982 had somewhat negative influence on land management particularly in the non-project area.

Some informal rules and regulations evolved in this study area contributed to improve land management. The *jhara* system practiced since the outset of 20th century has been a powerful means of mobilizing voluntary labor for the construction and maintenance of structural measures of land management for common benefits. Similarly, the *sanad* system practiced since last sixty years prevents livestock grazing in *phantkhet* from May to November is some areas.

The agricultural sector in Nepal accorded the highest priority in public sector investment from 1975 to 1997. However, most investment was made in relatively large-scale irrigation projects located in the *tarai* and selected accessible areas in the hills. Managing agricultural lands which have been main source of livelihood of the majority of people has not been paid much attention yet. Consistent with the national policy, even the local governments have virtually ignored the management of land resources. Most of the investment at district and VDC levels was made in production activities.

Several line agencies and NGOs are providing training, credit and extension services to farmers in both watersheds. The analysis of services provided by these organizations indicates that they could not meet farmers' expectation, owing to their weak technical and financial capability and un-coordinated activities.

There are eight types of user groups in the study area. These groups have been involved in some small-scale land management activities in collaboration with line agencies and NGOs. The forest user groups have planted trees and shrubs in gullies and landslides. Mothers and water user groups have mobilized cash, labor and kind for the construction, repair and maintenance of irrigation canals. Crop and fruit production groups are promoting tree-crop mixed farming at foot hills and valley floor. Livestock development groups have planted fodder trees. Saving groups are encouraging farmers to cultivate high value cash crops. Likewise farmers cooperative have been promoting agroforestry promotion in the project area. However, the efforts made by user groups are erratic and they are not systematically integrated in land management.

13.1.7 Local Organizational Capability for Land Management

As noted above, support services and facilities provided by local organizations have not been able to meet farmers' expectation in both areas. However, the project farmers received relatively better services than the non-project farmers. Overall NGOs have provided better services than GOs in the non-project area. Both NGOs and GOs have played equally important role in the project area which is reflected in farmers' medium level satisfaction with these organizations. Non-project farmers have low level of satisfaction with GOs and medium with NGOs.

Farmers' participation in joint land management activities organized by line agencies and NGOs was mainly coercive in nature. Most of the farmers contributed to the project implementation and their involvement was little in planning and decision making.

Line agencies can play very important role in promoting appropriate land management activities and socio-economic development. They have well established vertical network, trained office in-charge, regular funding from the central government and staff members with job security. Besides, the provision of international training opportunities for staff, increasing emphasis on local governance, and due attention towards enhancing their institutional capability are the major opportunities for strengthening their role in land management. However, the line agencies have not been able to gain full autonomy to prepare and execute local development and conservation programs. They are also highly compartmentalized, and have field staff with weak technical capability, and absence of job responsibility and interaction with local farmers.

The political change of 1990 has facilitated the development of NGOs in both project and the non-project areas. These organizations have been strongly supported by the government as its development partners, which has fostered new avenue for a tripartite partnership between farmers, line agencies and NGOs for natural resources conservation and socio-economic development. While efficient service delivery and direct contact with farmers are their strengths, somewhat closed operational system dominated by educated elite, retired bureaucrats and politicians, poorly trained field staff, unable to provide effective service are their weaknesses.

User groups, formed spontaneously or promoted by line agencies and NGOs, have strong unity and greater enthusiasm for land management. They have devised their own rules and regulations, decisions are made in a consultation with concerned members, and benefits are shared equally among the members. They are recognized by the governments, INGOs and donor agencies as important actors for resource management. According to the government policy, small-scale development works, normally pursued by the contractor should be the responsibility of the user groups, though policy has not been very effective. Weak management and technical capabilities combined with compartmentalized action programs implemented by line agencies have impaired the effective utilization of their potential capability.

13.2 Conclusions

In the past three decades, several research studies were pursued on the extent of land degradation and contributing factors in the Hills of Nepal. Research studies pursued during the 1970s and early 1980s present a bleak scenario of severe land degradation caused by human activities (Enke, 1971; Eckholm, 1976). Based on casual observation of the situation, findings of these studies are questioned as results of the studies conducted after the mid 1980s revealed the situation not as severe as perceived earlier. Findings of this study also indicate that farm lands are not undergoing degradation as seriously as commonly perceived. However, some of the farm lands are undergoing degradation to some extent due to the combined effects of natural and cultural factors. The effect of degradation is reflected in declining yields of selected staple crops and grass.

Accelerated soil erosion and landslide caused by high intensity of rainfall during the monsoon season, gully expansion, location of farmlands in steep hill slope and along fault lines, and weak geological structure are the major natural factors contributing to land degradation. Farmers have adopted assorted types of structural and biological measure to

prevent their small landholdings from degradation. Still they have not been able to control degradation, owing to soil nutrient mining caused by regular crop cultivation without application of required amount of fertilizers, repeated ploughing and hoeing of land and intensive livestock grazing. According to farmers, about one fifth of total farm lands in both watersheds have been severely affected by soil erosion.

Farmers are well aware of economic and environmental significance of practices like tree-crop mixed farming, crop rotation, legume cultivation, tree and shrub growing in marginal lands, alley cropping in sloping land, domestication of green manure species, composting, mulching and reduced tillage. Based on their traditional knowledge, farmers have made considerable change in their land management practices over last three decades in the pursuit of fulfilling subsistence requirements by utilizing their steadily shrinking landholdings. In this regard, they have increasingly improved terraces and participated in the construction of waterways, check dams, retention walls and landslide stabilization. Similarly, they have planted trees in terrace risers, gullies and landslide scars, adopted alley cropping and practiced mulching. They also have applied farmyard manure, chemical fertilizers, green manure and compost and cultivated legumes to enhance soil fertility and farm productivity. Overall change in land management has been positive in both project and the non-project watersheds. The former watershed experienced relatively high degree of change by virtue of financial and technical supports provided by an external agency. Some of the changes in the later watershed are spill-over effect of land management implemented in adjacent watershed. Despite their efforts, farmers in both areas have not been able to control land degradation effectively due to location of farm lands in steep hill slope, weak geological structure, high amount of rainfall during short time period, high incidents of landslide, gully expansion, regular plowing and hoeing of land, intensive livestock grazing during fallow period, soil nutrient mining, and incompatible land use practices in some areas.

In pursuing land management activities, farmers accord priority to different type of lands depending on soil fertility, vulnerability to erosion and landslide, cropping intensity, distance from the farm house and household labor force size. Being intensively utilized and relatively close to farm houses, *gharbari* received more attention, while *tarikhet* in both watersheds are facing the problem of declining soil fertility and crop yield, as farmers have not paid much attention to their management. As they account for major proportion of the farm lands, farmers will find it increasingly difficult to fulfil their food requirement, if attention is not paid to enhance the productivity of *tarikhet* through proper care of these lands.

Formal land acts and area based rules and regulations have evolved over past several decades, with aim of improving mainly land revenue. Little attention was paid to introduce rules and regulations conducive to improving land management. The existing land acts, rules and regulations are conflicting, which have created confusion among program executioners. Particularly due to insecure land tenure system, tenant farmers find it difficult to make investment in land management.

The government land use policy emphasizes production promotion without paying attention to land management required for sustainable agricultural production. This is reflected in allocation of most agricultural sector budget at national, district and VDC levels to cereal crop production promotion.

Local organizations can play important role in promotion of locationally suitable land use and management practices, as they are catalysts facilitating desirable changes. So far these organizations have not been much effective due mainly to top-down type of planning and implementation system and weak financial and technical capabilities. In the project area,

their performance has been relatively better, owing to external support. Farmers are expecting efficient support services and facilities from both GOs and NGOs, which they have not been able to receive so far.

The government of Nepal has been promoting NGOs as its development partners. Despite being independent and flexible in program planning and execution, a few local NGOs engaged in land management program have not been able to provide required services and facilities to farmers due to weak technical and financial capabilities. NGOs' inability in facilitating change in land use and management is partly attributed to planning and implementation of their programs without any coordination with government agencies.

The user groups formed spontaneously or promoted by GOs or NGOs have implemented small-scale land management program. However, their weak management and technical capabilities combined with compartmentalized action programs implemented by line agencies and NGOs have constrained effective implementation of the programs. There is prospect to mobilize these groups more effectively for the promotion of locationally suitable land management practices by involving them in planning and implementation of all land management programs.

The on-going process of farm land degradation in the Hills of Nepal, in general, and in the study area, in particular, cannot be controlled effectively as long as the arable agriculture is practiced there. Despite farmers' awareness of its environmental and economic disadvantages, they have been compelled to practice this type of agriculture, owing to lack of concentrated government efforts for facilitating locationally suitable non-tillage or minimum tillage type of land use systems. In view of farmers' immediate need of fulfilling food requirement and rudimentary support services and facilities, a rapid change in the existing cropping system cannot be expected. Therefore, the land management strategy should aim at facilitating gradual change in land use. In this regard, concentrated efforts should be made to enhance the productivity of the on-going agricultural enterprises in a sustainable way through required improvement in traditional land management practices. Simultaneously, efforts should be made to promote locationally suitable agricultural enterprises through a joint efforts made by GOs and NGOs. The local user groups should be actively involved in planning and implementation of all land management programs initiated or supported by GOs and NGOs. The government should strongly support such GO, NGO, and user group partnership in land management program through the provision of appropriate policies. Due attention should be paid to strengthen the capabilities of all institutions involved in land management. While the farmers would make formal decision on type of agricultural enterprises and related land management practices, the role of GOs and NGOs should be limited to catering necessary support services and facilities conducive to decision making on preferred agriculture enterprises and land management practices.

13.3 Recommendations for Future Research

1. The findings of this study indicated that considerable amount of soil loss is caused by natural factors including triggered landslide. A study to distinguish the relative role of natural and anthropogenic factors in land degradation would enhance the ongoing land management practices.
2. Promoting locationally suitable land use and management requires a comprehensive GIS assisted land suitability analysis. Such analysis should take into consideration the geology, soil texture, slope gradient, slope stability, climate and marketing opportunity for different agricultural enterprises.

3. Activities to be initiated to mitigate soil erosion should pay attention to the seasonal effect of monsoon rain. Soil erosion is high during the pre-monsoon season even in terraced farmlands in absence of vegetative cover. Identification of early growing grasses or vegetative covers and their propagation will contribute greatly to reduce the soil erosion and improving the productivity of farmlands.

4. This study could not cover the nutrient loss by natural processes like leaching, run-off and oxidation and gained by wrapping farmlands by flood water, atmospheric fixation and natural cycling. Further study on nutrient loss and gain by natural process will help to understand the actual fertility status of farmlands.

5. Legume based cropping pattern is considerably beneficial for improving the farm household economy as well as for sustaining the land productivity. An analysis of the nutrient fixation rate of different locationally suitable legume crops would help to identify most beneficial legume crops.

6. Tripartite partnership between GOs, NGOs and user groups facilitates to promote locationally suitable and economically profitable land use and management practices. A study on the procedure of establishing partnership and its operationalization in a coordinated way would contribute greatly to improve the productivity of farm lands.

7. There are limited number of crop, forage and legume species identified as suitable for *tarikhet*. Farmers have not been able to utilize these lands during the winter and dry summer seasons. Research on the identification of large number of crop and legume species could improve household economy and status of *tarikhet*.

8. A study on prospect of domestication of locationally suitable NTFPs would help to promote non-tillage type of land use and management system.

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Coordination Schema

Parameter	Complex variables	Simple variables	Source of Information
Biophysical condition	Climate	Annual rainfall , mean monthly temperature and relative humidity	Department of Hydrology Narayani Basin Office Pokhara
	Physiography	Relief , slope, rock type, geology contour line	Topographical maps, land use maps and geological maps
	Land type	Land type, ownership of land	Land use maps
	Natural vegetation	Natural vegetation by location of the study area	Observation and Department of Forest
Social condition	Population	Population size, age structure, sex ratio, dependent and independent population, seasonal migration	Household (HH) survey and Central Bureau of Statistics (CBS)
	Occupation	Agriculture, small and cottage industry, wage labor, teaching, government services, army, police, trade/business and other off farm sector	HH survey
	Food security	Production, consumption, sale and purchase of food grains	HH Survey
Economic Condition	Household income by sources	Farm sources (ground crop, tree crops and livestock) Off farm Sources (Business, salary, tourism, interest, bonus, industry, wage labor etc) Remittance (Pension and regular wage)	HH survey
	Household income by farm size and ethnicity	Income level of marginal, medium and large farmers. Household income by ethnic groups and surveyed villages	HH survey
Change in cropping pattern, cropping system and land sue	Change in cropping pattern	No of crop combination in 1975 and 1998 in *khet* and *bari* system	Group discussion and participatory rapid appraisal (PRA)
	Change in cropping system	Change from single crop to multiple crop Change from cereal to cash crop Change from cereal crops to tree crop Change from cereal crops to agroforestry based dairy production Change in fruit tree growing	Group discussion, PRA, household survey, institutional survey
	Change in crop varieties	Change from local to high yielding varieties during 1975-1998	Household survey
	Change in land use	Conversion of forest and rangeland into farmland. Change in the utilization of terrace risers. Land use change in public land	Group discussion and PRA mapping
	Change in cropping intensity	Cropping intensity in 1975 and 1998	Household survey

Coordination Schema Continue

Parameter	Complex variables	Simple variables	Source of Information
Status of farmland	Soil erosion	Process of soil erosion Farm area affected by soil erosion Intensity of soil erosion in different type of land (*Phantkhet, tarikhet, bari, gharbari*) Intensity of soil erosion in different type of soil Crop loss from the land affected by soil erosion.	Household survey Group discussion Meeting with key informants
	Landslide in farmlands	Landslides density in different types of land Farmland affected by landslides Intensity of landslide in different type of land Intensity of landslides in different soils Location of major landslide in the study area	Household survey Landslide mapping though field visit and observation
	Nutrient applied by farmers	Application of farmyard manure, compost, green manure, chemical fertilizers, oilseed cakes and ash by farmers per unit of land	Household survey
		Conversion of these fertilizers into NPK	Using coefficient of Agricultural Hand Book (1986) and other literatures
	Nutrient removed by crops	Soil nutrient (NPK) removed by crops is estimated based on crop yield including rice, maize, millet, and wheat	Using the removal rates estimated in FAO Fertilizer Manual 1993
	Nutrient balance	Nutrient status in *phantkhet, tarikhet, bari,* and *gharbari*	Simply supply minus removed by crops
	Change in crop yield	Maize, millet, wheat and paddy yield in 1975 and 1998	Household survey
	Change in grass yield	Grass yield in farm terrace risers in 1988 and 1998	Household survey
Change in structural measures of land management	Change in terracing system	Change in bench terraces Change in outward facing terraces Change in sloping terraces Change in passage terraces Proportion of farmers adopting terraced farming in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
	Change in terrace bund construction and maintenance	Change in bund construction Change in bund size Change in utilization of terrace bund Proportion of farmers adopting terrace bund in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
	Change in contour bund construction and maintenance	Change in contour bund construction and maintenance Proportion of farmers adopting counter bund in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
	Change in waterways construction	Type and density of waterways Change in waterways construction Proportion of farmers adopting waterways in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey

Coordination Schema Continue

Parameter	Complex variables	Simple variables	Source of Information
Farmers' changing practices to the application of structural measures of land management	Change in the construction of check dams	Farmers' selection of the area for check dam construction Change in type and construction materials Proportion of farmers adopting check dams to control flood in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
	Change in the construction of retention walls	Farmers' strategy for the construction of retention walls Change in construction materials Proportion of farmers adopting retention walls in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
	Change in gully control	Farm area protected by gully control measures Proportion of farmers implied gully control measures in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
Farmers' changing practices to the application of biological measures of land management	Alley cropping	Change in tree species Proportion of farmers adopting alley cropping in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
	Establish shrub species in gullies	Change in tree species Proportion of farmers establishing shrub species in gullies in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
	Vegetative measures in landslide control	Change in tree species Proportion of farmers establishing shrub species in landslides in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
	Mulching practices to control soil erosion	Area covered by mulch materials Type of mulch materials Proportion of farmers adopting mulching practices in 1975, 1985, 1995 and 1998	Observation and discussion with farmers Household survey
	Change in tree density in farmlands	Farm area with and without trees Tree density in farm terrace risers in 1988 and 1998	Household survey
Farmers' changing practices to fertility management	Application of FYM	Proportion of farmers applying FYM in 1975, 1985, 1995 and 1998	Household survey
	Application of compost	Proportion of farmers applying compost in 1975, 1985, 1995 and 1998	Household survey
	Application of chemical fertilizers	Proportion of farmers applying chemical fertilizers in 1975, 1985, 1995 and 1998	Household survey
	Application of green manure	Proportion of farmers applying green manure in 1975, 1985, 1995 and 1998	Household survey
	Legume cultivation	Proportion of farmers cultivating legume crops in 1975, 1985, 1995 and 1998	Household survey
	Change in other source of fertilizers	Wrapping farmland by flood, terrace risers scraping, use of oilseed cakes, ash etc	Discussion with farmers

Coordination Schema Continue

Parameter	Complex variables	Simple variables	Source of Information
Farmers' land management priority	Land tenure system	Owner operated, mortgaged, rented	Household survey
	Fragmentation	Parcel size Fragmentation and management priority	Household survey
	Location of farm plots	Distance of farm plots from farm house in km	Household survey
Farmers' priority to the application of structural measures	Terrace improvement	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey, observation and discussion
	Bunds construction	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey, observation and discussion
	Waterways construction	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey, observation and discussion
	Construction of retention walls	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey, observation and discussion
	Construction of check dams	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey, observation and discussion
	Landslide repairing	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey, observation and discussion
	Gully control	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey, observation and discussion
Farmers' priority to the application of biological measures	Priority to fodder trees growing	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey
	Priority to shrub formation	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey
	Priority to fruit trees growing	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey
	Priority to mulching	Priority to *phantkhet, tarikhet, bari and gharbari*	Household survey
Farmers' fertility management priority	Supply of NPK	NPK supply by cropping intensity in *phantkhet, tarikhet, bari and gharbari*	Household survey
	Supply of NPK	NPK supply by land holding size *phantkhet, tarikhet, bari and gharbari*	Household survey
	Supply of NPK	NPK supply by distance of farm plots from farm house in *phantkhet, tarikhet, bari and gharbari*	Household survey
	Supply of NPK	NPK supply by land tenure system in *phantkhet, tarikhet, bari and gharbari*	Household survey
	Labor investment	Labor investment priority to land management and crop cultivation in *phantkhet, tarikhet, bari and gharbari*	Household survey

Coordination Schema Continue

Parameter	Complex variables	Simple variables	Source of Information
Actors and factors motivating to adopt different land management practices	Actors motivating to adopt structural measures	Ancestors, line agencies, NGOs, self stimulation through observation and neighbors	Household survey and discussion with farmers
	Actors motivating to adopt biological measures	Ancestors, line agencies, NGOs, self stimulation through observation and neighbors	Household survey and discussion with farmers
	Actors motivating to apply fertilizers	Ancestors, line agencies, NGOs, self stimulation through observation and neighbors	Household survey and discussion with farmers
Actors and factors influencing the adoption of land management practices	Demographic factor	Family size, number of people involved in agricultural activities, labor input per unit of land, ethnicity, schooling period of the household heads	Household survey
	Resource ownership	Land, livestock and tree ownership	Household survey
	Farm output	Food crop production, farm income, crop and grass yields	Household survey
	HH income	Income from off-farm sources including remittances	Household survey
	Spatial factor	Distance of farm plots from farm house	Household survey
	Ecological factors	Landslides density in the farmland, land affected by soil erosion, land with declining soil fertility	Household survey
	Institutional factors	Agricultural credit, training on land management, institutional membership, and participation of farmers in joint land management activities	Household survey
Role of formal rule and regulations in land management	Role of different acts directly and indirectly related to land	Private Forest Nationalization Act of 1957 Rent Control Act for *Birta* land, 1958 *Birta* Abolition Act of 1959 Land Consolidation Act of 1962 New Civil Code of 1963 Land Act and Land Reform Program of 1964 Tenancy Reform Acts of 1961, 1967, 1971 Land Administration Act of 1967 National Park and Wildlife Protection Act of 1972 *Kharka* Nationalization Act of 1974 Land Acquisition Act of 1977 Watershed Management Act of 1982 Forest Act of 1993 Water Resources Act of 1993	Published documents of the Ministry of Law and Justice
Role of informal rules and regulations	Written/ unwritten local rule and regulations	*Sanad* system *Jhara* System	Discussion with farmers
Public sector budget allocation to agricultural sector	At the national level	Public sector budget allocation to agricultural sector at the national level during 1965-2002	Periodic development plans of the government
	At the district level	Public sector budget allocation to agricultural sector at the district level	Institutional survey
	At the VDC level	Public sector budget allocation to agricultural sector at the VDC level during 1995-1999	VDC survey

Coordination Schema Continue

Parameter	Complex variables	Simple variables	Source of Information
Role of line agencies and NGOs in land management	Development of NGOs and CBOs	Number of NGOs and CBOs in the study area Their legal status Evolution of NGOs and CBOs	Institutional survey
	Institutional credit	Number of farmers facilitated by agricultural credit during 1988-1998	Institutional survey Household survey
	Extension services	Number of extension visits made by field workers during 1988-1998	Institutional survey Household survey
	Training	No of farmers trained during 1988-1998 Frequency and duration of training	Institutional survey Household survey
	Institutional membership	Number of household members involved in local organizations	Institutional survey Household survey
Role of user groups in land management	Forest user groups Water user groups Crop production groups Livestock development groups Small farmers group Mothers' group Saving and credit groups Farmers' cooperative	Role in gully control Role in the promotion of biological measures Role in the promotion of agroforestry Role in the promotion of cash crops Role in changing the farming system Role in market improvement Role in credit disbursement among members Role in extension Role in training Role in the domestication of wild legume species Role in resource conservation	User groups survey
Institutional capacity of local organizations involved directly or indirectly in land management	Satisfaction of farmers	Satisfaction of farmers with line agencies and NGOs involved in land management	Household survey
	Participation of farmers in land management activities	Type of participation: Direct participation (attending meeting) Indirect active participation Direct passive participation Indirect passive participation Induced participation (for assured benefit) Voluntary participation Politically guided participation Coercive participation Elite pressure participation Peer group pressure participation Enlisting participation (demonstrating individuals role with other group members) Full-flagged participation	Household survey PRA Groups discussion Meeting with farmers and government and NGO officials
		Participation by project phase: During decision making During planning During implementation During evaluation In all process	Household survey
		Frequency of participation in joint land management activities organized by line agencies and NGOs during 1988-1998	Household survey

Coordination Schema Continue

Parameter	Complex variables	Simple variables	Source of Information
Institutional capacity of local organizations involved directly or indirectly in land management	Strengths Weakness Opportunities and Threats of line agencies	Governance, resources, manpower, motivation, accountability and transparency of line agencies	Institutional survey
	Strengths Weakness Opportunities and Threats of NGOs	Governance, resources, manpower, motivation, accountability and transparency of NGOs	Institutional survey
	Strengths Weakness Opportunities and Threats of user groups	Governance, resources, manpower, motivation, accountability and transparency in NGOs	User groups survey
Farmers knowledge and attitudes towards improved land management practices	Mixed cropping	Experience in and attitude towards mixed cropping Attitude on its promotion in future	Household survey and discussion with farmers
	Alternative crop rotation	Experience in and attitude towards alternative crop rotation Attitude on its promotion in future	Household survey and discussion with farmers
	Legume cultivation	Experience in and attitude towards legume cultivation Attitude on its promotion in future	Household survey and discussion with farmers
	Perennial tree and shrub growing in marginal land	Experience in and attitude towards perennial tree growing in marginal land Attitude on its promotion in future	Household survey and discussion with farmers
	Domestication of green manure species	Experience in and attitude towards domestication of green manure species Attitude on its promotion in future	Household survey and discussion with farmers
	Compost making	Experience in and attitude towards composting Attitude on its promotion in future	Household survey and discussion with farmers
	Mulching	Experience in and attitude towards mulching Attitude on its promotion in future	Household survey and discussion with farmers
	Reduced tillage	Experience in and attitude towards reduced tillage Attitude on its promotion in future	Household survey and discussion with farmers

Questionnaire for Household Survey

The Information filled in this questionnaire will be confidential and will be used only for academic purpose. Please feel free to express your personnel opinion.
Watershed:

Name of the village: Date :

Village: Household sample no: Interviewer:

Name of the respondent:

Education: Age: Sex:

SECTION 1: INFORMATION ON SOCIO ECONOMIC CONDITION

Q.1: Please describe your household size, sex composition, and age structure

Age group	Male	Female	Total
9 and below			
10-15			
16 -59			
60 and above			
Total			

Q.2: Has any member of your family been out of home for more than six months?
Yes ( ) No ( )

Q.3: Please describe the number and place of work

Male (No)	Place of work	Female (No)	Place of work
	Nepal		Nepal
	India		India
	Europe		Europe
	South East Asia		South East Asia
	North America		North America
	Gulf countries		Gulf countries

Q.4: Please Describe occupation of your household members (above 10 years)

Occupation	Female	Male	Total
Student			
Agriculture			
Agriculture and Service			
Agriculture and business			
Business			
Public services			
Private Services			
Cottage industry			
Unemployed			
Wage labor			
Tourism			
Other Specify ……..			

Q.5: Please describe your household sources of income in the last fiscal year
(From Shreepanchami of 2054 to Shreepanchami of 2055)

Sources of Incomes	Income in NRs.
Income from livestock products	
Income from the sale of livestock	
Income from the sale of food grains	
Income from the sale of oilseeds and pulses	
Income from the sale of vegetables	
Income from the sale fruits	
Income from business	
Salary	
Cottage industries	
Wage labor	
Remittances	
Interest of money	
Pension	
Other ... Specify	
Total income	

Q.6: Please give details of your land holding

S No.	Land Type	Number of parcels	Area in Ropani
1	*Phantkhet*		
2	*Tarikhet*		
3	*Gharbari*		
4	*Bari*		
5	*Kharbari*		
6	*Jungle*		
	Total		

Q.7: Please give detail of your cereal crop production in your own land?

Land type	Owner Operated	No of Parcel	No of crops	Cereal Crop production in *Muri*					
				Rice	Wheat	Maize	Millet	Barley	Buckwheat
Phantkhet									
Tarikhet									
Bari									
Gharbari									
Total									

Q.8: Please give detail of your cereal crop production in rented in or rented out land?

Land type	Land ownership ##	Area	No of Parcel	No of crops	Cereal Crop production in *Muri*					
					Rice	Wheat	Maize	Millet	Barley	Buckwheat
Phantkhet										
Tarikhet										
Bari										
Gharbari										
Total										

1. Share Cropped in 2. Share crop out 3. Mortgaged in 4. Mortgaged in 5. Mortgaged out
6. Lease in 7. Lease out

Q. 9: Please Give detail of your cash crops production. (Production in Muri)

Cash Crops (Ground crops)	Area	Parcels of land	Land ## ownership	Production	Practiced since	Inspired to practice
Potato						
Cardamom						
Peanuts						
Ginger						
Garlic						
Pulses						
Oilseeds						
Bee keeping (No of hives)						
Vegetables (Production in kg)						
Tea /cardamom						
Other specify						

1. Owner Operated 2. Share Cropped in 3. Share crop out 4. Mortgaged in 5. Mortgaged out 6. Lease in 7. Lease out

Q.10: Please give detail of your fruit tree farming and production? (Production in kg)

Tree species	No of trees	Parcels of land	Land ownership # #	Land type ####	Production	Practiced since	Inspired by whom?
Orange							
Lichi							
Lemon							
Pears							
Pineapple							
Guavas							
Mangos							
Maple							
Jackfruit							
Banana							
Bhogate							
Khurpani							
Aru/Arupakhara							
Other							

1. Owner Operated 2. Share Cropped in 3. Share crop out 4. Mortgaged in 5. Mortgaged out 6. Lease in 7. Lease out

1. *Phantkhet 2. Tarikhet 3. Bari 4. Gharbari 5. Bagaicha*

Q.11: Please describe the food grain situation in your family (Total food production, consumption, sale and import)

Name	Total production (In muri/kg)	HH consumption	Sale (In muri/kg)			Purchasing from others (In muri/kg)		
			Unit	Rate	Earning	Unit	Rate	Expenditure
Rice								
Maize								
Wheat								
Millet								
Oat								
Potato								
Pulses								
Oilseeds								
Ginger/garlic								
Vegetable								
Others								

Q.12: Do you hire in labor for farming?

Yes ( ) No ( ) If yes please answer question No. 14

Q.13: Do you hire out labor for farming?

Yes ( ) No ( )

If yes please answer question No. 15

Q.14: Please describe the labor hire in						Q.15: Please describe labor hire out				
Month	Work	Sex		Wage rate		Work	Sex		Wage rate	
		Male	Female	Male	Female		Male	Female	Male	Female
Jan.										
Feb.										
March										
April										
May										
June										
July										
Aug.										
Sept.										
Oct.										
Nov.										
Dec.										

Q.16 : Do you have labor exchange practices for farming?

Yes ( ) No ( )
If yes please answer question 17

Q.17: Please describe the labor exchange practices in your farming

Work	Exchange in			Exchange out		
	Male	Female	Total	Male	Female	Total
Land maintenance						
Land preparation						
Transporting manure						
Millet transplanting						
Millet/Maize weeding						
Millet harvesting						
Rice transplanting						
Rice weeding						
Rice harvesting						
Post harvest						

Q. 18: Do you have dropped out some crops in last 23 years (1975-1998)?
Yes ( ) NO ( )
If yes continue to question 19

Q.19:

Crop type (Cereal crops)	Dropped out year	Reasons for drop out
1.		
2.		
3.		
4.		
5.		
Cash crops		
1.		
2.		
3.		
4.		
5.		
Fruit Trees		
1.		
2.		
3.		
4.		
5.		

Q.20: Please give the detail of your livestock herd size?

Livestock species	Below 1 year	1-3 year	Above 3 year	Total	Before 10 years
Cow					
Cattle					
Buffalo (She)					
Buffalo (He)					
Horse and mull					
Sheep/Goat/Pig	Below 6 months	6-12 months	Above 1 year	Total	Before 10 years
Goat (she)					
Goat (He)					
Sheep (She)					
Sheep (He)					
Pig (she)					
Pig (he)					
Poultry Chicken and Duck					
Others					

Q.21: Please give detail of your livestock products last year

Livestock products	Production in kg/litter	HH consumption	Sale	HH Income
Milk				
Butter				
Yogurt				
Wool				
Leather				
Others				

Q.22: Please describe the sale and purchasing of livestock during last fiscal year

Livestock products	Unit sold	Amount earned	Unit buy	Expenditure
Buffalo				
Cow/Cattle				
Goat				
Sheep				
Pig				
Chicken dock				

Q.23: Please mention the time that your family has spent in livestock raising

Livestock type	Total man days involved last year		Total mad days
	Male	Female	
Buffalo			
Cattle			
Sheep			
Goat			
Pig			
Chicken duck			
Others if any			

Q.24: How livestock feed is supplied?

A. Stall feeding in %
B. Grazing in %

Q.25: Please mention the source of feed for your livestock

Sources of feed	Estimated supply in %
Crop residues	
Farm fodder	
Farm grass	
Forest fodder	
Forest grass	
Grass from grazing land	
Crop by products	
Improved feed	
Other	

Q.26: Do you graze your livestock?

Yes ( )

No ( )

If yes please give go to question No. 27

Q.27: Please describe the area time of your livestock grazing

Month	Number Of livestock	Grazing in farm land (Number of days)				Forest and grazing land (Number of grazing days)					Total grazing days
		Phant khet	*Tari khet*	*Bari*	*Ghar bari*	Comm. Forest	Open forest	Local forest	Private forest	Kharbari	
Jan.											
Feb.											
Mar.											
Apr.											
May											
June											
July											
Aug.											
Sept.											
Oct											
Nov.											
Dec.											

Q.28: Please describe the feed adequacy for your livestock

A. Adequate ( ) B. Surplus ( ) C. Inadequate ( )

Q.29: Please describe source to meet the deficit feed

1.

2.

3.

Q.30: Do you keep goth in farmland and forest?

A. Yes ( ) B. No ( )

If yes go to question No. 31

Q.31: Please give details of your goth keeping system

Place	Time in days	Number of livestock				
		Buffalo	Cattle	Sheep	Goat	Total
Forest	From.....to.....					
Khet	From.....to.....					
Bari	From.....to.....					

SECTION 2: CHANGES IN AGRICULTURAL LAND MANAGEMENT PRACTICES

Q.32: Do you have any reclaimed land?

Yes	No

If yes continue question 33
If no go to question no 34

Q.33: Please give detail about the reclaimed land?

Converted to	Area in Ropani	Parcels	Reclaimed year	Cash expenses	HH labor Man days
Phantkhet from.....					
Tarikhet from					
Bari from					
Gharbari from.....					
Kharbari from.....					
Forest from.....					
Others					
Total					

Q. 34: Why did not you reclaim any land?

1.

2.

3.

Q.35. Have you changed your *khet* land to *bari* land in past?

If yes continue to question 36

Yes	No

Q.36: Please give the detail of the changed lands?

Year of change	Area	Parcels	Reasons for change
			1. 2. 3.

Q. 37: Did you change your *bari* land into *khet* land in the past?

If yes continue to question 38

Yes	No

Q.38: Please give detail of the changed land?

Year of change	Area	Parcels	Reasons for change
			1. 2. 3.

Q. 39: Please describe the change in crop yields in your farmland.

Crops	Before 1975 muri/ropani	Last year muri/ropani
Rice in *phantkhet*		
Wheat in *phantkhet*		
Maize in *phantkhet*		
Rice in *tarikhet*		
Wheat in *tarikhet*		
Maize in *tarikhet*		
Wheat in *bari*		
Maize in *bari*		
Millet in *bari*		
Wheat in *gharbari*		
Maize in *gharbari*		
Millet in *gharbari*		

Q.40: If crop yields are decreasing what did you do to cope with decreasing crop yields?

1.
2.
3.
4.

Q.41: Do you leave your land fallow?

A. Yes ( ) B. No. ( )

If yes go to question No. 42

Q.42: Please give details of your fallow land

Land type	Fallow period last year	Fallow period before 20 years
Phantkhet		
Tarikhet		
Bari		
Gharbari		

Q.43: Please give reasons if there is any change in fallow period

Land type	Reasons for decrease	Reasons for increase
Phantkhet		
Tarikhet		
Bari		
Gharbari		

Q. 44: What crop varieties you have cultivated?

Land type	Crop type	Area under local variety	Area under HYV	HYV since when
Phantkhet	Rice			
	Wheat			
	Maize			
	Potato			
	Vegetables			
	Fruits			
Tarikhet	Rice			
	Wheat			
	Maize			
	Potato			
	Vegetables			
	Fruits			
Bari	Millet			
	Wheat			
	Maize			
	Potato			
	Vegetables			
	Fruits			
Gharbari	Millet			
	Wheat			
	Maize			
	Potato			
	Vegetables			
	Fruits			

Q.45: Please describe the mixed cropping in your farmland.

Land type	Mixed crop combinations	Area in ropani	Since when
Phantkhet	1. 2. 3.		
Tarikhet	1. 2. 3.		
Bari	1. 2. 3.		
Gharbari	1. 2. 3.		

Q.46: What structural measures did you adopt to manage your farmland in last 23 years?

Structural measures	Yes	No	If yes		If no
			Practiced since when	Motivating agency	Please give the reasons
Terrace construction					
Bund construction					
Runoff flow ditches					
Gully control					
Retaining walls					
Irrigation canals					
Check dams					
Foot trail construction and maintenance					
Others grazing control					

Q.47: Please describe your farmyard manure and compost production.

Type	Production in *bhari* (Last year)	Production before 20 years in *bhari*
Farmyard manure		
Compost		

Q.48: What biological measures you have applied to your farmland management in last 23 years?

Biological measures	Yes	No	If yes		If no
			Practiced since when	Motivating agency	Please give the reasons
Hedgerows establishment					1. 2.
Mulching					1. 2.
Legume cultivation					1. 2.
Green manure					1. 2.
Shrubs establishment					1. 2.
Use of live materials in construction					1. 2.
Others					1. 2.

Q.49: Please mention your experience in regard to change in agricultural land management

Parameters	Increasing	Decreasing	Constant	Don't know
Soil erosion in farmland				
Use of organic fertilizer				
Use chemical fertilizer				
Use of green legumes				
No of trees in farmlands				
Irrigation facilities				
Crop residues burning practice				
Intrude weeds				
Area under fern species				
Labor involvement in terrace maintenance				
Nutrient supply from forest (in the form of leaf litter and green legumes)				

SECTION 3: SOIL FERTILITY AND EROSION CONTROL MEASURES

Q.50: How do you think about the soil fertility in your farmlands over past?

Fertility	*Phantkhet*	*Tarikhet*	*Bari*	*Gharbari*
Decreasing				
Constant				
Increasing				
Do not know				

If fertility is declining continue to question 52

Q.52: What are the major causes of fertility decline?

A. Phantkhet
1.
2.
3.
B. Tarikhet
1.
2.
3.
C. Bari
1.
2.
3.
D. *Gharbari*
1.
2.
3.

Q.53 Do you have any barren land?

A. Yes ( ) B. No ( )
If yes go to question No. 54

Q.54: Please give details of your barren land

Land type	No of parcels	Area in Ropani	Barren since	Reasons

Q.55: Please give detail of your *phantkhet* management
(Area in ropani, distance in km, manure in *bhari* and chemical fertilizer in kg)

Plot no	Name	Area	Location *	Distance From home	Land tenure **	Land quality ***	No of Crops /year
1							
2							
3							
4							
5							

* 1 Hill slope 2 valley floor ** 1. Owner operated 2. Share crop in 3. Share crop out 4. Mortgage in 5. Mortgage out *** 1. Abbal 2. Doyam 3. Sim 4. Cahhar

Phantkhet management continue

Plot no	Farmyard manure (Bhari)	Compost (Bhari)	Keeping goth (days)	Urea kg	Ammonium Sulfate kg	TSP kg	Murate of potash in kg	Mustered cake (in kg)	Green manure (in *bhari)*
1									
2									
3									
4									
5									

Phantkhet management continue

Plot no	Legume cultivation (No of trees)	Shrubs (No of clumps)	Fodder trees (No of species)	Fodder trees (No of trees)	Slice terrace risers and bunds (area in %)	Irrigate with flood water (area in %)	Mulching	
							Crop residues*	Grasses and weeds**
1								
2								
3								
4								
5								

* 1. Collect all 2. Collect 50% 3. Collect ¾ 4. Collect 9/10
** 1. No harvest 2. Harvest all 3. Harvest 75% 4. Harvest 50% 5. Harvest 25% 6. Harvest less than 25%

Phantkhet management continue

Plot no	Runoff ditches (No)	Gully head protection (No)	Improved Foot trail and canals (No)	Landslide treatment (No)	Landslide treatment (Man days)	Terraces maintenance (No)	Terraces maintenance (Man days)	Grazing*
1								
2								
3								
4								
5								

* Frequent grazing 2. Occasional grazing 3. No grazing

Q.56: Please give detail of your *tarikhet* management
(Area in ropani, distance in km, manure in bhari and chemical fertilizer in kg)

Plot no	Name	Area	Location *	Distance From home	Land tenure **	Land quality ***	No of Crops /year
1							
2							
3							
4							
5							

* 1 Hill slope 2 valley floor ** 1. Owner operated 2. Share crop in 3. Share crop out 4. Mortgage in 5. Mortgage out ** * 1. Abbal 2. Doyam 3. Sim 4. Cahhar

Tarikhet management continue

Plot no	Farmyard manure (Bhari)	Compost (Bhari)	Keeping goth (days)	Urea kg	Ammonium Sulfate kg	TSP kg	Murate of potash in kg	Mustered cake (in kg)	Green manure (in *bhari)*
1									
2									
3									
4									
5									

Tarikhet management continue

Plot no	Legume cultivation (No of trees)	Shrubs (No of clumps)	Fodder trees (No of species)	Fodder trees (No of trees)	Slice terrace risers and bunds (area in %)	Irrigate with flood water (area in %)	Mulching	
							Crop residues*	Grasses and weeds**
1								
2								
3								
4								
5								

* 1. Collect all 2. Collect 50% 3. Collect ¾ 4. Collect 9/10
** 1. No harvest 2. Harvest all 3. Harvest 75% 4. Harvest 50% 5. Harvest 25% 6. Harvest less than 25%

Tarikhet management continue

Plot no	Runoff ditches (No)	Gully head protection (No)	Improved Foot trail and canals (No)	Landslide treatment (No)	Landslide treatment (Man days)	Terraces maintenance (No)	Terraces maintenance (Man days)	Grazing*
1								
2								
3								
4								
5								

* Frequent grazing 2. Occasional grazing 3. No grazing

Q.57: Please give detail of your *bari* land management
(Area in ropani, distance in km, manure in bhari and chemical fertilizer in kg)

Plot no	Name	Area	Location *	Distance From home	Land tenure **	Land quality ***	No of Crops /year
1							
2							
3							
4							
5							

* 1 Hill slope 2 valley floor ** 1. Owner operated 2. Share crop in 3. Share crop out 4. Mortgage in 5. Mortgage out *** 1. Abbal 2. Doyam 3. Sim 4. Cahhar

Bari land management continue

Plot no	Farmyard manure (Bhari)	Compost (Bhari)	Keeping goth (days)	Urea kg	Ammonium Sulfate kg	TSP kg	Murate of potash in kg	Mustered cake (in kg)	Green manure (in *bhari)*
1									
2									
3									
4									
5									

Bari land management continue

Plot no	Legume cultivation (No of trees)	Shrubs (No of clumps)	Fodder trees (No of species)	Fodder trees (No of trees)	Slice terrace risers and bunds (area in %)	Irrigate with flood water (area in %)	Mulching	
							Crop residues*	Grasses and weeds **
1								
2								
3								
4								
5								

* 1. Collect all 2. Collect 50% 3. Collect ¾ 4. Collect 9/10
** 1. No harvest 2. Harvest all 3. Harvest 75% 4. Harvest 50% 5. Harvest 25% 6. Harvest less than 25%

Bari land management continue

Plot no	Runoff ditches (No)	Gully head protection (No)	Improved Foot trail and canals (No)	Landslide treatment (No)	Landslide treatment (Man days)	Terraces maintenance (No)	Terraces maintenance (Man days)	Grazing*
1								
2								
3								
4								
5								

* Frequent grazing 2. Occasional grazing 3. No grazing

Q.58: Please give detail of your *gharbari* management
(Area in ropani, distance in km, manure in *bhari* and chemical fertilizer in kg)

Plot no	Name	Area	Location *	Distance From home	Land tenure **	Land quality ***	No of Crops /year
1							
2							
3							
4							
5							

* 1 Hill slope 2 valley floor ** 1. Owner operated 2. Share crop in 3. Share crop out 4. Mortgage in 5. Mortgage out *** 1. Abbal 2. Doyam 3. Sim 4. Cahhar

Gharbari management continue

Plot no	Farmyard manure (Bhari)	Compost (Bhari)	Keeping goth (days)	Urea kg	Ammonium Sulfate kg	TSP kg	Murate of potash in kg	Mustered cake (in kg)	Green manure (in *bhari)*
1									
2									
3									
4									
5									

Gharbari management continue

Plot no	Legume cultivation (No of trees)	Shrubs (No of clumps)	Fodder trees (No of species)	Fodder trees (No of trees)	Slice terrace risers and bunds (area in %)	Irrigate with flood water (area in %)	Mulching	
							Crop residues*	Grasses and weeds **
1								
2								
3								
4								
5								

* 1. Collect all 2. Collect 50% 3. Collect ¾ 4. Collect 9/10
** 1. No harvest 2. Harvest all 3. Harvest 75% 4. Harvest 50% 5. Harvest 25% 6. Harvest less than 25%

Gharbari management continue

Plot no	Runoff ditches (No)	Gully head protection (No)	Improved Foot trail and canals (No)	Landslide treatment (No)	Landslide treatment (Man days)	Terraces maintenance (No)	Terraces maintenance (Man days)	Grazing*
1								
2								
3								
4								
5								

* Frequent grazing 2. Occasional grazing 3. No grazing

SECTION 4: FARMERS' AWRENESS of AND ATTITUDES TOWARDS IMPROVED LAND MANAGEMENT

Q.59: Farmers' awareness of advantages and disadvantages of soil conservation practices

Practice	Advantages	Disadvantages
Mixed cropping: Tree crop and field crops	1. 2. 3.	1. 2. 3.
Mixed cropping: Tree crop and vegetables	1. 2. 3.	1. 2. 3.
Rotational cropping	1. 2. 3.	1. 2. 3.
Legume cultivation	1. 2. 3.	1. 2. 3.
Alley cropping	1. 2. 3.	1. 2. 3.
Domestication of *Asuro_Titepati and Khirro_*on bunds and terraces and uncultivated lands	1. 2. 3.	1. 2. 3.
Minimum tillage practice	1. 2. 3.	1. 2. 3.

Q. 60: Mulching helps to reduce soil erosion and improve soil fertility. Would you like to adopt following practices in your *khet* and *bari* plots?

Practice in *khet* plots	Yes	No	If yes why you have not practiced now?	If no, why?
Stop grazing				
Leave all crop residue in the field				
Stop cutting grasses				
Practice in *bari* Plots				
Stop grazing				
Leave all crop residues in the field				
Stop cutting grass				

Q. 61 Agroforestry, including fruit farming, helps to improve land fertility and household income. Would you like to expand this practice particularly in your *bari*?

Yes	No

If yes continue to question 62
If no go to question 63

Q. 62: Please explain your preferred varieties.

Preferred fruit trees	Preferred fodder trees

Q.63: Why you did not practice so far?
1.
2.

Q.64: Why don't you like to expand agroforestry?
1.
2

Q.65: Would you like to expand this practice in future?

If yes continue to question 66
If no go to question 67

Yes	No

Q.66: Why you don't like to expand agroforestry in future please give the reasons?

1.
2.

Q. 67: Is it possible to plant trees and shrubs crops on the edge of your *khet* plots?

If yes continue to question 68
If no go to question 69

Yes	No

Q.68: Why did not you adopt such practice so far?

1.
2.

Q.69: Why you don't like to adopt such practice?
1.
2

Q.70 Would you like to expand this practice in future?

If yes continue to question 71
If no go to question 72

Yes	No

Q. 71: Please explain your preferred varieties.

Preferred trees	Preferred shrubs

Q.72: Why you don't like to adopt such practice in future?

1.

2.

Q.73: Crop rotation helps to maintain or improve the soil fertility and crop yields. Do you want to practice crop rotation in all your farmlands?

If no go to question 74
If no go to question 75

Yes	No

Q.74: Why did not you practice so far?

1.

2.
Q.75: Why you don't like crop rotation?

1.

2.

Q.76: Cultivation of legume crops has multiple advantage like, increased soil fertility, crop yields, and fodder supply for livestock and household income. Do you agree with this statement?

Yes	No	Don't know

If yes continue to question 77
If no go to question 78
If don't know go to question 79

Q.77: Why have not you cultivated in all of your plots?

1.

2.
Q.78: Why don't you like to cultivate legume trees? Please give the reasons?

1.
2.
Q.79: Do you like to know about the legume trees?

Yes	No

If yes continue to question 80

Q. 80: Please explain what types of support services do you need to know in regard to legume tree and crops?
1.
2.

Q.81: Compost is better than farmyard manure in terms of plant nutrient content. Do you make compost from your farmyard manure and crop residues?

Yes	NO

If yes continue to question 82
If no go to question 83

Q.82: Please give the combination materials used to make compost.

1.
2.
3.
Q.83: Why don't you like to make compost?
1.
2.
3.

Q.84: Several species of leafy plants including *asuro*, *khiro* and *titepati* are very good quality of fertilizers. In view of difficulties in obtaining chemical fertilizer and diminishing farmyard manure supply, domestication and promotion of such plants would contribute to cope with declining land fertility. Do you see a prospect for growing such plants in community and private lands?

Yes	No	Don't know

If yes continue to question 85
If no go to question 86
If don't know go to question 87

Q.85: If yes what should be done to promote these plants?
1.
2.
3.
Q.86: If no why?

1.
2.
3.
Q.87: If don't know, what type of knowledge do you want to have to domesticate these plants?

1.

2.

3.

Q.88: If your *bari* plots on hill slopes are neither terraced nor with bunds, are you considering to construct such terraces?

Yes	No

If yes continue to question 89
If no go to question 90

Q.89: Why did not you construct so far?

1.

2.

Q.90: If no, why?

1.

2.

Q.91: Are you considering to convert your hills lopes *khet* into *bari* land?

Yes	No

If yes continue to question 92

Q.92: Why you want to do this?

1.
2.

SECTION 5: FARMERS' EXPOSURE TO LOCAL ORGANIZATIONS AND THEIR INVOLVEMENT IN AGRICULTURAL LAND MANAGEMENT

Q.93. Did you get any training from line agencies and NGOs in agricultural land management?

Yes	No

If yes continue question 94
If no go to question no 95

Q.94: Please mention the type of training that you received?

Type of support services	Frequency	Source		
		Line agencies	NGOs	Others
Training on terrace maintenance				
Training on soil fertility management				
Training on crop management				
Training on soil and moisture conservation				
Training on livestock management				
Training on agroforestry				
Training on gully control, land slide stabilization, torrent control				
Observation visit				
Other specify				

Q.95: What are the reasons for not receiving any training?

1.

2.

3.

Q.96: Did you receive loan from any government and non-government sources to improve your agricultural land?

Yes	NO

If yes go continue question 97
If no go to question 98

Q. 97: Please give the purpose and source of the credit that you received form GOs and NGOs

Purpose of credit	Amount	Interest	Source	Pay back period
Cash crop farming				
Fertilizer and pesticides				
Quality seeds				
Land maintenance				
Land purchasing				
Land reclamation				
Land rehabilitation				
Machinery and equipment				
Other specify				

Q.98: What are the reasons for not taking the credit?

1.
2.

Q.99: What is your experience in regard to adequacy of credit?

Purpose of credit	Sufficient	Not sufficient
Cash crop farming		
Fertilizer and pesticides		
Quality seeds		
Land maintenance		
Land purchasing		
Land reclamation		
Land rehabilitation		
Machinery and equipment		
Other specify		

Q. 100: Please describe technology, materials and services that you have received from GOs and NGOs?

No	Services/technology	Sources	Fully satisfied	Satisfied	Dissatisfied
1					
2					
3					
4					

Q.101: If not satisfied, please give the reasons?

1.
2.
3.

Q.102: Are you or any other members of your family involved in formal and informal local organizations?

If yes continue question 103
If no go to question 104

Yes	No

Q.103: Please give detail of your participation in local organizations or community programs?

Name of organization	Type of work	Respondent	Family members		Position held		
			Male	Female	Respondent	Family member	
						Male	Female

Q.104: What are the reasons for not participating in GOs and NGOs
1.
2.
3

Q.105: Please describe your level of participation in land management activities organized by local organization or your community over last 10 years?

Type of work	Problem identification	Decision making	Impleme-ntation	Supervision and monitoring	Labor contribution
Irrigation cannel construction and maintenance					
Gully control, gully head protection, gully plug					
Landslide stabilization, torrent control					
Foot trail construction and canal improvement					
Check dam, hill side ditches, Construction and maintenance					
Land rehabilitation					
Reforestation for erosion control, strip cropping, hedgerows					

Q. 106: Why did you participate in land management programs organized by local organization or your community?

Land management programs	Frequency	Motivating factors to participate
Irrigation canal construction and maintenance		
Gully control, gully head protection, gully plugging		
Landslide stabilization, torrent control		
Foot trail construction and canal improvement		
Check dams, hill side ditches, waterways Construction and maintenance		
Land rehabilitation		
Reforestation for erosion control, Strip cropping, hedgerows		
Other specify		

Q.107: Please describe your type of participation in land management programs. (Tick mark as appropriate)

Type of participation	Construction and maintenance of irrigation canals	Gully, torrent and land slide control and stabilization	Construction of check dams, hill side ditches, water ways	Foot trail construction and improvement
Innovative participation				
Collaborative participation				
Direct active participation				
Indirect active participation				
Direct passive participation				
Indirect passive participation				
Induced participation				
Voluntary participation				
Leader guided participation				
Coercive participation				
Elite guided participation				
Group guided participation				
Politically guided participation				
Social participation				
Cultural participation				
Full flagged participation				

Q.108: Please list out the local organizations concerned with land management and show your level of satisfaction with their performances?

Local organizations concerned with land management that you are familiar with	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly Dissatisfied

Q.109: If you have any dissatisfaction please give the reasons.

Local organizations concerned with land management that you are dissatisfied with	Reasons for dissatisfaction

Q.110: Do you have any problems in agricultural land management?

Yes	No

If yes continue to question 111, If no go to question 112

Q.111: Please mention the land management problems that you are facing.
Q.112: Please ranked the problems in order according to their severity.

(Question 111)			(Question 112)	
Problems	Yes	No	Don't know	1 for most severe
Infertile land				
High soil erosion				
Expansion of gullies				
Small-holding				
Fragmented holdings				
Inadequate loan and other extension services				
Stray livestock				
Insecure land tenure				
Inadequate irrigation water				
Low crop yield				
Labor shortage				
Other specify.....				

Q.113: If you have no any problems in agricultural land management please give the reasons.

Q.114: Do you think that local community organizations and NGOs can contribute to improve land management?

A. Yes ( ) B. No ( ) C. Don't know ( )

If yes continue to question115
If no go to question 116

Q.115: How they can contribute?
1.
2.

Q.116: Please specify organizations who can make contribution.
1.
2.

SECTION 6: CONSUMPTION AND SOURCE OF DOMESTICE ENERGY

Q. 117: Please specify your annual energy consumption of and their source

Type of energy	Use of energy in %			
	Cooking	Water heating	Warming	Lighting
Fuel-wood				
Crop residues				
Fodder residues				
Electricity				
Kerosene oil				
Bio-gas				
Cooking gas				

Q.118: Please specify the source and annual consumption of your energy

Type of energy	Annual consumption	Sources	Unit*	Used since
Fuel-wood		1. Farmland 2. Private forest 3. Community forest 4. Open access forest 5. Local forest 6. Crop residues 7. Fodder residues 8. Purchasing		
Electricity				
Kerosene				
Bio-gas				
Cooking gas				
Dung				

Note: Fuel in bhari (Load), Electricity in unit, kerosene in litter, cooking gas in number of cylinder, bio-gas number of plants and their capacity

Q. 119: Please mention how do you collect the required fuel-wood (last year)

1. Dry tree branches.....load
2. Live tree branches.....load
3. Dry trees.....load
4. Live trees..... load

Q.120: Do you feel any shortage of fuel-wood?

1. Yes
2. No

Please answer question No.121 if you feel any shortage

Q.121: Please explain the time you have invested to collect fuel-wood

Source	Time incurred last year	Time incurred 10 year before	Time incurred 10 year before
Private land			
Community forest			
Open access forest			
Locally protected forest			

SECTION 7: SOIL EROSION AND VEGETATION

Q.122: Please explain the trees, shrubs and fodder species in your farm land

Land type	Area in ropani	Number of trees		Shrub area		Green grass production in bhari	
		Last year 1998	10 year back 1988	Last year 1998	10 year back 1988	Last year 1988	10 year back 1998
Phantkhet							
Tarikhet							
Bari							
Gharbari							
Kharbari							
Private forest							

Q.123: Please explain and the wood-fuel and wood collection in your household (Last year)

Land type	Area in ropani	Wood-fuel in bhari		Wood in cubic feet	
		Last year 1998	10 year back 1988	Last year 1998	10 year back 1988
Phantkhet					
Tarikhet					
Bari					
Gharbari					
Kharbari					
Jungle					
Total					
Community forest					
Open access forest					
L. protected forest					

Q.124: Please explain the consumption of fuel-wood and wood in your household

Fuel-wood consumption in bhari		Wood consumption in cubic feet	
Last year	10 years back	Last year	10 year back

Q.125: Please explain the soil type and crop varieties in your farmland

Soil type	Area in ropani	Crop varieties	Production in Muri	Soil erosion rate *
Black				
Red				
Sandy				
Alluvial				
Brown				
White				
Others 1. 2. 3.				

* 1 High 2. Moderate 3: Low

Q.126: Please rank the area of soil erosion

Land type	Rank 1 to most severe soil erosion
Phantkhet	
Tarikhet	
Bari	
Gharbari	
Kharbari	
Grazing land	
Forest	
Marginal land	

Q.127: Please explain how soil erosion is going on

Type of soil erosion	Area affected by soil erosion	Land type
Landslide		
Mixing with water		
Wash out by water		
Rill erosion		

Q.128: Please explain productivity reduced by soil erosion

Land type	Area in ropani		Productivity in muri	
	Total land	Eroded land	Productivity before	Productivity after
Phantkhet				
Tarikhet				
Bari				
Gharbari				
Others				
Total				

Q.129: Please explain which soil is most infertile in your farm land. Explain the reason as you have experienced.

Soil type	Infertile area in ropani	Reason for being infertile
Black		
Red		
Sandy		
Alluvial		
Brown		
White		
Others		

Q.130: How we can control the soil erosion? Please explain your experience.

1.
2.
3.

Q.131: How we can prevent the soil of being infertile? Please explain your experiences.

1.
2.
3.

Q.132: What efforts are being made by GOs and NGOs?

1.
2.
3.

QUESTIONNAIRE FOR INSTITUTIONAL SURVEY

The information filled in this questionnaire will be confidential and will be used only for academic purpose.

Name of the institution: Name of the Respondent:

Education: Position in office:

Major professional training:

Working Experience (in year): Working in this district since:

Question 1: Please describe the personnel strengths of your office.

Type	District office				Field office				Grand Total			
	Technical		Non technical		Technical		Non technical		Technical		Non technical	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Officer												
Assistant												
Extension/field workers												
Support staff												
Total												

Question 2: Please give detail of your expenditure during last fiscal year.

Expenditure items	Total expenditure in Rs.
Salary and allowances of the staff	
TA/DA for field work/extension work	
Training to office staff	
Training to farmers/villagers	
Information/communication and education (IEC)	
Development works	
Office appliances/stationery/ telephone/water/electricity etc	
Grant to VDC/community	
Other expenditures	
Total	

Question 3: What are the major objectives of your office?

1.

2.

3.

4.

5.

Question 4: Do you have formed farmers'/community/user groups in your program execution?

If yes go to question 5

Question 5: Please give the type and number of groups.

Type of groups	Number of groups

Question 6: When and how do you involve local/community people in your program?

Level of participation	Yes	No	Criteria to select local people
Problem identification			
Program planning			
Program implementation			
Supervision, monitoring and evaluation			
Whole process			

Question 7: Dou you provide written job description to all your subordinates?

Yes No Partially

Question 8: Please give your comment on the strengths, weaknesses, opportunities and threats of your office regarding governance, resources, manpower, motivation, accountability and transparency.

8.A Strengths

Strengths are defined as one or more skills, distinctive competencies, capabilities, competitive advantages, or resources that your office can draw. List the strengths that your office can use in future in program planning, implementation and evaluation.

1.

2.

3.

4.

5.

6.

8.B Weakness

Weaknesses are defined as the lack of one or more skills, distinctive competencies, capabilities, and competitive advantages. List the weakness that the future programs should take into account.

1.

2.

3.

4.

5.

6.

8.C Opportunities

Opportunities are situation in which benefits are fairly clear and likely to be realized if certain action are taken. List the opportunities that are apparent to your office.

1.

2.

3.

4.

5.

6.

8.D Threats

Threats are situations that give rise to potentially harmful events and outcomes if actions are not taken in immediate future; they must be actively confronted to prevent trouble. List out the treats that currently confront in your office.

1.

2.

3.

4.

5.

6.

Question 9. Please give your comment from your own experience on existing land policy of the government.

Question 10: Please give your suggestions to formulate better land management policies in future.

Question 11: Please give the existing direct and indirect role of your office to increase farm productivity and better land management.

Question 12: What would be the potential role of your office in future for better land management.

Question 13: Please give your opinion how and on what way the users /women groups and local community based organizations formed spontaneously or assisted by different institutions can be involved in better land management.

QUESTIONNAIR FOR VDC SURVEY

Name of Village Development Committee: Watershed:

Q.1: Please describe the accessibility of villages in your VDC to the market centers

Ward no	Name of village	HH no	Nearest town	Distance from village in km	Road link		If yes type of road link *	Means of transport **	Distance of road head from village	Average walking distance
					Yes	No				
1										
2										
3										
4										
5										
6										
7										
8										
9										
Total										

* 1 Seasonal 2. All weather

** 1. Bus 2. Pick up 3. Lorry

Q.2: Please give the income and expenditure pattern of your VDC in last five years

Name of VDC: Watershed:

No	Budget heading	1994/95	1995/95	1996/97	1997/98	1998/99
	Sources of Income					
1	Government donation					
2	Locally generated income					
3	Grant from line agencies					
4	Donation from NGO/INGO					
5	Income from other sources					
Total income						
	Investment trend in development activities					
1	Salary and allowances					
2	Office stationery and equipment					
3	Other office cost					
	Total office operation cost					
	Development expenditures					
1	Educational infrastructures and activities					
2	Drinking water					
3	Health infrastructures and activities					
4	Income generation activities					
5	Agriculture promotion activities					
6	Livestock promotion activities					
7	Irrigation facilities					
8	Check dams and river control					
9	Gully control					
10	Land slide control					
11	Foot trails and suspension bridge					
12	Road construction motorable					
13	Plantation					
14	Electrification/telephone					
15	Unspecified small programs					
Total expenditure						

Q.3: Please give brief account of buying and selling prices of agricultural commodities in last five year

Name of VDC: Watershed:

Name of produces	Post harvest selling price				Buying prices following month			
	During last year (2055/1998)		Five year earlier (2050/1992)		During last year (2055/1998		Five year earlier (2050/1992)	
	Unit	Rate	Unit	Rate	Unit	Rate	Unit	Rate
Cereal crops								
Paddy								
Rice								
Maize								
Millet								
Wheat								
Barley								
Buckwheat								
Other								
Cash crops								
Potato								
Pulses								
Ginger								
Garlic								
Cardamom								
Black grams								
Beans								
Horse peas								
Others								
Livestock products								
Milk								
Butter								
Yogurt								
Wool								
Leather								
Others								
Chemical fertilizer								
Urea								
T.S.P								
Ammonia								
Potash								

Q.4: Please describe the average yield of crops per ropani of land in your VDC during normal, very high and low rainfall year

Name of VDC: Watershed:

Crops	Growing seasons		Average yields					
	Sowing month	Harvesting month	Normal year		Very high rainfall year		Very low rainfall year	
			With irrigation	Without irrigation	With irrigation	Without irrigation	With irrigation	Without irrigation
Cereal crops								
Paddy								
Rice								
Maize								
Millet								
Wheat								
Barley								
Buckwh -eat								
Other								
Cash crops								
Potato								
Pulses								
Ginger								
Garlic								
Cardam-om								
Black grams								
Beans								
Horse peas								
Others								

Q. 5: Please give the personal details of your VDC executive members

Name of VDC: Watershed:

Ward	Name	Post	Education	Past experience	Working experience	Training if any
1						
2						
3						
4						
5						
6						
7						
8						
9						

Q. 6: Please give the brief account of NGO, INGO, User Groups, Women Groups, Conservation Groups, Farmer's Groups, Livestock Groups, Youth groups, and the Cooperatives which are involved in agricultural production

Name of VDC: Watershed:

Name	Location	Est. Year	General Member			Executive members			Legal status		Source of support	Major activities undertaken
			Male	Female	Total	Male	Female	Total	Formal	Informal		
Total												

Q. 7: Please describe the land cover in your locality

Name of VDC: Watershed:

Site	Land sub group	Area in ropani	Dominant Soil type	Average gradient	Area fit for cultivation	Cropped area in ropani		Grass cover Area in ropani		Number of bushes		No of trees	
						Now	10 year before	Now	10 year before	Now	10 year before	Now	10 year before
1	Private farm land												
	Private forest												
	Private grass land												
	Rangeland												
	Community forest												
	Open access forest												
	Locally protected forest												
2	Private farm land												
	Private forest												
	Private grass land												
	Rangeland												
	Community forest												
	Open access forest												
	Locally protected forest												
3	Private farm land												
	Private forest												
	Private grass land												
	Rangeland												
	Community forest												
	Open access forest												
	Locally protected forest												

Q.8: Please describe the labor force involvement in agricultural production

Name of Village Development Committee: Watershed:

Land type	Crops	Land maintenance			Manuring			Ploughing			Hoeing			Transplanting			Weeding			Harvesting			Post harvest			Oxen used
		M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	
Irrigated rice field (*Phantkhet*)	Rice																									
	Wheat																									
	Maize																									
	Total																									
Rainfed rice field (*Tarikhet*)	Rice																									
	Wheat																									
	Maize																									
	Total																									
Upland maize and millet field (*Bari* land)	Wheat																									
	Maize																									
	Millet																									
	Total																									
Home plot (*Gharbari*)	Wheat																									
	Maize																									
	Millet																									
	Total																									

APPENDIX A: SUPPLEMENTARY TABLES

Table A 1: Population, area and livestock distribution by ecological zone in Nepal

Particular	Nepal	Mountain >4000 M.	Hills 500-4000	Tarai <500
No of districts	75	16	39	20
Population 1991	18,491,097	7.8	45.5	46.7
Population density person/ per/ sq.km 1991	125.6	27.8	137.3	253.6
Population growth rate 1981-1991	2.1	1.0	1.6	2.7
Population density per/ha/arable land 1991/92	7.9	8.8	9.6	6.6
Average family size	5.6	5.3	5.4	5.8
Total area of Nepal in hectare (Distribution in %)	14,718,100	35.2	41.7	23.1
Total farmland in hectare 1991/92 (Distribution in %)	2,353,715	7	37.3	55.7
Irrigated farmland 882,400 hectare 1991/92 (Distribution in %)	37.5	1.8	10.4	25.3
Rainfed farmland 1,471,315 hectare 1991/92 (Distribution in %)	62.5	5.2	26.9	30.4
Total parcel in Nepal 1,0831,202 in 1991/92 (Ownership no/house)	3.3	4.4	3.4	2.9
Per capita arable land per/person/hectare 1991/92	0.13	0.11	0.10	0.15
Total forest land in Nepal (Distribution in %)	5,464,866	23.2	51.1	25.7
Others land	3,752,736	54.4	35.7	9.9
Livestock Standard Units (LSU) 1995/96	8,688,975	13.5	53.0	33.5
Livestock density LSU/per hectare of arable land	3.7	7.2	5.2	2.2
Livestock growth rate 1984/85-1995/96	1.4	3.7	1.2	0.6

Source: Adopted from CBS 1998 and 1994 and MA 1995/96

Table A 2: Crop yields in Nepal

Year (Ton/hectare)	Rice	Wheat	Maize	Millet	Barley
1974/75	1.98	1.14	1.81	1.14	0.93
75/76	2.07	1.18	1.65	1.14	0.96
76/77	1.89	1.04	1.79	1.13	0.84
77/78	1.81	1.12	1.66	1.07	0.88
78/79	1.85	1.17	1.64	1.08	0.88
79/80	1.64	1.2	1.33	0.97	0.88
80/81	1.93	1.22	1.63	1.0	0.85
81/82	1.97	1.32	1.58	1.0	0.85
82/83	1.45	1.36	1.41	0.94	0.88
83/84	2.07	1.34	1.51	0.93	0.88
84/85	1.96	1.15	1.40	0.92	0.86
85/86	2.01	1.22	1.41	0.91	0.80
86/87	1.78	1.29	1.38	0.92	0.86
87/88	2.09	1.25	1.34	1.0	0.84
88/89	2.26	1.38	1.49	1.16	0.92
89/90	2.36	1.42	1.60	1.17	0.93
90/91	2.41	1.41	1.63	1.15	0.94
91/92	2.28	1.36	1.60	1.17	0.93
92/93	2.05	1.25	1.67	1.08	0.93
93/94	2.40	1.41	1.60	1.07	0.95
94/95	2.06	1.44	1.7	1.10	0.94
95/96	2.39	1.55	1.7	1.08	1.04
96/97	2.46	1.60	1.6	1.11	1.04
1997/98	2.42	1.60	1.7	1.08	1.00

Source: MOF (Ministry of Finance), 1995 and DA, 1999

Table A 3: Arable and permanently cropped land in the Asia Pacific Region (Area in ,000 ha)

Country	Total Land	Arable and Permanently Cropped Land		Arable and Permanently Cropped Land as a Percentage of Total Land		Percentage of Agricultural Population to Total Population		Per capita Arable Land in hectare		Agricultural Land % of Total Land
		1961	1985	1961	1985	1961	1985	1961	1985	
Developing Countries										
Bangladesh	13391	8880	9135	66.3	68.2	85.6	71.8	0.2	0.13	72.7
Bhutan	4700	65	102	1.4	2.2	95	91.6	0.08	0.08	6.8
Myanmar	65774	10120	10067	15.4	15.3	67.5	50	0.68	0.54	15.7
China	932641	105234	100883	11.3	10.8	82.7	71	0.19	0.13	41.4
Cook Islands	23	6	6	26.1	26.1	50	15	0.67	2	26.1
Dem. Kampuchea	17652	2353	3056	13.3	17.3	81.5	72.3	0.52	0.58	20.6
DRP. Korea	12041	1894	3282	15.7	19.6	60.7	38.1	0.29	0.3	20.2
Fiji	1827	215	240	11.8	13.1	58.6	42.3	0.9	0.82	16.4
India	297319	160990	168950	54.1	56.8	70.6	64.5	0.5	0.35	60.8
Indonesia	181157	17100	20880	9.4	11.5	70.7	48.8	0.25	0.26	18.1
Iran	163600	15271	14830	9.3	9.1	51.8	30.5	1.4	1.09	36
Laos	23080	830	900	3.6	3.9	82.6	73.7	0.42	0.3	7.4
Malaysia	32855	3500	4370	10.7	13.3	60.3	34.8	0.69	0.81	13.4
Maldives	30	3	3	10	10	73.1	68.1	0.04	0.02	10
Mongolia	156500	550	1354	0.4	0.9	59.5	35	0.97	2.03	79.6
Nepal	13680	1831	2319	13.4	17	94.3	92.4	0.2	0.15	31.4
Pakistan	77080	16881	20500	21.9	26.6	63.7	55.4	0.52	0.37	33.1
Papua New Guinea	45171	305	383	0.7	0.8	88.7	71.9	0.18	0.15	1
Philippines	29817	6697	7900	22.5	26.5	60.3	49	0.39	0.3	30.4
Rep. of Korea	9819	2095	2144	21.3	21.8	56.9	27.5	0.14	0.19	22.6
Samoa W.	283	108	122	38.2	43.1	38.5	14.1	2.16	5.3	43.5
Solomon Islands	2754	50	55	1.8	2	61.9	48.5	0.64	0.42	2
Sri Lanka	6474	1538	2205	23.8	34.1	56.4	52.5	0.27	0.26	40.8
Thailand	51177	11393	19620	22.3	38.3	80.9	64	0.51	0.6	38.9
Tonga	67	47	54	70.1	80.6	47.8	16.5	1.47	3	86.6
Vanuatu	1476	80	95	5.4	6.4	61.2	48.6	1.95	1.38	8.1
Vietnam	32536	5985	6795	18.4	20.9	81	64.1	0.21	0.18	21.7
Sub Total	2172955	374021	399330	17.2	18.4	75.9	64.1	0.32	0.24	40.9
Developed Countries										
Australia	761793	30358	48600	4	6.4	11	5.8	26.35	53	64
Japan	37643	5900	4758	13.7	12.6	30.5	8.1	0.2	0.49	14.3
New Zealand	26867	466	501	1.7	1.9	14.5	10.1	1.33	1.52	53.5
Sub Total	826303	36724	53859	4.4	6.5	28.2	7.9	1.21	4.89	61.4
Asia Pacific Total	299258	410745	453189	13.7	15.1	72.8	61.2	0.34	0.27	46.5
Rest of the World	10081760	938453	1023294	9.3	10.1	40.6	29.4	1.61	1.63	46.5
World	13081014	1349198	1476483	10.3	11.3	57.8	47.1	0.76	0.65	

Source: Dent F.J.,1990. Land Resources of Asia and the Pacific. In problem Soils of Asia and the Pacific RAPA Report 1990/6, FAO Bangkok, Thailand PP44-67

NB: Total land excludes inland water bodies and river

Table A 4: Comparison of soil lost estimates for developing countries

Source	Sediment Yield (t/km^2)	Suspended Load (000 tones)	Average Erosion t/ha)	Total Soil Loss (000 tones) **
Fouriner (1967)	570	40,060,740	114.0	869,398,200
Kuene	320	22,490,240	64.0	488,083,200
Gilluly	313	21,998,266	62.6	477,406,380
Pechinov	238	16,727,116	47.6	363,011,880
Schumm	201	14,126,682	40.2	306,577,260
Lopatin	124	8,714,968	24.8	189,132,240
Holeman	360	27,454,680	71.9	548,519,050
Jansen & Painter	216	15,180,912	43.2	329,456,616
World Watch***	49	3,408,777	9.7	73,975,110
World Watch****	185	13,002,170	37.0	282,173,100
Younis and Dragum	290	20,381,780	53.3	406,282,780

NB: * Based on a total land area of 76,263,000 km^2 (FAO Production Year Book, 1980)

** Based on Estimated Average 76,263,000 Erosion Times

*** Worldwatch, global estimate applied to the area of developing countries

**** Worldwatch, estimate for India and then applied to all developing countries

Source: Younis and Dragum, 1993: 78

Table A 5: Soil erosion estimation in different part of the world

No	Land Use	Country	Erosion rate ton/ha/year	Source
1	Corn field	Thailand	0.13-5-41	Sombatpaint, 1996
2	Siwalik + Midhills Nepal	Nepal	44.42-52.52	JICA, 1996
3	Crop Land Slope 30^0	Japan	270	Honda,1993
4	Grass Land Slope 30^0	Japan	13.5	Honda,1993
5	Forest Slope 30^0	Japan	1.35	Honda,1993
6	Loess Mountain cultivation	China	20-250	Gong and Xiang, 1980
7	Volcanic region	Japan	26.5-130	Kadomura, 1980
8	Mountains	Japan	2.65-13.25	Kadomura, 1980
9	Well Managed forest	Japan	0.26-1.32	Kadomura, 1980
10	Mountains/Midhill	Nepal	23.98	World Bank, 1978
11	Mountains	Cameron	0.3-0.85	Olivvry, 1977
12	Severely eroded land	Equador	210-564	Flemming, 1977
13	Corn Contour	Sate of Sao Polo	4.1-19.8	Lal, 1977
14	Corn Downhill	Sate of Sao Polo	21.4-52.8	Lal, 1977
15	Geological erosion	USA	7.62	Patric,1976
16	Natural forest	USA	0.40-0.60	Patric,1976
17	Severely eroded land	USA	446	Patric,1976
18	Forest Grazing	Nepal	7.8-36.8	Chattra,1975
19	Sikiang valley	China	6.60	UNESCO,1974
20	Red river watershed	China	11.90	UNESCO,1974
21	Yangtzekiang watershed	China	4.20	UNESCO,1974
22	Godawari Catchment	India	3.84	UNESCO,1974
16	Mahandi catchment	India	5.13	UNESCO,1974
17	Ganga+Barmaputra River	India+China+Nepal	14.0	UNESCO,1974
18	Mountain	Latin America	0.65-1	UNESCO,1974

19	Grass on 8% slope	Punjab India	5.45	Starkel, 1972
20	Maize and wheat	Punjab India	10.26	Starkel, 1972
19	Grass on 8% slope	Punjab India	5.45	Starkel, 1972
20	Maize and wheat	Punjab India	10.26	Starkel, 1972
23	Grass and un-grazed thicket	Tanzania	0.0	Temple, 1972
24	Cultivated land millet	Tanzania	73.53	Temple, 1972
25	Bare weed removed	Tanzania	219.23	Temple, 1972
26	Maize field	Tanzania	12.0	Temple, 1972
27	Banana field with mulch	Tanzania	0.5	Temple, 1972
28	Coffee clean weeded	Tanzania	22.40	Temple, 1972
29	Island mountain with grass	Cyprus	1-8	Phanartiz,1971
30	Island mountain rocks	Cyprus	5-15	Phanartiz,1971
31	Mountains	Hungary	0.5-5	Daicon, 1971
32	Forest Agriculture	Nepal	10-15	Kindal, 1970
33	Natural forest	USSR	0.71-1.18	Khanbekov,1970
34	Severely eroded land	USSR	354-590	Khanbekov,1970
35	Forest	Senegal	0.076	Roose,1967
36	Millet	Senegal	10.34	Roose,1967
37	Cotton	Senegal	7.75	Roose,1967
38	Groundnot	Senegal	6.89	Roose,1967
39	Maize	Senegal	10.22	Roose,1967
40	Cultivated land	India, Kota	1.11-2.86	Singh et al., 1967
41	Grass	India, Kota	0.26-0.39	Singh et al., 1967
42	Cultivated fellow	India, Kota	3.49-3.72	Singh et al., 1967
43	Bare soil	Iowa	104.5-143.2	Fountier, 1967
44	Secondary forest	Iowa	0.002-2.40	Fountier, 1967
45	Manioc	Iowa	28.70-92.8	Fountier, 1967
46	Cultivation	South Africa	2-5	Schwartz and Pullen,1966
47	Highland and range	South Africa	0.15-1.7	Schwartz and Pullen,1966
48	Densely populated Mountain	South Africa	>5	Schwartz and Pullen,1966
49	Mountains	USSR Caucasus	1-5	Atlas Mira, 1964
50	Mountain	Pakistan	10.5-35	Ahamad, 1960
51	Maize	Rhodesia	7.93	Hudson, 1958
52	Napier Grass	Rhodesia	0.52-2.09	Hudson, 1958
53	Cotton	USA	15.76	Bennet, 1939
54	Kafir	USA	26.32	Bennet, 1939
55	Grass	USA	0.65-2.892	Bennet, 1939
56	Cultivation	Senegal	0.076	Roose , 1939

Source: FAO, 1994; Felmming, 1980; Graaff, 1993; Jansen, 1982; JICA/JSECE, 1996

Table A 6: Estimation of soil erosion in developing countries by continent

Region	Catchment (000km^2)	Land Area (000km^2)	Area as % of Eroded land	Estimated Erosion (000tones)	Erosion for Region (000tones)	Estimated Erosion (per/ ha/year)
Asia	7328	26,938	28	100,823, 840	364,028,420	137.6
S. America	9995	20,201	49	12,383,676	25,049,240	12.4
Africa	10082	29,662	34	5,848,460	17,205,120	5.8
Total	27,405	76263	36	119,055,976	406,282,780	53.3

Source: FAO Production Yearbook, 1980: Cited by Younis and Dragum, 1993:79

Table A 7: Soil Erosion Estimate in Nepal

Area	Soil Loss tons/ha/year	Soil Loss tons/ha/year	Soil Loss tons/ha/year	Soil Loss tons/ha/year
Triguga Watershed Udayapur and Saptari District, Churia Hill of Eastern Nepal (Sah, 1996)	By Slope Erosion 1-4 4.5- 5.8 5-10 6.3- 9.7 11-20 12.3-19.6 21-40 59.8-80.3 >40 113.8-167.5 Average 1978: 12.48 1991: 17.98	By land Use Erosion Shrubland 123.4-180.2 Degraded land 6-11 Protected Forest 1.7-2 Agricultural Land 34.6-41.2	Elevation (In MT) Erosion 75-200 7-9 201-500 4.4-7.5 501-1000 6.7-42.8 >1000 96.3-117.6	Aspect Erosion East 7.4-12.1 North east 5.2-7.9 North 3.3-4.5 North west 2.8-3.1 West 6.9-14.7 South West 20.4-27 South 16.1-26.8 Southeast 18.7-36.6
Andhikhola Watershed Shyangja District Midhill Nepal (Pahari, 1993)	By Slope Erosion 0-5 1.48 5-10 6.48 10-20 19.40 20-30 47.69 30-50 03.41 >50 186.42 Average 59.48	By land Use Erosion Primary forest 2.20 Secondary forest 15.13 Shrub lands 29.8 Agriculture land 69.72 Grazing lands 213.95	Elevation (In MT) Erosion 750-1000 34.15 1000-1250 54.60 1250-1500 78.35 1500-1750 77.16 1750-2000 66.56 2000-2500 65.55	Agricultural Land Erosion 0.5 2.36 5-10 6.59 10-20 18.17 20-30 50.63 30-50 125.92 >50 269.99
Tinahu Watershed Palpa District Low Midhill and Churia (Shrestha,1996)	Subwatershed of Tinahu Watershed 1. Kusum khola 2. Hulanggai Khola 3. Majharikhola 4. Upper Tinau Khola 5. Bhainskatta Khola 6. Sukhajor khola 7. Lower Tinahu Khola 8. Average Tinahu Watershed		Soil loss ton/ha/year 35.79 35.51 33.92 30.75 35.94 24.91 31.04 32.59	
Nepal (FSMP Soil Sub Sector, 1988) and Phewatal watershed (Labon, 1978)	Area Under use 1. Well Managed forest land 2. Well managed rice terraces 3. Well managed maize terraces 4. Poorly managed sloping terraces 5. Degraded rangelands		Sub-sector plan,1988 5-10 5-15 5-10 20-100 10-100	Phewatal Labon, 1978 5-10 5-10- 5-15 20-100 40-200
Nakkhu Khola Watershed South West of Kathmandu (Tiwari, 1990)	Area Under use 1. Forest 2. Shrubland 3. Grazing land 4. Lele Plain 5. Nallu Plain 6. Lale foothill 7. Nalu foot hill 8. Steep terraces 9. Whole watershed average		Soil Loss ton/ha/yr 5.56 42.49 173.11 16.26 13.64 25.13 64.14 73.55 44.13	Soil loss depth mm/yr 0.2 0.3 2.7 10.8 1.0 0.9 1.6 4.0 4.6
Nepal (Carson,1992)	1. Rainfed Bench terrace 2. Rainfed marginal land 3. Degraded grazing land		5.0 20.0 100.0	
Claver and Nakarmi,1995	Monitoried data in four hydormetric stations of Jhikkukhola watershed, Kavre District, Midhill Nepal		Ranges from 44-87 (between 1988-1991)	
Kulekhani Watershed (FAO,1994)	Runoff % 1985/90	Soil loss ton/ha/yr 1985/90	Runoff % 1991/92	Soil loss ton/ha/year 1991/92
Outward s. terraces	18.90	1.52	7.8	0.596
Inward s. terraces	18.90	1.35	13.20	0.800
Outward s. terraces and contour ridge	21.10	2.24	7.18	0.665
Hillside ditching	24.0	2.07	8.88	0.717

Table A 8: Watershed condition in Nepal by district

Rank	Name of District	Value	Rank	Name of District	Value	Rank	Name of District	Value
	Very Poor Class 5			**Good Class 2**			**Excellent Class 1**	
1	Surkhet	5,118	26	Ilam	1,468	51	Achham	471
2	Kavrepalanchok	4,958	27	Baitaidi	1,449	52	Kapilvastu	462
3	Dang	4,944	28	Nawalparasi	1,392	53	Solokhumbu	389
4	Okhaldhunga	4,941	29	Makwanpur	1,370	54	Sankhuwasabha	263
5	Mustang	4,824	30	Sindhuli	1,325	55	Chitwan	261
6	Shyangja	4,725	31	Sallyan	1,294	56	Dhanusha	257
7	Nuwakot	4,646	32	Panchthar	1,277	57	Bardiya	246
	Poor Class 4		33	Sindhupalanchok	1,268	58	Dadhaldhura	219
8	Kathmandu	3,627	34	Dhankuta	1,254	59	Morang	213
9	Gulmi	3,477	35	Bajhang	1,159	60	Rauswa	194
10	Arghakhanchi	3,476	36	Rolpa	1,144	61	Kailali	170
11	Bhaktpur	3,450	37	Jajarkot	1,036	62	Taplejung	157
12	Ramechhap	3,299	38	Tehrathum	1,000	63	Mugu	138
	Fair Class 3		39	Kaski	982	64	Dolkha	94
13	Parbat	2,822	40	Doti	944	65	Sunsari	93
14	Manag	2,486	41	Gorkha	934	66	Saptari	92
15	Piuthan	2,341	42	Bhojpur	929	67	Sirah	42
16	Khotang	2,261	43	Darchula	823	68	Jhapa	10
17	Myagdi	2,126	44	Kalikot	812	69	Mahottari	0
18	Palpa	2,032	45	Jumla	636	70	Sarlahi	0
19	Dolpa	1,990	46	Banke	627	71	Rautahat	0
20	Udiyapur	1,945	47	Bajura	623	72	Bara	0
21	Rukum	1,854	48	Rupandehi	575	73	Parsa	0
22	Dhading	1,765	49	Lamjung	575	74	Humla	0
23	Tanahun	1,744	50	Baglung	569	75	Kanchanpur	0
24	Lalitpur	1,695						
25	Dailekh	1,544						

NB: Low rank and higher value indicate poor watershed condition, and low value and high rank indicate better watershed condition.

Source: Shrestha, B.D., Ginnekh P.V., Sthapit, K.M. (1983) and Nelson, D., Laban, P., Shrestha, B.D., Kandel, G.P. (1980)

Definition of Watershed Class by Conditions

Nelson et al (1980) had classified the watershed into five major groups based on the extent of degradation.

Class 1- Excellent: The watershed which were near to pristine. Natural erosion processes, including land slides may present.

Class 2- Good: Minor amount of disturbances may present from land use. Productivity of the land is not impaired and correction can come through normal management practices.

Class 3- Fair: There are significant disturbances by accelerated soil erosion. Productivity of the land has been in diminishing trend. It needs a combination of education and structural measures for such watersheds.

Class 4- Poor: Disturbances by accelerated soil erosion is serious, and extension, structural and land use changes are required to upgrade the land to a productive condition.

Class 5-Very Poor: Accelerated soil erosion has break down the soil structures and productivity is significantly reduced. Rehabilitation requires structural protection and high investment to upgrade the watersheds.

Ranking of the district by watershed conditions: Based on the watershed condition defined by Nelson et al. (1980), Shrestha et al. (1983) calculated the percentage area under each categories. The percentage was multiplied by class to derive the district value.

Table A 9: List of organization/institutions surveyed

Organization	Institution/organization/department	Location	Coverage
Line agency	Agriculture Service Sub-Center	Lwang Ghalel	3 VDC
"	Veterinary Service Sub-Center	Lwang Ghalel	3 VDC
"	Agriculture Service Sub-Center	Pame Kaskikot	3 VDC
"	Veterinary Service Sub-Center	Pame Kaskikot	3 VDC
"	Agriculture Service Center	Naudanda	7 VDC
"	Agriculture Service Sub-Center	Hemja	3 VDC
"	Veterinary Service Sub-Center	Hemja	3 VDC
"	Veterinary Service Center	Naudanda	6 VDC
"	Forest Range Post	Naudanda	5 VDC
"	Forest Range Post	Hemja	4 VDC
"	Forest Range Post	Pumdi Bhumdi	3 VDC
"	Small Farmer Development Program	Lwang Ghalel	1 VDC
"	Small Farmer Development Program	Hemja	1 VDC
"	Small Farmer Development Program	Sarangkot	1 VDC
"	Women Development Sub-Office	Naudanda	3 VDC
"	Women Development Sub-Office	Chapakot	1 VDC
"	Gramin Bikash Bank Branch Office	Hemja	7 VDC
"	Agriculture Development Bank Branch Office	Naudanda	12 VDC
"	Agriculture Development Bank	New Road	District
"	Agriculture Development Bank Rural Sector	New Road	District
"	District Agriculture Development Office	Dam Side	District
"	District Agriculture Development Committee District Agricultural Program Implementation Committee	Sahidchock	District
"	District Land Administration Office	Sahidchock	District
"	District Land Survey Office	Sahidchock	District
"	District Cooperative office	Sahidchock	District
"	District Development Committee	Sahidchock	District
"	District Irrigation Office	Nadipur	District
"	District Veterinary Office	Ramghat	District
"	District Forest Office	Simpani Bagar	District
"	District Watershed Management Office	Ratnapuri	District
"	District Women Development Office	Ratnapuri	6 VDC
Association	Forest Users Group Federation, Kaski District	Taxichock	District
Joint Project	JICA/HMG Watershed Management Project	Ratnapuri	12 VDC
"	DANIDA/HMG Natural Resources Management Project	Janapriyatol	11 District
Reg. Office	Regional Soil Laboratory	Khairenitar	16 District
"	Regional Agriculture Training Center	Khairenitar	16 District
"	Regional Forestry Training Center	Dam Side	16 District
"	Agriculture Development Bank Regional Office	Nayabazar	16 District

Table A 9: Continue organizations/institutions surveyed

Organization	Name of the institution/organization	Location	Coverage
Regional off.	Agriculture Input Corporation, Zonal Office	Prithivechock	6 District
"	Soil Laboratory, LAC	Lumle	16 District
Department	Planning Department, Ministry of Land Reform	Singhadarbar	Country
"	Marketing Department, Ministry of Agriculture	Singhadarbar	Country
"	IWM Department Ministry of Forest & Soil Con.	Babarmahal	Country
"	Outreach and Soil Departments, NARC	Khumaltar	Country
Statistical Bur.	Central Bureau of Statistics, Population Section	Thapathali	Country
Research Project	Fish Breeding and Development Center	Baidam	Phewatal
Joint Project	Watershed Management Project, Site Office	Chapakot	1 VDC
Joint Project	PDDP Field Office	Dhital	1 VDC
Joint Project	PDDP Field Office	Lahachock	1 VDC
Joint Project	Pokhara Environment Improvement Project	Dam Side	Town area
Joint Project	Upper Andhokhola Watershed Management Project	Shyangja	16 VDC
NGO	Machharapuchare Development Org.	Tamagi	8 VDC
NGO	ACAP Filed Office Lwang Sector	Lwang Ghalel	7 VDC
NGO	Sarangkot Community Development Committee	Sarangkot	1 VDC
NGO	Women Environmental Development Organization	Chapakot	1 VDC
NGO	Save Phewatal	Baidam	Lakeside
NGO	Phewatal Environment and Awareness Forum	Baidam	Lakeside
NGO	Fisherman Association	Baidam	Lakeside
NGO	Women Group for Society and Environmental Improvement	Naudanda	1 VDC
Cooperatives	Naudanda Dairy Cooperative	Naudanda	2 VDC
"	Guntechour Dairy Cooperative	Kaskikot	1 VDC
"	Mardikhola Cooperative (Lwang Ghalel)	Khorkomukh	4 VDC
"	Laxmi Cooperative Naudanda	Naudanda	1 VDC
"	Kirshak Akata Women Cooperative	Hemja	1 VDC
"	Janajagrit Cooperative	Lahachock	1 VDC
Local Government	Pumdi Bhumdi VDC Office	Pumdi Pakha	-
Local Government	Bhadure Tamagi VDC Office	Tamagi	-
Local Government	Chapakot VDC Office	Bamdi	-
Local Government	Dhikurpokhari VDC Office	Naudanda	-
Local Government	Dhampus VDC Office	Deurali	-
Local Government	Dhital VDC Office	Astamdanda	-
Local Government	Hyamgja VDC Office	Pragatichock	-
Local Government	Kaskikot VDC Office	Thulipokhari	-
Local Government	Lwang Ghalel VDC Office	Lumre	-
Local Government	Lahachock VDC Office	Lahachock	-
Local Government	Rivan VDC Office	Anandathanti	-
Local Government	Sarangkot VDC Office	Thulipokhari	-

Table A 9: Continue: Discussion with key organizations/institutions surveyed

Type	Name of the institution, organization, groups, associations	Location	No.
Backed by ACAP	Conservation area Management Committees	Mardi Watershed	4
"	Mother's Group	Mardi Watershed	4
Backed by politicians	Mother's Groups	Phewatal Watershed	4
Spontaneous	Mother's Groups	Phewatal -Yamdi W.	4
Backed by Gramin Bank	Saving, Credit and Production Groups	Yamdi Watershed	2
Backed by L. Agency	Saving, Credit and Production Groups	Yamdi Watershed	5
Backed by Joint Project	Saving, Credit and Production Groups	Mardi Watershed	28
Backed by SFDP	Small Farmers Groups	In both Watersheds	15
Backed by NGOs	Crop Production Groups	Yamdi-Mardi Watershed	5
Backed by Line Agency	Crop Production Groups	Phewatal Watershed	4
"	Livestock Groups	Phewatal Watershed	2
"	Forest User Groups	Phewatal & Yamdi W.	17
Backed by NGO	Forest User Groups	Yamdi-Mardi Watershed	6
Backed by Line Agency	Water User Groups	In both watersheds	5
Spontaneous	Cooperatives	In both watersheds	6
Informal groups	Informal farmers groups during filed visit	In both watersheds	55
School Teachers	Secondary School Teachers	In both watersheds	6
NGO Executives	Machhapuchare Development Organization	Phewatal watershed	1
VDC Executives	All VDCs of the study area	In both Watersheds	12

Table A 9: Continue Interview with key informants

Name	Organization	Post
Mr. Punya P. Paudel	District Development Committee	Chairman -District Development Committee -District Agriculture Committee -District Agricultural Programs Implementation Committee -Phewatal Boundary Demarcation Committee
Mr. Tanku Giri	District Agriculture Office, Kaski	Planning Officer
Mr. Thakur P. Pradhana	District Agriculture Office, Kaski	Agriculture Development Officer
Mr. Rabindra Bataju	District Agriculture Office, Kaski	Assistant Fishery Officer
Dr. Bhaba P. Tripathi	LAC Under NARC, Lumle	Head Soil Lab Section
Mr. Govinda P. Acharya	LAC Under NARC, Lumle	Senior Agronomist
Mr. Hem P. Gautam	Land Survey Office Kaski	Survey Officer
Mr. Ram P. Shrestha	Land Administration Office, Kaski	Land Administration Officer
Mrs. Biddha Bhattachan	Women Development Office, Kaski	Women Development Officer
Dr. Krishan P. Sabkhi	Veterinary office, Kaski	Veterinary Officer
Mr. Hitraj Sharma	Veterinary office, Kaski	Assistant Planning Officer
Mr. Bharat R. Paudel	ADB Rural Sector, Kaski	Manager
Mr. Puspa Neupane	ADB, District Office, Kaski	Agricultural Loan Officer
Mr. Lilachandra Baral	ADB, Branch Office, Naudanda	Manager
Mr. Rajendra Legal	HMG/JICA Watershed M. Project	Engineer, Nepalese Counterpart
Mr. Praksah Regmi	Watershed Management Office Kaski	Watershed Management Officer
Mr. Gaganath Adhikari	Regional Soil Lab	Soil scientist
Mr. Jhapat B. Kunwar	Farmers Group, Dhikurpokhari	Chairman
Mr. Badri. P. Banskota	Forest Office, Kaski	Assistant Forest Officer
Mr. Narendra Lama	ACAP, Project Office, Lwang	Officer In-charge
Mr. Khagendra. P. Aryal	Gramin Bank Brach Off, Hemja	Manager
Mr. Ashok R.Tuladhar	Pokhara Environment Project	Consultant
Mr. Muktaman Tulachan	Regional Irrigation Office	Engineer
Mr. Rameshor Bharati	District Irrigation Office, Kaski	Irrigation Engineer
Dr. R.P Sah	LAC	Station Chief
Mr. Gajaraj Giri	Lwang Ghalel Agriculture Sub-center	Extension Worker (JT)
Mr. Sashidhar Subedi	Agriculture Service C., Naudanda	Extension Worker (JT)
Mr. Gurudutta Dahal	LAC	Extension Worker (JTA)
Ms. Kiran K.C	Agriculture Service Sub-C. Hemja	Extension Worker (JTA)
Mr. Maherman Shrestha	Hotel Association Lake Side	President
Dr. Anil Subedi	LIBIRD	Executive Director
Mr. Prem B.K.C	Forest Users Group Federation	Chairman, Kaski District
Ms. Dambar K. Gurung	Lwang Mother Group	Chairperson
Ms. Bimala Khadka	WD Field Office, Naudanda	Group Facilitator
Mr. Dibakar Paudel	Ministry of Agriculture	Joint Secretary
Mr. Nabin Ghimire	Ministry of Land Reform and Management	Under Secretary

Table A 9: Continue interview with key informants

Name	Organization	Post
Mr. Michael Ollgaard	NARAMSAP	Regional Program Advisor
Mr. Baburam Paudel	Cooperative Office, Kaski	Cooperative Officer
Mr. Birendra Adhikari	CEAPRED, Hemja	Project In-charge
Mr. Ganga. P. Khanaya	Agriculture Input Corporation	Zonal Officer
Mr. R.K. Baral	SFDP, Hemja	SFDP Officer
Ms. Ratna K. Gurung	Deurali Mother's Group, Dhampus	Chair Person
MS. Nirmal Gurung	Hotel Association, Dhampus	Executive Member
Mr. Krishan B. Gurung	-	Ex- Member of Parliament
Mr. Somnath Adhikari	-	Ex- Member of Parliament
Mr. Krishana Thapa	Pokhara Sub-Metropolitan, Pokhara	Mayer
Mr. Nar B. Gurung	CAMC Rivan VDC	Chairman
Mr. Tika B. Gurung	CAMC Lwang Ghalel VDC	Secretary
Mr. R. B. Gurung	CAMC Dhampus VDC	Chairman
Mr. Dambar Gurung	CAMC Dhampus VDC	Secretary
Mr. Narayan P. Paudel	CAMC Lahachock	Secretary
Mr. Yadav Dhital	Regional Forestry Training Center	Training Officer
Mr. Jayadev Bista	Fish Section Phewatal	Senior Research Scientist
Mr Guru P. Tripathi	Travel and Tours Agents Assoc.	Executive Member
Mr. Jhapat B. Thapa	Sarangkot VDC	Chairman
Mr. Tek B. Gurung	Pumdi Bhumdi VDC	Chairman
Mr. Gan B. Gurung	Lwang Ghalel VDC	Chairman
Mr. Bhesh R. Parajuli	Chapakot VDC	Chairman
Mr. Bhakta B. Gurung	Bhadure Tamgi VDC	Chairman
Mr. Gunga B. Sapkota	Hemja VDC	Ex VDC Chairman
Mr.Dharma R. Banstoal	Hemja VDC	Vice Chairman
Mr. Kedar N. Adhikari	Dhukurpokhari VDC	Chairman
Mr. Tkaram Lamichhane	Rivan VDC	Chairman
Mr. Liladhar Adhikari	Lahachock VDC	Chairman
Mr. Purna P. Paudel	Dhital VDC	Ex-VDC Vice Chairman
Mr. Bhubeneshor Subedi	Kaskikot VDC	Chairman
Mr. Champha S.Gurung	Dhampus VDC	Vice Chairman
Ms. Gita Aryal	WD Filed Office Chapakot	Group facilitator
Mr. Padam Shrestha	Agriculture Service Sub-service Center, Pame	Extension Worker (JT)
Mr. Buddhi B. Gurung	Lwang Ghalel, Lumre	Sheep herder

Table A10: Nutrient in/out by production functions

Nutrient in/out	Soil nutrient gain and loss by production functions	N	P	K	Total
Nutrient up take by crops	Paddy ton/kg /hectare[1]	23.7	3.4	26.3	53.4
	Maize ton/kg /hectare[1]	27.4	4.9	18.1	50.4
	Wheat ton/kg /hectare[1]	19.0	3.4	20.0	42.4
	Millet ton/kg /hectare[1]	48.3	5.0	13.3	66.6
Nutrient content	Farmyard manure % of fresh weight[2]	0.6	0.13	0.6	1.33
Nutrient content	Compost (Prepared in heap) % of fresh weight[3]	0.60	0.06	0.6	1.26
Nutrient content In green manure	*Adhatoda vasica* (Ashuro) % of fresh weight[3]	4.3	0.9	4.5	9.7
	Artemisia vulgaris (Titepati) % of fresh weight[3]	2.06	0.22	4.10	6.38
	Albizzia lebbek (Siris) % of fresh weight[3]	2.90	0.65	2.59	6.5
	Walsura trijuga (Ankhitare) % of fresh weight[3]	2.57	0.04	1.2	3.81
	Sesbania sp (Dhaincha) % of fresh weight[3]	1.48	0.29	2.04	3.81
	Sapium insigue (Khiro) % of fresh weight[3]	2.99	0.37	2.31	5.67
	Azolla pinnata (Azolla) % of fresh weight[3]	4.5	1.60	1.0	7.1
	Euplatorium adenophorium (Banmara) % of fresh weight[3]	2.36	0.76	3.89	7.1
	Helianthus sp (Taramandal) % of fresh weight[3]	4.96	0.87	5.23	11.1
	Oilseed cake % of fresh weight basis[4]	6.90	3.10	1.60	11.6
	Household ash % of fresh weight basis[4]	1.20	0.60	7.15	8.95
Nutrient content mineral fertilizer	Urea % of fresh weigh[4]	46.6	0	0	46.6
	Diammonium phosphate (DAP) % of fresh weigh[4]	18	23.5	48	89.5

Source: 1.Tandon and Kimmo, 1993, White 1979, 3. Subedi and Gurung, 1991, 4. Joshi and Khatiwada, 1986

Table A 11: Mean monthly temperature of the study area (1977-1997)

(Mean temperature in 0^0 c)

Months	Pokhara Airport (827 m. amsl)	Malepatan (856 m. amsl)	Lumle (1740 m. amsl)
January	13.1	12.97	8.77
February	15.1	14.97	10.21
March	19.2	19.40	14.19
April	22.33	22.29	17.43
May	24.00	24.35	18.46
June	25.57	25.90	19.90
July	25.75	26.23	20.15
August	25.95	26.40	20.20
September	24.76	24.35	18.96
October	21.58	21.21	16.90
November	17.73	17.99	13.79
December	14.1	14.13	10.67
Annual mean	20.75*	20.53*	15.75*

Source: Computed from raw data of the Department of Hydrology and Meteorology, Narayani Basin Office Pokhara

NB: * Significantly different at 0.001 confidence level (F test, $P \leq 0.01$)

Table A 12: Mean monthly rainfall of the study area (1977-1997)

(Rainfall in mm)

Months	Pokhara Airport (827 m)	Malepatan (856 m)	Lamachour (1070 m)	Bhadure (1600 m)	Lumle (1740 m)	Ghandruk (1960)
	Year 1977-1997	1977-1997	1981-1997	1987-1997	1977-1997	1977-1994
January	25	19	27	27	36	26
February	35	37	30	37	48	59
March	63	63	82	50	65	70
April	115	105	98	75	98	106
May	323	302	326	321	300	180
June	655	629	817	630	840	478
July	943	918	1061	1084	1430	872
August	810	789	973	944	1371	869
September	639	594	737	570	807	426
October	148	138	140	117	176	115
November	21	23	19	31	34	25
December	34	28	30	30	32	32
Annual	3,811*	3,645*	4,340*	3,916	5,237*	3,258*

Source: Computed from raw data of the Department of Hydrology and Meteorology Narayani Basin Office, Pokhara

NB: * Means in row are significantly different at 0.001 confidence level (F Test, $p \leq 0.01$)

Table A 13: Age of the respondents

Age groups	Project Area (N=155)						Non-project Area (N=145					
	Male		Female		Total		Male		Female		Total	
	n	f'	n	f'	n	f'	n	f'	n	f'	n	f'
Young (15-35)	18	11	12	8	30	19	25	17	9	6	34	23
Adult (36-59)	71	46	14	9	85	55	56	39	14	9	70	48
Old (60 and above)	37	24	3	2	40	26	33	23	8	6	41	29
Total	126	81	29	19	155	100	114	79	31	21	145	100
Mean age	51	-	41	-	49	-	49	-	45	-	48	-

Source: Household survey, 1999

NB: N= Sample size, n= number of respondents, f'= proportion of n

Table A 14: Ethnicity of the respondent

Ethnicity	Project Area (N=155)						Non-project Area (N=145					
	Male		Female		Total		Male		Female		Total	
	n	f'	n	f'	n	f'	n	f'	n	f'	n	f'
Brahmin	52	34	8	5	60	39	39	27	9	6	48	33
Chhetri	23	15	10	6	33	21	31	21	7	5	38	26
Gurung/Magar	13	8	3	2	16	10	21	25	12	8	33	23
Occupational cast	34	22	6	4	40	26	16	11	1	1	17	12
Others	4	3	2	1	6	4	7	5	2	1	9	6
Total	126	81	29	19	155	100	114	79	31	21	145	100

Source: Household survey, 1999

NB: N= Sample size, n= number of respondents, f'= proportion of n

Table A 15: Educational status of the respondent

Educational status of the respondent	Project Area (N=155)						Non-project Area (N=145					
	Male		Female		Total		Male		Female		Total	
	n	f'	n	f'	n	f'	n	f'	n	f'	n	f'
Illiterate	20	13	12	8	32	21	22	15	11	8	33	23
Literate	78	48	14	9	89	57	54	37	18	12	75	49
School education	17	11	3	2	20	13	18	13	2	1	20	14
Higher education	14	9	0	0	14	9	20	14	0	0	20	14
Total	126	81	29	19	155	100	114	79	31	21	145	100

Source: Household survey, 1999
NB: N= Sample size, n= number of respondents, f'= proportion of n

Table A 16: Dependent and independent population in surveyed households

Active and inactive population	Project Area (N=155)						Non-project Area (N=145					
	Male		Female		Total		Male		Female		Total	
	n	f'	n	f'	n	f'	n	f'	n	f'	n	f'
Dependent below 10	140	14	129	12	269	26	119	13	111	11	230	24
Dependent 60 and above	42	4	31	3	73	7	43	5	43	4	86	9
Partially active 11-15	90	9	68	6	158	15	82	9	67	7	149	16
Active 16-59 years	268	25	279	27	547	52	239	26	244	25	483	51
Total	540	52	507	48	1,047	100	483	53	465	47	948	100

Source: Household survey, 1999
NB: N= Sample size, n = total population in surveyed households, f'= proportion of n

Table A 17: Distention of migrants

Destination	Project Area			Non-project Area		
	No of migrants	% of total labor force aged 11-59	% of migrants	No of migrants	% of total labor force aged 11-59	% of migrants
In country	11	1.5	11	23	3.6	22.5
India	33	4.7	33	26	4.0	25.5
Europe/America	3	0.6	3	6	1.0	5.8
South East Asia	10	1.5	10	10	1.6	9.8
Arabian countries	43	6.2	43	37	5.8	36.4
Total	100	14.5	100	102	16	100

Source: Household survey, 1999

Table A 18: Land ownership by farm category

(Average land ownership ropani/household)

Land Type	Project Area (N=155)				Non-project Area (N=145)			
	Marginal	Medium	Large	Total	Marginal	Medium	Large	Total
	f'= (35)	f'= (30)	f'= (35)	100	f'= (23)	f'= (29)	f'= (48)	100
Phantkhet	0.1	1.3	2.6	1.3	0.9	2.3	6.1	3.8
Tarikhet	1.2	6.6	16.9	8.4	1.9	4.4	10.1	6.4
Bari	0.2	1.9	2.1	1.1	0.6	1.8	3.5	2.3
Gharbari	1.2	0.8	2.9	2.0	1.3	1.7	2.5	2.0
Kharbari	0.2	1.0	3.7	1.7	0.3	1.3	3.2	2.0
Jangle	0	0.2	0.9	0.4	0.1	0.2	1.9	1.0
Total mean	2.9*	11.8*	29.1*	14.8	4.4*	11.7*	27.4*	17.6

Source: Household survey, 1999: f'= proportion of N
NB: * Means in row within the groups in both areas are significantly different at 0.01 confidence level (F test, P≤0.01).

Table A 19: Land ownership by ethnicity

(Average land ownership in ropani/household)

Area	Ethnicity	f'	Phantkhet	Tarikhet	Gharbari	Bari	Kharbari	Jungle	Mean
Project area (N=155)	Brahmin	39	1.7	12.8	6.9	1.3	2.9	0.5	26.1*
	Chhetri	21	0.6	6.5	1.7	1.4	0.5	0.2	10.9*
	Gurung-Magar	10	4.0	10.8	2.7	1.6	2.5	0.7	22.3*
	Occupational cast	26	0.3	2.7	1.4	0.2	0.5	0.2	5.3*
	Minority groups	4.0	1.7	5.4	1.2	0.5	2.3	0.0	11.1*
	Mean	100	1.3	8.4	2.0	1.0	1.7	0.4	14.8
Non-project area (N=155)	Brahmin	33	4.9	6.4	2.0	2.1	2.8	1.5	19.7*
	Chhetri	26	5.3	5.8	2.6	4.5	3.3	0.7	22.2*
	Gurung-Magar	23	3.1	8.2	1.2	4.1	0.5	1.2	18.3*
	Occupational cast	12	0.9	1.6	1.1	0.6	0.2	0.2	4.6*
	Others	6.0	0.2	6.8	2.0	1.1	0.6	0.6	11.3*
	Mean	100	3.8	6.4	2.0	2.3	2.0	1.0	17.5

Source: Household survey, 1999

NB: f'= proportion of N

* Means in last column within ethnic groups are significantly different at 0.01 confidence level (F Test, P≤0.01)

Table A 20: Land ownership by surveyed village

(Average land ownership ropani/household)

Area	Village	f'	Phantkhet	Tarikhet	Gharbari	Bari	Kharbari	Jangle	Mean
Project area (N=155)	Tamagi	15	0	6.0	2.2	0.9	1.6	0.5	11.2*
	Barang	13	2.4	11.6	2.0	0.6	2.8	0.2	19.6*
	Pamdur	28	2.0	13.7	2.2	1.7	3.2	0.4	23.2*
	Kotmuni	22	0.9	4.5	1.6	0.3	0.4	0.3	8.0*
	Pandeli	18	0.7	5.6	1.7	1.5	0.5	0.2	10.2*
	Anadu	4.0	4.2	2.8	2.3	0.5	0.1	0.9	10.8*
	Total	100	1.3	8.4	2.0	1.0	1.7	0.4	14.8
Non-project area (N=145)	Suikhet	30	5.0	3.0	1.9	1.7	2.1	0.2	13.9*
	Dhand	10	0.0	16.5	1.6	2.1	1.9	0.2	22.3*
	Dhital	14	0.6	8.8	3.2	1.9	3.9	2.3	20.7*
	Lwang	23	1.9	8.0	1.2	3.9	0.4	0.7	16.1*
	Charem	8.0	7.3	8.3	1.3	3.8	1.4	1.5	23.6*
	Lahachock	15	8.2	0.5	3.0	1.1	2.6	2.1	17.5*
	Mean	100	3.8	6.4	2.0	2.3	2.0	1.0	17.6

Source: Household survey, 1999

f'= proportion of N

* Means in last column within surveyed villages in both areas are significantly different at 0.01 confidence level (F Test, P≤0.01)

Table A 21: Food grain production by farm category

(Average production in kg/household/year)

Farm category	Project Area (N=155)						Non-project Area (N=145)					
	f'	Paddy	Wheat	Maize	Millet	Total mean	f'	Paddy	Wheat	Maize	Millet	Total mean
Marginal	35	122	88	101	108	419*	23	310	69	139	101	619*
Medium	30	814	137	202	187	1,340*	29	749	158	265	173	1,345*
Large	35	1,980	271	315	302	2,868*	48	1,800	176	372	281	2,629*
Mean	100	986	233	208	202	1,629	100	1,159	145	284	202	1,790

Source: Household survey, 1999

f'= proportion of N

NB: Means in column within farm size in both areas are significantly different at 0.01 confidence level (F Test, P≤0.01)

Table A 22: Food grain production by ethnicity

(Average production in kg/household/year)

Ethnicity	Project Area (N=155)						Non-project Area (N=145)					
	f'	Paddy	Wheat	Maize	Millet	Total	f'	Paddy	Wheat	Maize	Millet	Total
Brahmin	39	1,505	252	271	252	2,280*	33	1,440	158	346	216	2,160*
Chhetri	21	684	120	183	187	1,174*	26	1,426	221	328	187	2,162*
Gurung/M	10	1,548	151	227	223	2,149*	23	878	69	227	238	1,412*
Occ. cast	26	266	101	120	144	631*	12	569	76	189	194	1,028*
Others	4.0	778	139	195	187	1,112*	6.0	583	189	164	194	1,130*
Total	100	986	233	208	202	1,629	100	1,159	145	284	202	1,790

Source: Household survey, 1999

f'= proportion of N

NB: Means in column within ethnic groups in both areas are significantly different at 0.01 confidence level (F Test, P≤0.01)

Table A 23: Food balance by farm category

Farm category	Project Area (N=155)					Non-project Area (N=145)				
		Subsistence	Deficit	Surplus	Total	n	Subsistence	Deficit	Surplus	Total
	n	f'	f'	f'	f'		f'	f'	f'	f'
Marginal farmers	54	-	99	1	100	33	6	85	9	100
Medium farmer	46	15	67	18	100	42	12	79	9	100
Large farmer	55	16	35	49	100	70	23	39	38	100
Total	155	10	67	23	100	145	16	61	23	100

Source: Household survey, 1999

NB: n= sub-sample, f'= proportion of n

Table A 24: Production of non-cereal crops

(Average production kg/household/year)

Type	Project Area (N=155)	Non-project Area (N=145)
Vegetable	119*	317*
Potato	67	66
Garlic, ginger, onion	13*	20*
Lentils	4	2
Tree fruits (Orange, lemon, banana, pears etc)	77	87
Total	280*	492*

Source: Household survey, 1999

NB: * significantly different at 0.001 confidence level (T Test, P≤0.01)

Table A25: Balance of non-cereal crops by farm category

(Average kg/household/year)

Farm category	Project Area (N=155)						Non-project Area (N=145)					
	f'	Pro.	Con.	sale	Pur.	Balance	f'	Pro.	Con.	Sale	Pur.	Balance
Marginal farmers	35	167	218	51	102	-50	23	371	248	161	38	123
Medium farmer	30	261	283	38	60	-22	29	370	284	132	46	86
Large farmer	35	406	398	99	91	-8	48	623	499	185	61	124
Mean	100	280	301	64	85	-21	100	492	379	164	51	113

Source: Household survey, 1999

f'= proportion of N

Table A 26: Balance of non-cereal crops by ethnicity

(Average kg/household/year)

	Project Area (N=155)						Non-project Area (N=145)					
Ethnicity	f'	Prod.	Con.	Sale	Pur.	Balance	f'	Pro.	Con.	sale	Pur.	Balance
Brahmin	39	276	311	52	87	-35	33	541	404	170	33	137
Chhetri	21	335	320	64	49	15	26	617	410	239	32	207
Gurung/Magar	10	404	392	97	85	12	23	247	350	5	108	-103
Occu. cast group	26	209	250	77	118	-41	12	557	365	226	34	192
Minority groups	4	145	195	4	50	-50	6	480	259	273	52	221
Mean	100	280	301	64	85	-21	100	492	379	164	51	113

Source: Household survey, 1999
f'= proportion of N

Table A 27: Average annual household income by sources

(Average income Rs Household)

Sources		Project area (N=155)			Non-project Area (N=145)		
		f'	Rs	% contribution	f'	Rs	% contribution
Farm sources	Livestock	61	8,709	9.0	54	8,216	5.0
	Food crops	28	9,544	4.0	32	6,818	3.0
	Fruits and cash crops	6.0	17,600 *	0.3	13	7,910 *	2.0
	Vegetables	9.0	1,893 *	2.0	26	5,218 *	1.0
	Mean	100	9,292	15.3	100	8,951	11
Off-farm source	Business	9.0	31,700	4.0	8	18,400	2.0
	Monthly salary	19	38,172	11	28	43,638	14
	Small scale industry	14	16,767	3.7	14	17,125	3.0
	Seasonal labor	22	18,781 *	7.0	13	11,353 *	2.0
	Interest and bonus	8.0	21,250	2.0	17	25,064	1.0
	Tourism	3.0	29,400	3.0	3	27,000	2.0
	Mean	100	19,111	30.7	100	19,742	24
Remittances	Wage	36	86,541 *	50	31	161,956*	60
	Pension	12	23,218	4.0	17	25,064	5.0
	Mean	100	33,963	54	100	54,583	65
Total mean			62,366			83,276	

Source: Household survey, 1999
f' proportion of N
NB: *Significantly different at 0.05 confidence level (T Test, P≤0.05)

Table A 28: Average annual income by source

Rs/household

Source of income	Project Area (N=155)		Non-project Area (N=145)	
	f'	Income	f'	Income
Only farm source	11	21,817	14	17,540
Only off farm source	19	38,212	10	30,387
Only remittance	11	105,223	14	244,952
Farm and off farm source	27	37,806	28	42,256
Off farm and remittance	5	118,112	14	69,890
Farm and remittance	19	75,622	12	105,175
Farm, off farm and remittance	8	133,125	8	105,092
Total mean	100	62,366	100	83,276

Source: Household survey, 1999
f'= proportion of N

Table A 29: Average annual income by ethnic groups

Rs household

Ethnic groups	Project Area (N=155)				Non-project Area (N=145)			
	Farm	Off-farm	Remittance	Total	Farm	Off-farm	Remittance	Total
Brahmin	16,174	22,056	25,230	63,461 *	13,911	18,121	19,004	51,036 *
Chhetri	6,363	10,067	26,933	43,363	12,075	26,979	12,505	51,559
Gurung/Magar	5,350	14,419	78,625	98,394 *	1,092	16,121	186,800	204,013*
Occupational C.	3,819	22,084	40,091	65,994 *	4,488	15,500	12,871	32,859 *
Others	3,583	32,100	0.0	35,680	6,550	19,111	16,000	41,661
Mean	9,292	19,111	33,963	62,366	8,951	19,742	54,583	83,276

Source: Household survey, 1999

NB: *Significantly different at 0.05 confidence level (T Test, P≤0.05)

Table A 30: Average annual income in surveyed village

Rs/ household

Ethnic groups	Project Area (N=155)				Non-project Area (N=145)				
	Farm	Off-farm	Remittance	Total	Village	Farm	Off-farm	Remittance	Total
Tamagi	3,388	14,183	77,568	95,139	Suikhet	14,023	27,865	14,488	56,376
Barang	10,350	28,730	21,500	60,580	Dhand	7,723	6,295	18,000	32,018
Pamdur	15,543	16,692	43,763	75,998	Dhital	7,048	26,471	7,676	41,195
Kotmuni	9,309	27,533	5,441	42,103	Lwang	970	16,697	126,406	144,073
Pandeli	5,685	9,114	22,850	37,649	Charam	9,495	4,273	213,363	227,131
Anadu	1,317	24,050	44,333	69,700	Lahachock	13,388	18,909	15,545	47,842
Mean	9,292	19,111	33,963	62,366	Mean	8,951	19,742	54,583	83,276

Source: Household survey, 1999

NB: Means within surveyed villages are significantly different at 0.05 confidence level (F Test, p<0.05)

Table A 31: Accessibility to market center

Project Area (Mean distance in km)				Non-project Area (Mean distance in km)			
Name of VDC	No of Hamlet	Distance to market	Nearest road head	Name of VDC	No of hamlet	Distance to market	Nearest road head
Bhadure Tamagi	53	13	5.4	Hemja	37	2	0.3
Chapakot	26	11	3.2	Dhampus	48	11	4.4
Dhikurpokhari	57	27	2.5	Dhikurpokhari	6	12	1.8
Kaskikot	60	20	3.9	Kaskikot	1	21	2.5
Sarangkot	39	5	1.5	Dhital	45	7	3.0
Pumdi Bhumdi	10	13	6.3	Lwang Ghalel	39	20	7.2
Pokhara Baidam	1	0	0	Rivan	13	11	1.7
Total	246	16.4*	3.5	Lahachock	23	5	1.5
				Total	212	10 *	3.6

Source: Household survey, 1999

NB: Average walking distance is 3.7 km /hour

Table A 32: Annual average household expenditure on food grains by farm category

(Rs/ household)

	Project Area (N=155)			Non-project Area (N=145)		
Farm category	f'	Expenditure	% of income	f'	Expenditure	% of income
Marginal farmers	35	13,354	30	23	11,181	23
Medium farmers	30	7,514	12	29	7,837	10
Large farmers	35	6,061	8	48	4,776	5
Mean	100	9,033	15	100	7,120	9

Source: Household survey, 1999

f' = proportion of N

Table A 33: Annual average expenditure in food grains by ethnicity

Rs household

	Project Area (N=155)			Non-project Area (N=145)		
Ethnicity	f'	Expenditure	% of income	f'	Expenditure	% of income
Brahmin	39	5,229	8.0	33	4,772	9.0
Chhetri	21	11,309	26	26	5,827	11
Gurung/Magar	10	8,581	9.0	23	7,663	5.0
Occupational cast	26	13,097	20	12	8,724	27
Minority groups	4.0	8,672	24	6	20,085	48
Total	100	9,033	15	100	7,120	100

Source: Household survey, 1999
f'= proportion of N

Table A 34: Annual average labor input for livestock raising

	Project Area (N=155)						Non-project Area (N=145)					
Type	f'	Herd size	Man days	Woman days	Total days	Minutes day/head	f'	Herd size	Man days	Woman days	Total Days	Minutes day/head
Buffalo	86	2.0	28	111	139	92	88	2.0	39	94	133	88
Cattle	37	2.3	19	41	60	35	39	1.5	29	39	68	60
Goat/sheep	47	3.3	11	36	47	19	34	3.2	19	44	63	26
Pig	2.0	10	4	12	16	3	3	2.2	4	22	26	9
Mean	90	4.3	41	142	183	50	92	3.6	57	126	183	62

Source: Household survey, 1999
f'= proportion of N

Table A 35: Annual average labor input for livestock raising by farm category

	Project Area (N=155)						Non-project Area (N=145)					
Farm category	f'	Herd size	Man days	Women days	Total days	Minutes day/head	f'	Herd size	Man days	Women days	Total Days	Minutes day/head
Marginal	27	2.5	22	111	133	70	17	2.6	19	106	125	63
Medium	30	5.5	38	147	185	44	28	2.9	48	120	160	73
Large	33	6.8	58	165	223	43	47	4.9	77	141	218	59
Total	90	4.3	41	142	183	50	92	3.6	57	126	183	62

Source: Household survey, 1999
f'= proportion of N

Table A 36: Annual average milk production by ethnicity

(in liter)

Ethnicity	Project Area (N=155)					Non-project Area (N=145)				
	f'	Production	Conumption	Converted to butter	Sold	f'	Production	Consumption	Converted to butter	sold
Brahmin	39	658	118	273	267	33	1112	269	629	214
Chhetri	21	539	137	318	84	26	984	246	575	163
Gurung/Magar	10	407	118	276	13	23	475	142	333	-
Occu. cast	26	327	88	203	36	12	195	58	137	-
Others	4.0	497	266	114	117	6.0	200	43	101	56
Total	100	515*	113*	265*	137	100	770*	196*	457*	117*

Source: Household survey, 1999
f'= proportion of N
NB: *Significantly different at 0.01 confidence level (T Test, P ≤0.01)

Table A 37: Annual average production and consumption of butter and mustard oil

(In kg)

	Project Area (N=155)					Non-project Area (N=145)				
Type	Prod.	Con.	Sale	Purchase	Balance	Prod.	Con.	sale	Purchase	Balance
Butter	11	10	1	-	1	18	15	3	-	+3
	4	12	-	8	-8	3	11	-	8	-8
Total	15*	22*	1	8	-7	21*	26*	3	8	-5

Source: Household survey, 19999

NB: Significantly different at 0.05 confidence level (T test, P≤ 0.05)

Table A.38: Per capita calorie intake

Per capita kilocalorie/day

Farm category	Project Area (N=155)		Non-project Area (N=145)	
	f'	Calorie intake	f'	Calorie intake
Marginal farmers	35	1,453*	23	1,575*
Medium farmers	30	2,398*	29	2,558*
Large farmers	35	3,395*	48	3,710*
Mean	100	2,416	100	2,879

Source: Household survey, 1999.

NB: f' proportion of N

Calculated based on Table 4.4, 4.5, 4.8 and A 39

* Means in column within farm size in both areas significantly different at 0.05 confidence level (F test, P≤ 0.05)

Table A:39 Food value of different edible food items

(Nutrient per 100 grams of edible protein)

S.NO	Main edible items	Calorie	S.NO	Main edible items	Calorie
1	Barley	336	52	Pineapple	46
2	Buckwheat	323	53	Cardamom	229
3	Biscuit sweet	450	54	Carrot	48
4	Biscuits salt	534	55	Colocasisa	97
5	Bread white	245	56	Onion big	50
6	Maize dry	342	57	Onion small	59
7	Maize tender	125	58	Potato	97
8	Millet (Varagu)	309	59	Radish pink	32
9	Papad	288	60	Radish white	17
10	Rice parboiled milled	346	61	Sweet potato	120
11	Rice raw milled	345	62	Turnip	29
12	Rice flake	346	63	Yam elephant	79
13	Rice puffed	325	64	Yam wild	110
14	Ragi Millet	328	65	Yam ordinary	111
15	Suji	348	66	Bitter gourd	25
16	Vermicell	352	67	Bottle gourd	12
17	Wheat whole	346	68	Brinjal	24
18	Wheat flour whole	341	69	Broad beans	48
19	Wheat flour refined	348	70	Cauliflower	30
20	Bengal gram whole	360	71	Cho Cho Marrow	27
21	Bengal gram dal	372	72	Cucumber	13
22	Black gram dal	347	73	Cow pea pods	48
23	Cow pea	323	74	Drumstick	26
24	Field bean dry	347	75	French bean	26
25	Green gram whole	334	76	Giant chilies	24
26	Green gram dal	348	77	Knol-khol	21
27	Horse gram	321	78	Ladies finger	35
28	Kheseri dal	345	79	Peas	93
29	Lentil	343	80	Parwar	20
30	Peas dry	315	81	Pumpkin	25
31	French bean	346	82	Tomato ripe	20
32	Red gram (pigeon pea)	335	83	Tomato green	23
33	Soybean	432	84	Mustard seeds	541
34	Amaranth tender	45	85	Sun flower seed	620
35	Bamboo tender shoot	43	86	Ground nut	567
36	Cabbage	27	87	Sowed bean	44
37	Colocasia leaves	56	88	Garlic dry	145
38	Coriander leaves	44	89	Ginger fresh	67
39	Fungreek levels	49	90	Fish bam	100
40	Giria sag	26	91	Fish Katla	111
41	Ipomea leaves	28	92	Fish Hilsa	273
42	Mustard leaves	34	93	Rahu	97
43	Pumpkin leaves	57	94	Milk	496
44	Radish leaves	28	95	Butter	900
45	Rape leaves	48	96	Egg one Chicken	173
46	Spinach	26	97	Egg one duck	181
47	Turnip green	47	98	Mustard oil	900
48	Lemon	57	99	Honey	319
49	Apple	59	100	Meat	1700*
50	Guava country	51	101	Pigeon	137
51	Jack fruit	88	102	Pork muscle	114

Source: DA (1996) and * Regmi, 1999

Table A 40: Cropped area under local and high yielding variety

(Cropped area in hectare)

Crops	Project Area				Non-project Area (N=145)			
	Cropped area	% of total cropped area	% of area under local varieties	% of area under HYVs	Cropped area	% of total cropped area	% of area under local varieties	% of area under HYVs
Rice	76.7	47	49	51	75.7	42.4	76	24
Maize	25.8	15.8	12	88	41.8	23.4	80	20
Wheat	25.6	15.7	10	90	24.6	13.8	14	86
Millet	21.6	13.3	100	0.0	25.9	14.5	100	0.0
Vegetable	4.7	2.9	72	28	5.2	2.9	54	46
Mustard	5.0	3.1	100	0.0	1.5	0.8	100	0.0
Other cash crops	3.6	2.2	30	70	3.8	2.2	68	32
Total	163	100	46	54	178.5	100	71	29

Source: Household survey, 1999

NB: The area was counted according to number of crops in a year in same land

Table A 41: Change in HYV adoption

Crops	Project Area (N=155)				Non-project Area (N=145)			
	1975	1985	1995	1998	1975	1985	1995	1998
	f'	f'	f'	f'	f'	f'	f'	f'
Wheat	6	59	67	70	3	30	35	41
Maize	6	70	77	85	-	7	15	25
Paddy	2	42	52	53	-	7	10	15

Source: Household survey, 1999

f' = proportion of N

Table A 42: Extension of local crop species after adoption of HYV

(Number of species)

Crops	Project Area					Non-Project Area				
	Current species			Threatened local species	Extinct local species	Currently existent			Threatened local species	Extinct local species
	HYV	Local	Total			HYV	Local	Total		
Rice	5	21	26	7	8	5	28	34	8	4
Maize	4	5	9	4	2	5	7	12	4	3
Millet	1	12	13	6	4	1	19	20	8	3
Wheat	3	1	4	1	2	4	1	5	1	2
Potato	4	3	7	2	1	4	3	7	3	2
Beans	7	6	13	2	1	4	7	11	2	1
Vegetable	20	47	67	13	4	25	40	65	15	6
Total	44	95	139	35	22	48	105	153	41	21

Source: Household survey, 1999

Table A. 43: Conversion of forest and grazing land into private farmland

(Labor workdays and cash /hectare)

Converted land between 1975-1998	Project Area (N=155)				Non-project Area (N=145)			
	f'	Area	Labor	Cash	f'	Area	Labor	Cash
Phantkhet converted from flood area	2	0.3	373	37,728	4	1.0	413	34,938
Tarikhet converted from forest/ grazing land	6	0.4	648	49,125	9	1.2	609	67,714
Bari converted from forest/ grazing land	6	0.4	236	61,485	3	0.4	629	32,285
Gharbari converted from grazing land	10	0.7	472	74,552	2	0.2	432	24,562
Kharbari converted from forest/grazing land	6	1.8	197	11,790	-	-	-	-
Total	30	3.6	472	29,612	18	2.8	531	49,341

Source: Household survey, 1999

f'= Proportion of N

Converted land constitutes about 4 percent of the total farmland in the project area and 3 percent in the non-project area

Table A 44 Farmers' ranking the land management problem

Problems	Project Area (N=155)			Non-project Area (N=145)		
	f'	Relative index value	Rank	f'	Relative index value	Rank
Decreasing soil fertility	78	0.019	I	93	0.023	I
Top soil erosion	83	0.025	II	86	0.024	II
Small holding	75	0.025	II	79	0.028	IV
Inadequate irrigation facility	40	0.026	III	88	0.025	III
Land fragmentation	75	0.027	IV	67	0.024	II
Stray livestock and wild animals	41	0.028	V	68	0.044	VII
Labor shortage	61	0.028	V	65	0.041	VI
Inadequate input services	41	0.029	VI	56	0.048	IX
Insecure land tenure	40	0.031	VII	55	0.033	V
Expansion of gullies	60	0.032	VIII	56	0.045	VIII

Source: Household survey, 1999

f' Proportion of N

Lower the index value more severe the problem

Table A 45: Landslide history in Phewatal Watershed

Name of VDC	Name of Landslide	Active since		Soil Type	Aspect	Destruction	Current status and management practices
		AD	BS				
Bhadure Tamagi VDC ward No.4	Harpan Landslide	2014	1957	Red	South	Destroyed 300-400 *ropani* of farmland, heavy siltation in valley floor and Phewatal and smashed large are of farmland along Harpan *Khola*	Stabilized by The Phewatal Watershed Management Project through check dam, fencing and plantation
Chapakot VDC between ward 3-4	Bamdi Landslide	1990	1933	Red	East	Destroyed 672 *ropani* of farmland, threatened 20 houses in 1953 and smashed 2 houses in 1999, silt deposition in Phewatal and side cutting along Harpan khola due to heavy load	Ever active along the Bamdi *Khola* and partly stabilized through fencing and plantation by the Phewatal Watershed Management Project
Chapakot VDC Ward No. 3	Puranogaunko landslide	1998	2056	Kamere	North east	Cracked 200 *ropani* of farmland and threatened for 20 houses of Magarhaun village and 25 houses of Chapakot village.	Strongly active and efforts of local people are insufficient to stabilize
Chapakot VDC Ward No. 3	Kharikhola landslide	1933	1990	Kamare	North east	Destroyed 200 *ropani* of farmland land, lost one life and washout both sides of the torrent route	Stabilized from 1975 to 1985 through construction of check dams and plantation by the Phewatal Watershed Management Project. It is reactive again from other side.
Chapakot VDC Ward No. 3	Nirmane Kalimati landslide	1997	2054	Red	North east	Destroyed 12 *ropani* of farmland and threatened 30 houses	Active during summer monsoon
Dhikurpokhari VDC Ward No.8	Pamdur landslide	1933	1990	Red	South	Destroyed 100 ropani of farmland, 700 *ropani* of forest and grazing land. Moved out 4 houses and heavy siltation in the northern fringe of Phewatal.	Stabilized by the Phewatal Watershed Management Project through, check dams, fencing and plantation. It is active again along Andheri Khola after construction of Kande-Salyan link road as an effect of sliding soil during its construction.
Dhikurpokhari VDC between Ward No.5-7	Thulabensi landslide	1933	1990	Kamere	South west	Destroyed 50 ropani of farmland and formed large gully in the farmland	Active during summer monsoon. Farmers have planted shrub along gully to stabilize its occurance.

Continue landslide history in Phewatal Watershed

Name of VDC	Name of Land slide	Active since		Soil Type	Aspect	Destruction	Current status and management practices
		AD	BS				
Dhikurpokhari VDC Ward No.1	Bhalkola landslide	1833	1890	Kamare	West	Washed out 100 *ropani* of farmland along its root and destroyed 500 *ropani* of farmland in the valley floor	Partly stabilized by the Phewatal Watershed Management Project through, check dams, fencing and plantation and partly it is active.
Dhikurpokhari VDC between ward No. 1-2	Thulikhola Bhunikhola Surekhola	1948	2005	Red	West	Destroyed 500 *ropani* of farmland in hill slope and valley floor	Major part is stabilized by the Phewatal Watershed Management Project through, check dams, fencing and plantation. Minor part it is still active.
Kaskikot VDC between ward No. 7-8	Smaili landslide	1833	1890	Kamere	South west	Destroyed 400 *ropani* of farmland in hill slope and valley floor, destroyed 20 houses and people migrated in *tarai* and formed a large gully in the farmland	Major part is stabilized by the Phewatal Watershed Management Project through, check dams, fencing and plantation. Minor part it is still active.
Kaskikot VDC	Laurk landslide	1849	1907	Kamere	South west	Destroyed 1000 *ropani* of farmland during consecutive years. Moved out 4 households to another villages.	Major part is stabilized by Watershed Management Project through, check dams, fencing and plantation. Minor part it is still active.
Between Kaskikot and Dhikurpokhari VDC	Sandikhola landslide	1933	1990	Red	South west	Destroyed 400 *ropani* of farmland during consecutive years. Threatened 18 houses moved to other villages.	Stabilized by The Phewatal Watershed Management Project through, check dams, fencing and plantation
Kaskikot VDC Ward No.8	Mandredhunga landslide	1997	2054	Balute gagren	South west	Destroyed 100 *ropani* of farmland and cracked 3000 *ropani* of other land. A total of 40 houses were made vulnerable and they were suggested for resettlement	It is active and the government does not introduce any controlling measures and local efforts are not sufficient.
Sarangkot VDC Ward No. 6	Meathlang landslide	1957	2014	Red	West	Smashed 200 *ropani* of farmland, destroyed 2 houses, and killed 2 people.	Stabilized by the Phewatal Watershed Management Project through, check dams and plantation

Continue landslide history in Phewatal Watershed

Name of VDC	Name of Land slide	Active since		Soil Type	Aspect	Destruction	Current status and management practices
		AD	BS				
Sarangkot VDC ward No. 7	Mulabari landslide	1983	2040	Kamere	South west	Destroyed 120 *ropani* of farmland and forest.	Stabilized by the Phewatal Watershed Management Project through, check dams and plantation
Sarangkot VDC ward No. 7	Paireshaunra landslide	1983	2040	Kamere	South west	Destroyed 80 *ropani* of farmland and forest.	Stabilized by Watershed Management Project through, check dams and plantation
Sarangkot VDC ward No.4	Kahare landslide	1933	1990	Balaute	South west	Destroyed 40 *ropani* of farmland and forest.	Stabilized by the Phewatal Watershed Management Project through, check dams and plantation
Sarangkot VDC ward No.2	Kanchock landslide	1998	2056	Red	South west	Destroyed 10 *ropani* of farmland and forest.	Active during summer monsoon
Pumdi Bhumdi VDC ward No.1	Buddha Mandir landslide	1997	2054	Red	North east	Affected two houses and direct sediment deposition in Phewatal	Active due to ongoing construction works in the hilltop.

NB: Please see Table 5.2 for scientific name of soil type
Please see Figure No. 5.1 for their location in the map

Continue landslide history in Yamdi-Mardi Watershed

Name of VDC	Name of Land slide	Active since		Soil Type	Aspect	Destruction	Current status and management practices
		AD	BS				
Dhikurpokhari VDC ward No.2	Simplai landslide	1979	2036	Brown	North east	40 *ropani* forest in the hill slope and more than 100 *ropani* farmland along Yamdi khola was destroyed by associated flood	Ever active but natural growth of forest has reduced volume of rock sliding
Dhikurpokhari VDC ward No.2	Majhuwa landslide	1957	2014	Kamere	North east	50 *ropani* forest in the hill slope and more than 200 *ropani* farmland along Dhand *Khola* was destroyed by associated flood	Stabilized by Lumle Agricultural Research Center through plantation
Dhikurpokhari VDC ward No.2	Raikar Bahakane landslide	1964	2021	Kamere	North east	Destroyed 15 *ropani* farmland and 40 *ropani* forest and grazing land.	Ever active but natural growth of forest has reduced volume of rock sliding
Hemja VDC ward No.8	Hemaban landslide	1997	2054	Kamere	East	Destroyed 20 *ropani* of forestland and 300 meter of Hemja Samibagar agricultural road. Rock flow was directly poured into Seti River	Active and no any controlling measures have been applied
Hemja VDC ward No.6	Kahare Kholse Landslide	1997	2054	Kamere	South west	Destroyed 20 *ropani* of farmland and affected 4 households	Partly stabilized by plantation but gravel fall down regularly
Hemja VDC ward No.6	Banskot Kahare Landslide	1997	2054	Kamere	South west	Destroyed 10 *ropani* of farmland and affected few households	Partly stabilized by plantation but gravel fall down regularly
Hemja VDC ward No.4	Kahati Kholsi Landslide	1997	2054	Kamere	South west	Destroyed 10 *ropani* of farmland by boulder deposition	Partly stabilized by plantation but gravel fall down regularly
Dhampus VDC Ward No.5	Dhandkhola landslide	1969	2026	Kamere	South west	Chain of landslide along Dhand khola destroyed 2 houses and threatened to 13 houses. An estimated 200 ropani of farmland was destroyed by associated flood in the consecutive years.	Partly stabilized by plantation and natural growth of forest species and partly it is active during summer monsoon.
Dhampus VDC ward No.3	Pokharidanda landslide	1967	2024	Kamere	South	Destroyed 1 house, 50 *ropani* farmland, killed 6 people and formed a large gully in the middle of the farmland. National relief team rescued the victims.	Stabilized by plantation and natural growth of forest

Continue landslide history in Yamdi-Mardi Watershed

Name of VDC	Name of Land slide	Active since		Soil Type	Slope Aspect	Destruction	Current status and management practices
		AD	BS				
Dhampus VDC Ward No.7	Lekhane landslide	1957	2014	Red	South east	Destroyed 200 *ropani* of farmland along Edikhola. Frequent occurrence during summer monsoon has made vulnerable to downstream farmlands.	It has been located in the forest, no controlling measures have been applied and it is strongly active.
Dhampus VDC ward No. 9	Jhinje, Khurpe khola landslide	1985	2042	Brown	North east	Destroyed 100 *ropani* of farmland along Edikhola. Frequent occurrence during summer monsoon has made vulnerable to downstream farmlands.	Strongly active and no controlling measures have been applied
Dhampus VDC ward No.8	Makuwako landslide	1989	2046	Kamere	North east	Destroyed 120 *ropani* of farmland along Edikhola by associated floods.	Strongly active and it is pulling more farmland in its head side.
Dhampus VDC ward No 8	Sandikhola landslide	1998	2056	Red	North east	Destroyed 50 *ropani* of farmland along Edikhola by associated floods.	Active and no controlling measures have been applied
Dhital VDC ward No. 8	Lohore Astamkhola landslide	1989	2046	Kamere	North east	Destroyed 40 *ropani* farmland and 20 *ropani* forest	Landslide spot is in forest area and no controlling measures have are applied.
Dhital VDC ward No. 1-9	Thulagaunko landslide	1992	2049	Red	North east	Destroyed 30 *ropani* farmland and 40 *ropani* forest	Active and no controlling measures have been applied
Dhital VDC ward No. 3-1	Nivareko landslide	1933	1990	Kamere	North east	Destroyed 150 *ropani* of farmland was destroyed by associated floods.	Spontaneously growing fern weeds and .....trees partly stabilized the land slide.
Lwang Ghalel VDC ward No.1	Tijupakah landslide	1989	2046	Kamere	South	An estimated 40 ropani farmland was destroyed by associated floods and 3 households were threatened and move out.	Partly stabilized by bamboo plantation by farmers and partly active during summer.
Lwang Ghalel VDC ward No.4	Bhangkhola landslide	1997	2054	Brown	East	An estimated 20 *ropani* farmland and one irrigation cannel were destroyed	Annually active and farmers drop out farming activities in the adjoining area.

Continue Landslide history in Yamdi-Mardi Watershed

Name of VDC	Name of Land slide	Active since		Soil Type	Slope Aspect	Destruction	Current status and management practices
		AD	BS				
Lwang Ghalel VDC ward NO.2	Phirphire Puwakhola	1997	2055	Kamere	North east	Destroyed 10 *ropani* farmland in downstream area	Ever active
Lwang Ghalel VDC ward NO.3	Bhubang landslide	1983	2040	Black	North east	Cracked 100 *ropani* adjoining farmland during torrent flow	Active and framers planted firewood trees to stabilize
Lwang Ghalel VDC ward NO.4	Bhulke landslide	1945	2002	Black	North east	Destroyed 400 *ropani* farmland along Bhulke Khola and Mardi river by associated flood and wash out.	Ever active
Lwang Ghalel VDC ward NO.9	Ttendeko landslide	1993	2050	Black	North west	Destroyed 1000 *ropani* farmland along Mardi *Khola*, 16 suspension bridges, killed 3 people and smashed 2 houses along its routes. A national relief team was involved in rescue operation.	Its origin was just below the Machharepuchare Himal and no controlling measures have been applied. It is active and annually erode thousand tones of soil.
Lwang Ghalel VDC ward NO. 2-3	Majhpandhera landslide	1965	2022	Kamere	South east	Destroyed 200 *ropani* farmland by flood and washout.	Stabilized by plantation and check dams by farmers
Lwang Ghalel VDC ward NO.3-4	Kamere khola landslide	1971	2028	Kamere	South east	Destroyed 400 *ropani* farmland along Mardi *Khola* and its route	Stabilized by plantation and check dams
Lwang Ghalel VDC ward NO.4	Walche landslide	1933	1990	Kamere	South east	Destroyed 100 *ropani* farmland along Mardi *Khola* and its route. Threatened 1 household to move out	Active
Lwang Ghalel VDC ward NO.9	Bhumdi Thendku	1996	2053	Black	South east	Destroyed an estimated 30 *ropani* of forest land	Active
Lwang Ghalel VDC ward NO.8	Ratopani landslide	1997	2054	Black	North	Destroyed an estimated 10 *ropani* of forest land	Active
Lwang Ghalel VDC ward NO.9	Plague landslide	1998	2055	Black	North	Destroyed an estimated 10 *ropani* of forest land	Active
Lwang Ghalel VDC ward NO.9	Timli landslide	1998	2055	Black	North	Destroyed an estimated 15 *ropani of* forest land	Active

Continue landslide history in Yamdi-Mardi Watershed

Name of VDC	Name of Land slide	Active since		Soil Type	Slope Aspect	Destruction	Current status and management practices
		AD	BS				
Lwang Ghalel VDC ward NO.9	Dandako landslide	1998	2056	Red	North west	Destroyed *26 ropani* forest and farmland	Active
Lwang Ghalel VDC ward NO.9	Uppalobhir land slide	1998	2056	Red	North west	Destroyed 8 *ropani* forest and farmland	Active
Lwang Ghalel VDC ward NO.5	Kesabang landslide	1997	2055	Red	South	Created a flood havoc in downstream area and affected few houses	Active
Rivan VDC ward NO. 1,2 and 3	Patikhola landslide	1957	2014	Black	South west	Washout 70 *ropani* farmland in up stream and 500 *ropani* in down stream.	Partly stabilized by plantation and natural growth of forest
Rivan VDC ward NO. 7,8 and 9	Thadakhola landslide	1951	2008	Black	South west	Killed 3 people and smashed approximately 40 *ropani* farmland in the upstream	Partly stabilized by plantation and natural growth of forest
Rivan VDC ward NO.7,8 and 9	Sankhe landslide	1957	2014	Black	South west	Destroyed 30 *ropani* farmland in the upstream	Partly stabilized by plantation and natural growth of forest
Rivan VDC ward NO.6	Jodhi landslide	1987	2044	Black	South west	Destroyed 70-80 *ropani* farmland in the upstream	Partly stabilized by plantation and natural growth of forest
Rivan VDC ward NO.1 and 6	Bhirpakha landslide	1985	2042	Black	South west	Destroyed 60 *ropani* farmland in the upstream	Partly stabilized by plantation and natural growth of forest
Lahachock VDC ward No.9	Tare Paharo landslide	1989	2046	Sandy	South west	Destroyed 300 *ropani* farmland in the upstream, threatened 15 houses. A national relief team including the King was involved to rescue the victims.	Partly stabilized by plantation and natural growth of forest
Lahachock VDC ward No.4	Danda Pakho landslide	1998	2055	Brown	South west	Destroyed 200 *ropani* farmland in the upstream	Active

NB: Please see table 5.2 for scientific name of the soil
Please see Figure 5.1 for their location in the map

Table A 46: Livestock grazing stress on lands

Month	Project Area (N=155)						Non-project Area (N=145)					
	f'	Liv. No	% of total Liv.	Grazing herd size	Day in private land	Day in public land	f'	Liv. No	% of total Liv.	Grazing herd size	Day in private land	Day in public land
Jan.	38	207	31	3.5	12	18	14	95	18	4.8	30	-
Feb.	38	211	32	3.6	13	17	14	95	18	4.8	30	-
March	36	196	30	3.5	13	18	14	95	18	4.8	30	-
April	34	185	28	3.5	10	20	13	94	18	4.8	29	-
May	32	183	28	3.8	9	21	14	93	18	4.9	30	-
June	33	187	28	3.7	6	22	14	93	18	4.9	26	-
July	25	134	20	3.4	1	28	10	96	18.4	4.8	4	26
August	23	110	17	3.0	-	30	9	68	13	4.9	-	30
Sept.	23	112	17	3.0	-	30	9	67	13	5.2	-	30
Oct.	23	116	18	3.2	-	30	9	64	12	5.3	-	30
Nov.	28	170	26	4.0	6	24	11	64	12	5.3	6	24
Dec.	34	184	28	3.5	14	17	11	76	15	5.0	31	-
Annual	39	166	25	3.0	73	204	17	88	17	5.2	162	72

Source: Household survey, 1999
f'= proportion of N

Table A.47: Soil nutrient analysis

Land Type	Project Area						Non-project Area					
		N Kg/ha	P Kg/ha	K Kg/ha	OM in %	pH		N Kg/he	P Kg/he	K Kg/he	OM in %	pH
Phantkhet	5	.21	82	264	4.2	5.2	11	.18	143	235	3.7	5.0
Tarikhet	7	.08	26	218	1.8	4.9	7	.07	59	212	1.5	4.9
Bari	7	.19	182	287	4.4	5.0	13	.12	127	274	2.5	6.0
Gharbari	4	.14	240	538	4.4	6.0	6	.17	101	350	3.4	5.8
Mean	23	.15 *a*	123	305		5.2	37	.13 *a*	115	264		5.4

Source: Computed from raw data recorded in regional soil lab in khairenitar, 1999
NB: Significantly different at 0.05 confidence level (T test, $P \leq 0.05$)

Rating the soil nutrients based on western mid hill context (Regional Soil Lab Khairenitar, 1998)

Nitrogen in % (N) : <0.1 low, 0.1-0.2 medium and >0.2 high
Phosphorus in kg/hectare (P_2O_5) : <30 low, 30-55 medium and >55 high
Potassium in kg/hectare (K_2O) : <110 low, 110-280 medium and >280 high
Organic matters in % (OM) : <2.5 low, 2.5-5.0 medium and >5.0 high
Soil reaction pH : <6.0 acidic, 6.0-7.5 neutral and >7.5 alkaline

Table A 48: Extent of permanently barren farmlands

(Area in hectare)

Reason for leaving barren	Project Area			Non-project Area		
	Tarikhet	*Bari*	Total	*Tarikhet*	*Bari*	Total
Labor shortage	3.15	0.61	3.76	1.90	2.3	4.2
Least profitable	0.10	0.20	0.30	0.35	0.60	0.95
Land slide	0.45	-	0.45	0.61	0.50	1.11
Incursion of wild animals	0.10	0.31	0.41	-	-	-
Total	3.80	1.10	4.9	2.9	3.4	6.30
% of total farmland	6.0	12.0	4.0	6.0	16.0	4.5

Source: Household survey, 1999

Table A 49: Labor demand for crop cultivation

(workdays/hectare/crop)

	Project Area (N=155)					Non-project Area (N=145)				
Land type	Paddy	Wheat	Maize	Millet	Mean	Paddy	Wheat	Maize	Millet	Mean
Phantkhet	295	137	197	0.0	210	295	118	216	0.0	210
Tarikhet	295	137	197	0.0	210	334	98	197	0.0	210
Bari	0.0	157	236	255	216	0.0	157	197	275	210
Gharbari	0.0	137	216	236	197	0.0	138	177	295	204
Mean	295	143	212	246	224	324	128	197	285	236

Source: Household survey, 1999

Table A 50: Annual average total labor investment in crop cultivation

(workdays/household)

Land type	Project Area (N=155)					Non-project Area (N=145)				
	Paddy	Wheat	Maize	Millet	Total	Paddy	Wheat	Maize	Millet	Total
Phantkhet	20*	2*	2*	0.0	24*	57*	4*	7*	0.0	68*
Tarikhet	126	3	3*	0.0	132	109	5	9*	0.0	123
Bari	0.0	11	12*	10*	33*	0.0	7	23*	27*	57*
Gharbari	0.0	11*	21*	24*	56	0.0	7*	15*	30*	52
Total	146	27	38*	34*	245*	166	23	54*	57*	300*

Source: Field survey, 1999

NB: * Significantly different at 0.05 confidence level (T Test, P ≤0.01)

Table A. 51: Annual average labor supply

(workdays/household)

Source of supply	Labor situation	Project Area (N=155)		Non-project Area (N=145)	
		f'	work days	f'	workdays
Use only own labor	Enough	21	86*	30	184*
Use own and exchanged labor	Hardly enough	29	230*	12	299*
Use own and hired labor	Shortage	15	220*	40	501*
Use own, exchanged and hired labor	Shortage	35	360	18	400
Total		100	245*	100	300*

Source: Household survey 1999

f'= Proportion of N

NB: Significantly different at 0.05 confidence level (T Test, P ≤0.01)

Table A 52: Characteristics of high and low adopters

Variables	Project area (N=155)			Non-project area (N=145)		
	High	Low	Total	High	Low	Total
Active labor force, aged 11-59 at home (no/household)	4.7*	3. 8*	4.5	4.4	4.2	4.3
Active people involved in agricultural activity (no/household)	4.0	2.7	3.8	3.7	3.0	3.4
Schooling period of the household head (Number of year studied at school/campus)	6	4	5	6	5	5.5
Labor input (workdays/hectare)	424	371	392	435	386	419
Land ownership (hectare/person)	0.14*	0.05*	0.11	0.16	0.11	0.14
Tree ownership (fruit, fodder and timber trees no/person)	27.5	15.6	24.0	25.4*	13.2*	18
Livestock ownership (head/person)	0.72	0.33	0.63	0.44	0.63	0.55
Food production (kg/person/year)	285*	110*	258	347*	248*	299
Crop yield (kg/hectare)	3,427	2,980	3,223	2,853	2,742	2,790
Cropping intensity (ratio of gross cropped area under different crop to available net farmland)	1.64	1.58	1.62	1.68	1.63	1.66
Farm income (Net cash income from sources Rs/person)	1,744*	914*	1,366	1,862*	1,149*	1,356
Off-farm income including remittances (Rs/person)	8,861	7643	7,805	9,610*	13,634*	11,261
Distance to farm plots from farm households (in km)	1.7*	0.5*	1.5	2.7	2.1	2.5
Landslide density (no/hectare)	11.5	13	12	9.8	8.8	9.3
Percentage of farmland seriously affected by soil erosion	21.0	61.0	18.0	23.0	19.0	21.0
Percentage of agricultural land with declining soil fertility	33.0	24.0	28.0	41.0	33.0	37.0
Credit (Rs/person)	377*	50*	277	870	613	771
Number of family members affiliated with local institutions (No household)	0.40	0.20	0.30	0.92	0.67	0.80
Land management training attended by the household head (no during 1988-1998)	0.50*	0.60*	0.54	0.85	0.11	0.51
Frequency of visits by extension workers during 1988-98	3.7	3.2	3.6	2.51*	.90*	1.8
Participation in joint land management activities (during 1988-98 workdays/household)	28	23	27	22	16	19
Number of household members aged 16-59 migrated outside from large farm household (No/household) #	1.2	1.7	1.2	0.7	4.0	2.2
Percentage of labor force aged 16-59 migrated outside from large farm households	18.0	27.0	19.0	10.0	56.0	32.0

Source: Household survey, 1999

NB: * Significantly different at 0.05 confidence level (T Test, $p \leq 0.05$)

Farm households up to six family members are classified as average family and with more six members are classified as large family.

Table A 53: Land capability classification classes in Nepal

Class	Slope Gradient	Soil Depth	Limitations	Potential Erosion and hazard
I	Land are nearly leveled and the slopes are in less than 1^0	Soil depth are enough for cultivation	They have few limitation for cultivation and landscape is not significantly affected by engineering works	Except river bank cutting mass wasting is not the problem for land stability
II	Lands are gently slopping and slopes are in between 1-5 ^{0}	Soils are deep enough and well to moderately drained	There are no limitation for forestry, agroforestry and pasture development, but it needs terracing and contouring for agriculture	Little soil erosion and eventual high runoff
III	Lands are moderately to steeply slopping in between 5 -30^0	Soils are well drained (between 50 to 100 cm) deep	There is no limitation for forestry and agroforestry, but all lands are not suitable for agriculture and grazing. Terracing is mandatory for food crop cultivation	Surface erosion and land slides are major constraints for their development
IV	Lands are located in >30^0 or above the agricultural limit	Soils depths are less than 20 cm and imperfectly drained	Soil depth and high erosion constraints for agriculture, but suitable for all type of forestry and agroforestry provided a good management system with permanent vegetation cover	Severe mass wasting, flooding and gully erosion
V	Land are in less than 30^0 but these lands are located in alpine area above the tree lines	Soil depths are less than 20 cm	Land are too cold or too dry to support agriculture. These lands are suitable for pasture, if the stocking rates are carefully controlled	Rain shadow effect in alpine Himalayas and flooding in wet sub-tropical lowlands
VI	Very steepy land and the slopes are in between 40^0-50^0	Soils depths are less than 20 cm	Steepy slopes and lower soil depth restrict for agriculture. Lands are severely degraded and difficult to rehabilitate	Severe gulling and erosion
VII	Rock and ice and includes extremely rugged terrain	Exposed bedrock and rugged topography with no top soil	Not suitable for commercial and subsistence farming needs protection and rehabilitation	Rock deformation and loosing prompt removal of top soils

Source: Adopted from Land Resources Mapping Project (LRMP), 1984

Table A 54: Comparison of the cost for vegetative measure in watershed management

Country Year	Type of Plantation	Cost US$/ha	Output assumed				Year
			Fuel-wood	Fodder	Timber	Fruit	
India 1980	Silvi-pasture	188	17.5 m^3	0.6mt.	-	-	20
India 1983	Fodder plant	158	0.9mt.	5.0mt.	-	-	20
India 1983	Fuel wood and timber	274-379	3.6 m^3	1.5mt.	-	-	20
Indonesia 1979	Silvi-pasture	233	-	-	-	-	-
Indonesia 1989	Reforestation	150	5.0 m^3	1.5mt.	8.6 m^3	0.6mt	35
Morocco 1981	Silvi-pasture	69	0.6 m^3	0.3 m^3	-	-	35
Nepal 1983	Community forestry Private Reforestation Wood lots Agro-forestry plots	277 104 250 954	6.4 m^3	1.7 m^3	1.4 m^3 10 m^3 20 pole	0.3mt	40
Thailand 1979	Village wood lots Forest plots	252 193	7.6mt.	-	0.4mt 0.5 m^3 pole	-	10
Source: Graaff, 1993: 80							

Table A 55: Cost to establish physical conservation measures in watershed management

Country Year	Measure	Slope degree	Cost US$/Ha	Labor Man Days	Wage Rate (US$/Man day)	IRR
Graded Bunds and Ditches						
Burkina Faso, 1986 *	Stone Bunds 10 M. Interval	2%	60-120	80	1.0	-
Jamaica 1981 *	Hillside Ditch & Grass barrier	10% 20%	1200-1600 2300-2900	150 250	6.00 6.00	34 16
Mali 1986 *	Graded Bunds Grass barrier	2% 2%	110 80	50 30	2.00 2.00	- -
Mexico (1976) *	Terracing Maguey Plant	7% 9%	250 240	- -	- -	11 18
Thailand 1979 *	Hillside Ditch	30%	125	100	1.25	-
Tunisia 1980 *	Banquette	gentle	1000-2000	-	-	-
Bench Terracing						
Indonesia 1986 *	Bench terracing Waterways	0-5% 5-30% 30-50%	250 560 1020	210 750 1520	0.50 0.50 0.50	44 24 13
Indonesia 1989 *	Bench terracing Waterways	12% 21%	450 640	570 770	0.60 0.60	24 16
Jamaica 1970 *	Bench terracing Waterways	23%	1440	500	2.00	-
Jamaica 1981 *	Bench terracing Waterways	20% 32%	3900-5200 5000-6900	530 670	6.00 6.00	23 14
Nepal 1999 **	Bench terracing	5-30%	1,328-1,728	700-910	1.89	-
Thailand 1979 *	Bench terracing Waterways	30%	625	500	1.25	-
Source: * Graaff, 1993: 78 ** Field survey						

Table A 56: Traditional classification of land by quality

Lowland *tarai*			Mountain and Hills including study area
Type	Quality	Basis of classification	Basis of classification
Khet	*Abbal* (best)	Year round irrigated and potential for more than two crops in a year	Year round irrigated and potential for more than two crops in a year. Located below 900 m.amsl
	Doyam (better)	Seasonally irrigated and potential for two crops	Seasonally irrigated and potential for two crops and located between 900-1200 m
	Sim (good)	Rainfed and potential for single crop	Irrigated only for two months in a year Located below 900 meter with sandy gravel soil Located between 1200-1500 m. with good soil
	Chahar (fair)	Rainfed, low water holding capacity and potential for a crop in a year	Sandy gravel soil, rainfed, poor water holding capacity and located between 900-1800 m up to the upper limit of rice
Pakho bari	*Abbal*	Good quality of soil potential for wheat, maize, millet, mustard, and other cash crops production	Good soil, ploughable terraces, located below 600 m. and enough temperature to ripe crop within 90 days
	Doyam	Sandy silty soil potential for wheat, maize, millet, mustard, and other cash crops production	Moderate quality of soil, slightly sloping but ploughable terraces, located between 600-1200 m and no enough temperature for crops
	Sim	Sandy gravel soil potential for wheat, maize, millet, mustard, and other cash crops production in one or two year interval	Sandy gravel soil, sloping terraces, high soil erosion by surface run-off, no enough temperature for crops and located between 1200-1800 m
	Chahar	Steep sandy gravel land and least potential for crop production	Dominantly sandy gravel soil with steep slopes in lowland area, steep and north facing slopes in the upland area located normally between 1200-2400 meter
	Fifth category	-	Least productive land above 2400 m.

Source, Ministry of Law and Justice Nepal, Land Consolidation Act, 1962

Table A 57: Public sector budget allocation in Nepal 1965-2002

(Million Rs)

Plan	planning Year	Agriculture and forestry		Industry and electricity		Road and communication		Social services		Total public sector budget	
		Budget	%	Budget	%	Budget	%	Budget	%	Budget	%
Third	1965-70	377	22	125	7	875	50	362	21	1,739	100
Fourth	1970-75	662	26	470	18	1,050	41	387	15	2,569	100
Fifth	1975-80	2,278	30	1,506	20	1,990	26	1,770	24	7,544	100
Sixth	1980-85	6,600	30	5,600	26	4,230	19	5,320	24	21,750	100
Seventh	1985-90	8,875	31	7,546	27	5,132	18	7,329	25	28,882	100
Eighth	1992-97	26,904	32	20,094	24	15,217	18	21,859	26	84,074	100
Ninth	1997-02	24,421	20	31,629	25	28,306	23	40,805	33	125,161	100
Total	1965-2002	70,117	26	66,970	25	56,800	20	77,832	29	271,719	100

Source: Maskey, 1995, NPC, 1998

Table A 58: Public sector budget allocation in Kaski District

(Million Rs)

Expenditure	Agriculture and forestry		Industry and electricity		Road and communication		Social services		Total public sector budget	
	Budget	%	Budget	%	Budget	%	Budget	%	Budget	%
Administration	19.3	4.0	7.5	1.5	0.3	0.5	112.9	22.5	140.1	28.5
Development	226.1	46	35.9	7.3	15.4	2.7	74.2	15.5	351.5	71.5
Total	245.4	50	43.4	8.8	15.7	3.2	187.1	38	491.6	100

Source: Summarised from Kaski DDC minute book, 1997

Table A 59: Income in Village Development Committees

(Income in million Rs)

Income (1995-1999)	Project Area	percent	Non-project Area	Percent
Government donation	11.10	81.4	13.33	74.4
Development grant from line agencies	0.62	4.5	1.50	8.4
Grant from INGO	0.92	6.7	0.37	2.0
Land tax	0.27	2.0	0.23	1.3
Other taxes	0.73	5.4	2.49	13.9
Total	13.64	100	17.92	100

Source: VDC survey, 1999

Table A 60: Background of VDC executives

Post in VDC	Project Area					Non-project Area				
		Farmer	Ex army	Others	Total		Farmer	Ex army	Others	Total
	N	f'	f'	f'		N	f'	f'	f'	f'
Chair person	5	0.0	20	80	100	6	17	0.0	83	100
Vice chairperson	5	60	0.0	40	100	6	67	0.0	33	100
Ward chairperson	45	58	20	22	100	54	76	15	9	100
Ward member	180	76	7	17	100	216	86	10	4	100
Total	235	70	10	20	100	282	82	10	8	100

Source: VDC survey, 1999
NB: N= Number of post
f' proportion of N