

Environmental Science

Vishwambhar Prasad Sati

Towards Sustainable Livelihoods and Ecosystems in Mountain Regions

 Springer

Environmental Science and Engineering

Environmental Science

Series editors

Rod Allan, Burlington, Canada

Ulrich Förstner, Hamburg, Germany

Wim Salomons, Haren, The Netherlands

For further volumes:

<http://www.springer.com/series/3234>

Vishwambhar Prasad Sati

Towards Sustainable Livelihoods and Ecosystems in Mountain Regions

 Springer

Vishwambhar Prasad Sati
Geography and Resource Management
School of Earth Sciences
Mizoram University
Aizawl, Mizoram
India

ISSN 1431-6250

ISBN 978-3-319-03532-1

ISBN 978-3-319-03533-8 (eBook)

DOI 10.1007/978-3-319-03533-8

Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013955052

© Springer International Publishing Switzerland 2014

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law. The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Diversifying and enhancing livelihood options for reducing poverty and securing livelihoods is an essential activity. It has greater relevance in areas where subsistence agricultural practices dominate the economy. About 70 % of the world's economy is based upon the cultivation of subsistence cereal crops. This practice is a major characteristic feature of mountain regions. Mountains constitute about 20 % of the total earth's land-surface and comprise of underdeveloped economy. Here, agriculture and its allied activities are the main occupation of the people. Agriculture is largely carried out on narrow patches of terraced fields. Cultivation of subsistence cereals dominates the cropping pattern. Production and per ha yield of cereal crops is considerably low and does not meet even the two-times food requirements of the poor and marginal farmers. The case study area, 'the Alaknanda Basin' constitutes one of the major sub-systems of the Ganges. It has five vertical landscapes (zones) from the valleys to the highly elevated Himalayan ranges, i.e. the river valleys, mid-altitudes, highlands, alpine meadows and the perpetual snow-clad mountain peaks of the Himalayas. Human settlements and high population density are largely concentrated in the mid-altitudes and in the valleys, while the highlands are sparsely populated. The highland areas are used for grazing animals through seasonal migration mainly during the summer. The alpine meadows remain covered with snow for up to 6 months during the winter, and during the summer an abundance of flowers and medicinal plants grow naturally. Medicinal plants are collected by the local people and widely used for health care through the traditional system.

The Himalayan region is ecologically fragile, tectonically and seismically active, geologically unstable, economically backward and geographically remote. So far, the waves of modern civilization could not influence the whole region because of its remoteness and distance from mainstream development. High growth in population and less availability of arable land further accelerates the human pressure on the agricultural land. Intensive agricultural practices are carried out on the fragile and narrow terraced fields, which are located in the mid-altitudes and the highlands. In the valley regions, wherever narrow patches of terraced fields are found, agricultural practices are carried out. Extension of arable land towards the fragile mountain niches poses severe threats to the landscape stability as the

entire region is highly vulnerable. Suitability in the agro-climatic conditions for growing cash crops such as fruits and off-season vegetables in particular, leads to sustainable development of the Himalayan region. Similarly, an abundance of economically viable forests with rich agro-biodiversity manifests to diversifying livelihoods at a larger scale. Multiple uses of timber and non-timber forest products such as bees and bee keeping, natural dyes, bamboo and bamboo-based products, herbs, wild fruits and their products, oak bark and its products, and a number of other products can enhance the livelihood options of the people.

The book constitutes ten chapters. In the [Chap. 1](#), research problems, questions, objectives and hypotheses are illustrated. Literature review, methodology and tools and techniques of the research, which were used to carry out this study, are well elaborated in this introductory part. [Chapter 2](#) deals with the geographical background. It further elaborates the climatic conditions and natural resources availability. [Chapter 3](#) discusses *Socio-Economy and Population Profile* of the study area. *Sustainable Livelihoods: Diversifications and Enhancements* are discussed in [Chap. 4](#). Agricultural intensification and diversification through cultivating cereals and cash crops and use of timber, non-timber and biodiversity resources are widely illustrated in this chapter. *Livelihood Analysis* viz. income–expenditure analysis of the households is carried out in [Chap. 5](#). [Chapter 6](#) examines the potential of development of tourism and hydroelectricity in the Himalayan region and illustrates how they are useful in terms of enhancing livelihoods. Case studies of the Khanda Gad sub-watershed of the lower Alaknanda basin and the Kewer Gadhera sub-watershed of the Pindar basin are discussed in [Chap. 7](#). Household level survey of the villages of these two sub-watersheds was carried out. [Chapter 8](#) discusses *Mountain Ecosystems* and impacts of anthropogenic activities on it. *Sustainable Mountain Development and Livelihood Enhancement: Challenges and Opportunities* are examined in [Chap. 9](#). Finally, conclusions and suggestions are given in [Chap. 10](#) that also describes the major problems and prospects of sustainable livelihoods. Illustrations exhibiting the natural and cultural landscapes of the Himalayan region and appendices that give numerical information further enrich the manuscript.

This work is a result of the ICSSR Fellowship, which was awarded to me as ‘ICSSR Fellow’ during 2008–2009. This fellowship was carried out in the Department of Geography at the HNB Garhwal University Srinagar, Uttarakhand. The Mizoram University, Aizawl provided publication grant to this work. I acknowledge my gratitude to the ICSSR, New Delhi for awarding this fellowship. I am thankful to the Department of Higher Education, the Government of Madhya Pradesh for sanctioning study leave. I am indebted to the Department of Geography, HNB Garhwal University for allowing and providing me all the necessary facilities to commence this study. I am also grateful to the Mizoram University for providing publication grant to publish this book. The academicians and the scholars working in mountain regions are greatly thankful as their work is well

cited in this book. I acknowledge the contribution of Mrs. Lekha Bhat for taking the initiative to edit this book. I am indebted to my family members; Dr. Nirmala Sati and Vishwani Sati for the valuable support that they have extended from time to time. I dedicate this book to my grandmother late Smt. Savitri Devi, grandfather late Shri Govind Ram Sati, mother late Smt. Saradi Devi and father late Shri Shiv Dutt Sati.

Aizawl, 2013

Vishwambhar Prasad Sati

About the Book

Sustainable livelihoods and Ecosystems are comprehensive and burning issues in the wake of high growth of population, low production and per ha yield of crops, and depletion of biodiversity resources. Mountainous regions of the world are facing the menace of poverty, food insecurity and malnutrition. Further, tremendous growth in population and slow pace of development together push most of the population to live below the poverty line. Traditionally depending upon cultivating subsistence crops for food requirement, people living in the mountainous regions cannot produce sufficient food grains to manage their livelihood smoothly. The Himalayas, one of the biodiversity hotspots of the world, has an abundance of natural resources—land, water, and forest, the life sustaining layers. The geo-environmental conditions—climate and landscape further enhance the possibility of sustainable livelihoods through eco-tourism, harnessing water resources, utilising forest and its products sustainably. Diversifying agricultural practices through cultivating cash crops and enhancing livelihood options through extensive use of timber and non-timber-based forest products thus, can assist to eradicate poverty and ensure food security. There are ten chapters comprising Introduction, Geo-Environmental Setting, Socio-Economy and Population Profile, Sustainable Livelihoods: Diversification and Enhancement, Livelihood Analysis, Development of Tourism and Hydro-Electricity, Case Study, Mountain Ecosystems, Sustainable Mountain Development and Conclusion. This book will be highly significant to all stakeholders working for the sustainable livelihoods in mountain regions.

Contents

1 Introduction	1
Geographical and Economic Constrains to Sustainable Livelihoods in Mountain Regions	5
Literature Review	8
Conceptual Framework	10
Murray (2001) Derives the Following ‘Principles’ of Livelihoods Research	11
References	11
2 Geo-Environmental Setting	15
Location and Extension	15
Physiographical Division	16
Major Rivers and Their Tributaries	17
Climatic Conditions	18
Rainfall	20
Humidity	22
Climate Change Phenomenon in the Himalaya	23
Potentials of Natural Resources and Their Distribution Pattern	23
Soil Resources	25
Water Resources	25
Forest Resources	27
Land Resource and Environmental Services	29
Livestock Rearing	30
Potential of Environmental Services	31
References	31
3 Socio-Economy and Population Profile	35
Introduction	35
Economic Development	36
Infrastructural Facilities	38
Perspectives of Natural Resource Management	39
Population Profile of the ICHR	43
Social Composition	46
References	48

4 Sustainable Livelihoods: Diversifications and Enhancements	49
Cash Crops	49
Prospects of Off-season Vegetables	49
Fruit Cultivation	54
Potential of Dairy Farming	60
Prospects of Tea Cultivation	65
Non-timber Forest Products	69
Resin Industry	69
Wild Fruits	72
Medicinal Plants and Herbs	72
Bees and Beekeeping	77
Natural Dyes	79
References	81
5 Livelihood Analysis	83
Traditional Livelihood Pattern	83
Livelihood Analysis	84
Household Income (X)	85
Household Expenditure (Y)	86
Emerging Trends	88
Village-Wise Comparison of Income and Expenditure	88
References	89
6 Development of Eco-Tourism and Hydroelectricity	91
Tourism Types and Development	91
Pilgrimage Tourism	92
Natural Tourism	93
Adventurer Tourism	94
Wildlife Tourism	94
Cultural Tourism	94
Tourist Places of Religious Importance	95
Panch Prayags	95
Panch Kedars	95
Panch Badris	96
Hydroelectricity Development	97
Hydroelectricity Generation Through Water Mills	98
Potentials of Micro-Hydroelectric Projects	101
References	101
7 Case Studies	103
The Khanda Gad Sub-Watershed	103
Population Profile 1991–2001	105
Changes in Land-Use Pattern	106
Demographic Profile of Nepali Immigrants	107

The Kewer Gadhera Sub-Watershed	108
Shubhas Herbal Nursery	111
Junglechatti Village	111
The Takori Sub-Watershed	112
The Lastar Gad Watershed	112
Conclusions	113
8 Mountain Ecosystems	115
Himalayan Ecosystem	116
Indian Himalayan Region	119
Effect of Climate Change on the Himalayan Ecosystem.	119
Global Sustainable Development Depends on Mountain Resources	120
Challenges to Sustainable Mountain Development.	120
9 Sustainable Mountain Development: Challenges and Opportunities	123
Major Issues of Sustainable Mountain Development	123
Challenges to Sustainable Mountain Development.	125
Opportunities for Sustainable Mountain Development	127
How Is Climate Change Affecting Mountain Areas?	128
Approaches to Sustainable Mountain Development	129
Natural Resources Management	131
Soil and Water Conservation in Mountains.	132
Conservation Landscape	133
Economic Opportunities	133
Mountain Environmental Services	134
The Future of Sustainable Mountain Development	134
Reference	135
10 Conclusions: Major Problems and Prospects of Sustainable Livelihoods	137
Mountain Specificities	140
Constraints	140
Potentialities	141
Diversity.	142
Major Constraints to Sustainable Livelihood.	143
Lacking in Infrastructural Facilities	143
Lacking in Holistic Government Initiatives.	143
Lack of Proper Marketing.	143
Lack of Training Programmes.	144
Limited Understanding of Mountain Environments	144
Institutional Gaps	145
Climate Change.	145
Opportunities and Options for Sustainable Livelihoods.	146

Agricultural Diversification 146

Use of Non-timber Forest Products 147

Alternate Occupations 148

Value Addition 148

Policy Interventions 148

References 149

**Illustrations: Representing Abundance Natural Resources
and Livelihoods 151**

Appendix 173

Glossary 203

About the Author 205

Abbreviations

AEZ	Agri Export Zones
APEDA	Agriculture and Processed Food Products Development Authority
ADB	Asian Development Bank
ARB	Alaknanda River Basin
BDF	Bhararisen Dairy Farm
CDPCUL	Chamoli District Dairy Production Cooperative Union Limited
COI	Census of India
DID	Department of International Development
FA	Forest Act
FAO	Food and Agricultural Organization
FDA	Forest Development Agency
GBPIHED	Govind Ballabh Pant Institute of Himalayan Environment and Development
H and MP	Herbs and Medicinal Plants
HAPPRC	High Altitude Plant Physiology Research Center
HDR	Human Development Report
HDRI	Herbal Research and Development Institute
HMS	Himalayan Mountain System
HNBGU	Hemwati Nandan Bahuguna Garhwal University
HYV	High Yield Variety
IC	Indian Currency
ICAR	Indian Council of Agricultural Research
ICHR	Indian Central Himalayan Region
ICIMOD	International Center of Integrated Mountain and Development
ICSSR	Indian Council of Social Science Research
IHR	Indian Himalayan Region
IIEs	Integrated Industrial Estates
IPCC	Inter-Governmental Panel of Climate Change
IDD	Iodine Deficiency Disorder
IMDP	Intensive Mini Dairy Project
JMS	Journal of Mountain Science

KGSW	Keewer Gadhera Sub-Watershed
KGSW	Khanda Gad Sub-Watershed
LSI	Livelihood Sustainability Index
LODI	London-based Overseas Development Institute
MPCA	Medicinal Plant Conservation Area
MRD	Mountain Research and Development
NAGI	National Association of Geographers, India
NAP	National Afforestation Programme
NAPCC	National Action Plan on Climate Change
NGOs	Non-Governmental Organisations
NMSHE	National Mission for Sustaining Himalayan Ecosystems
NORAD	Norway Research and Development
NSP	Nauti Sub-Projects
NTFP	Non-Timber Forest Products
PIB	Public Investment Board
PRA	Participatory Rural Appraisal
RLD	Rural Livelihood Department
SC	Scheduled Caste
SHN	Shubhas Herbal Nursery
SL	Sustainable Livelihood
ST	Scheduled Tribes
TF	Terraced Farmland
ULDB	Uttarakhand Livestock Development Board
UNCBD	United Nations Convention of Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programmes
UNEP	United Nations Environment Programmes
UNFCCC	United Nations Framework Convention on Climate Change
UNU	United Nations University
UTDB	Uttarakhand Tea Development Board
VFDC	Village Forest Development Committee
VFDC	Valley Flower Development Corporation
WCED	World Commission on Environment and Development
WLA	Wildlife Act

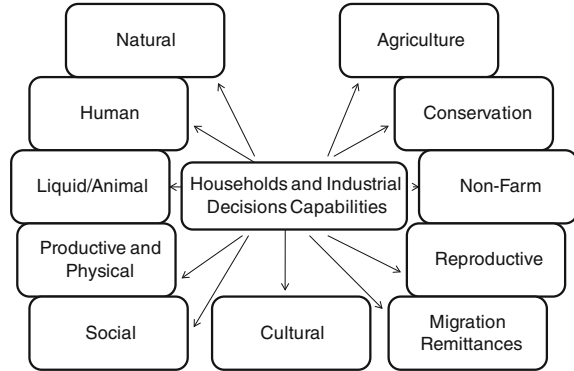
Chapter 1

Introduction

The term 'livelihood' refers to enough food and cash to meet basic needs (Chambers 1988) and poverty reduction also mentions those 'livelihoods' under the basic definition of poverty. Chambers and Conway (1991) explained, 'a livelihood includes the capabilities, assets (financial, physical, human, natural resource, and social) and activities required for a means of living'. Here assets include both material and social resources, or both tangible and intangible resources. Poverty indeed is the result of a lack of these assets. The poor may not have access to these assets and this could be because of physical constraints like remoteness or resource scarcity (Asian Development Bank). Scholars like Jegannathan have observed that livelihood aims to generate adequate resources, both cash and non-cash, which is a set of economic activities by utilising human and material resources. Livelihood includes the access to resources, materials and services into the content (Ellis 2000). Besides material and economic supplies, livelihood is also about management of social relationships, personal and group identity and the interrelation of these tasks to each other. Livelihood can also include creativities, new opportunities, people's attempts, willingness and capabilities to cope with shocks, risks and stresses, such as natural disasters, epidemics such as HIV/AIDS, financial crisis or conflicts and competition both at national and international levels (UNDP 2006). These intensive definitions of livelihood also reflect the multi-goals of poverty reduction, in which the development of human and social capital increases the possibility of poverty reduction. In this way, livelihood is a very comprehensive term that deals with all issues related to human needs and capacities.

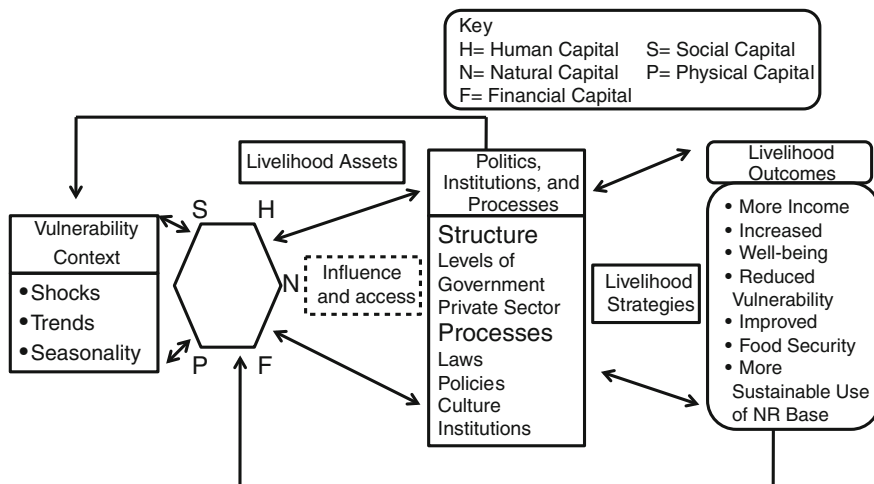
Livelihood is sustainable when it can cope with and recover from stresses and shock; can maintain or build on available capabilities and assets; and does not undermine the natural resource base. Sustainable livelihood (SL) is the long-term goal for poverty reduction that gives adequate importance to development from different levels, scale and sectors. It is regarded as a conceptual framework, can be used to assess and analyse sustainability, capability, security and resilience of livelihoods in different scales under different contexts (Scoones 1998a, b). SL tries to work out integrated solutions under the complicated and flexible political and economic environment.

Fig. 1.1 Livelihood strategies: assets, decision and activity portfolios



Mountains occupy 24 % of the global land surface and are home to 12 % of the global population. In addition, another 14 % of the global population lives adjacent to mountain areas. Most of the people living in mountain regions are economically vulnerable and socially backward (ICIMOD 2007). Mountains are sources of water, energy, agricultural and forest products, centres of biological and cultural diversity; besides this tourism and pilgrimages are the other important aspects upon which the livelihoods of the mountain people are dependent (Ives and Messerli 1989). Further, among the mountain communities cultural and traditional diversity is also high. Mountains have ecological, aesthetic and socio-economic significance both as natural ecosystems and as people's living place. 10 % of the world population's livelihoods and well-beings rely directly on mountainous resources (UNU 2002). For sustainable development of the mountain regions, various methodologies are required, primarily to deal with development issues under its complex ecological and agricultural systems. It is the interactivity between social and ecological systems, and between human and nature (Kemp and Martens 2007). Due to the specificities and peculiarities of the mountain regions, there is a need to have specific and targeted policies. The livelihood of mountain people in many countries of the world are still lagging behind in their development processes (Figs. 1.1, 1.2, 1.3, 1.4, 1.5).

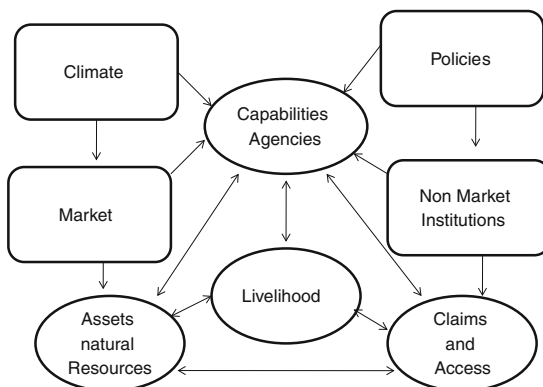
Enhancing and diversifying livelihood options in mountain regions need attention against the backdrop of framing an integral strategy for coping with physical hazards and food insecurity. It must also seek ways to improve livelihood and enhance economic growth through which increased security—physical, economic and social can be obtained. The people of mountain regions are entirely dependent on mixed agriculture systems, which include farming of subsistence cereal crops and animal husbandry. Low production and productivity (per ha yield), home consumption of produced materials and limited access to market are the characteristics of mountain systems. The potentials to avail sustainability through enhancing and diversifying livelihood options, within the context of vulnerability and fragility of mountain terrain, have largely remained unexplored by mountain habitants. The impact of this is that the phenomena of poverty, food



Source: DFID, 2001

Fig. 1.2 Sustainable livelihood framework

Fig. 1.3 Livelihood components and flows



insecurity and malnutrition are still prevalent in these regions. In addition to this, high population pressure and high dependency on forest resources has led to severe environmental degradation.

Most of the mountain areas have not been able to adequately harness their unique resources to improve livelihoods because of inadequate and unfavourable policies. Harnessing mountain niches appropriately through (i) better management of natural resources; (ii) application of technologies; (iii) new methods of production and exchange to generate employment and income opportunities in the mountain regions is required. However, the cultivation of off-season vegetables, fruits, medicinal plants along with the appropriate use of non-timber-based forest

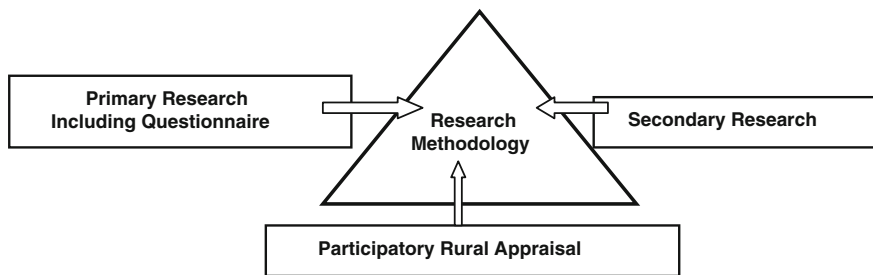


Fig. 1.4 Sustainable livelihood research design (A)

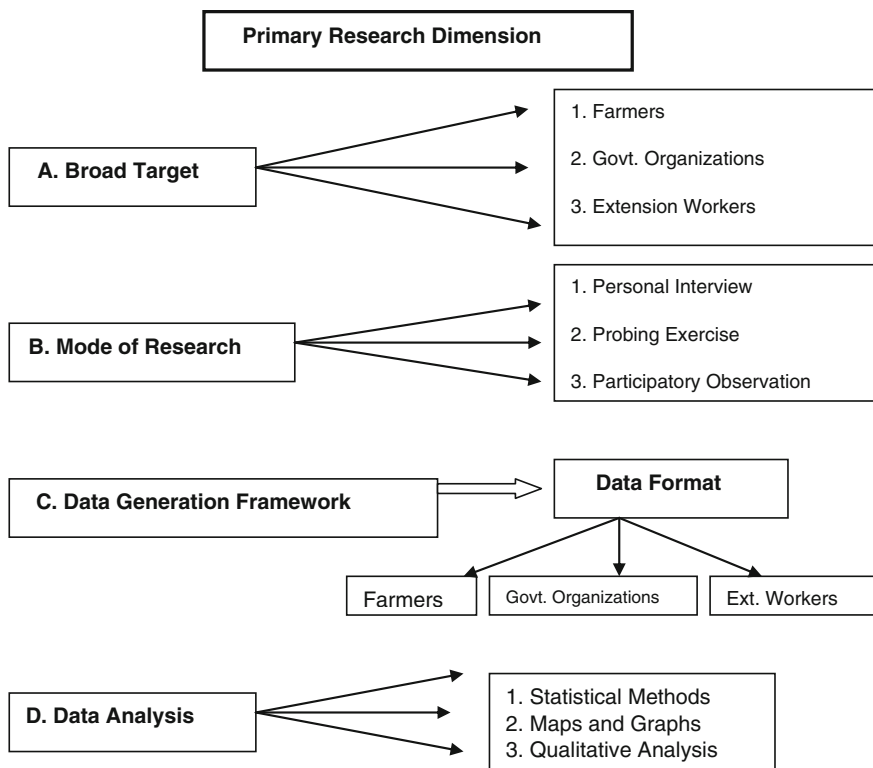


Fig. 1.5 Sustainable livelihood research design (B)

products of the mountains demonstrate their high potential to provide viable bases for households to rise above poverty and subsistence.

In mountain areas, livelihood options are often linked to a range of economic activities, products and productivity of cereal farming, natural assets of mountains as well as economic and human assets. Harnessing mountain resources for

hydroelectricity, tourism and for the production of food/non-food products along with conserving resources to generate valuable environmental services can create new employment and income opportunities. Human resource development is also vital for the all-round development of mountain regions.

Agriculture and its associated activities continue to play a major role in the economy of mountain regions. It is a major source for providing employment to the rural populace. In India, for the past several centuries, agricultural practices are avenues of subsistence and agriculture is sustaining the livelihood of rural households. Over the years, unprecedented increasing trend of population pressure on land—both—for employment and livelihood has led to a situation where the land–man ratio has considerably declined. Further, increasing fragmentation of agricultural holdings and inequalities in the distribution of arable land among farming households, have caused decline in per household income. Despite increasing application of labour-saving farm production technologies, the agriculture sector is hardly in a position either to provide gainful employment opportunities at pace with the increasing workforce or to sustain the livelihood of rural households. Carrying out a large-scale diversification and modernisation of economic system through initiating industrialisation and large-scale production system is severely limited in hilly and mountainous areas because of a number of factors—such as the availability situation of limited environmentally sensitive resource bases and the spread of usable resources across different and inaccessible areas. Factors such as inaccessibility to markets/modern inputs/technology, deficient infrastructure and high transport costs are also leading to non-competitiveness of products (Mehta 1996).

Geographical and Economic Constrains to Sustainable Livelihoods in Mountain Regions

Mountain regions have been regarded as the most fragile, remote and marginal ecological systems on the earth. As they are lagging behind in infrastructure facilities, returns from investment are tremendously low. As a result, in many cases, development of mountainous areas is experiencing a minor and passive mode that is dependent on external aids or strong governmental interventions (Klaus 1983). Some scholars believe that in the agricultural society, the differences in people's living standards in mountain areas and plains were not so remarkable; but in a globalised world, mountain areas became more vulnerable and widened the regional imbalances (Klaus 1983; Guojie 2007). Besides, natural disasters such as earthquakes, flash floods and the risk of climate change are all drivers that increasingly threaten the capacity of mountainous sustainability. This in turn influences mountain communities and even lowland populations.

The Indian Central Himalayan Region (ICHR) is one of the richest regions in terms of biodiversity resources, but is amongst the poorest in terms of economic

growth and development. The livelihood is largely dependent on the biomass-based production and on the use of natural resources—forest, grassland, fresh water etc. Agriculture in this region is based upon century-old practices, which are carried out mainly on narrow patches of terraced fields and characterised by the dominance of subsistence cereal farming, which is the main occupation of the populace. Rice, wheat, barley, millets, oilseeds and pulses are the main cereal crops and the economic viability of these crops is insufficient even to meet the daily basic requirements. The scope of modernisation and expansion of agriculture is negligible. Fragility of the terrain further reduces the scope of implementation of modern innovations in the field of agriculture. Mounting pressure of human population on arable land and high man–land ratio compelled farmers to leave the land abandoned. This process led to low soil fertility and land degradation. Apart from adverse climatic stress, increased human population and the insatiable demand for more natural resources including land, forest and food are the major factors contributing to natural resources depletion and losses in biodiversity (Arimoro et al. 2002; Okali 1985). Furthermore, inaccessibility and the low level of infrastructural facilities are significant constraints to generating opportunities. As a result, the resources of the region have remained grossly underutilised and undervalued. These natural and man-made disadvantages manifest in the form of poverty, malnutrition and food scarcity. As a coping strategy to these severe impediments, a large proportion of the population has migrated to the foothills of the Himalaya and the Ganges plains. There are instances from the Garhwal Himalaya where about two-thirds of the total families in a village emigrated during the period 1972–1988 (Maikhuri et al. 1995). Unsustainability of agriculture and lack of other economic opportunities together with higher literacy rate in the hill region lead to very high rate of out-migration of the youth in search of jobs (Khanka 1984).

In the Himalayan region, the impediments related to the development processes are not only due to the adverse geo-environmental conditions, but also due to the policies of the various governments (both State and Central) and development agencies. Lack of systematic planning was accentuated by inadequate and improper coordination between different governmental departments. These programmes paid scant attention to the needs and requirements of various infrastructural facilities for sectoral schemes, inefficiency of the administration in implementation of programmes, a multiplicity of programmes to meet the same goals and faulty criteria for identifying beneficiaries in assistance linked to employment generation (Mehta 1990).

The landscape, geo-environmental conditions and availability of natural resources have heterogeneity in all respects and this can be seen on the agrarian system, occupation, working potential and migration. Other aspects such as low availability of agricultural land, harsh environmental conditions, inaccessibility of forestland and instability of terrain affect the livelihood of the Himalayan people (Sati and Kumar 2004). With increasing needs as well as pressure of population, traditional farming has become unsustainable both economically and ecologically (ICIMOD 1996). Further, expansion of agriculture on marginal land and declining

crop yields are considered to be major unsustainable trends in the Himalayas (Eckholm 1979; Jodha 1990).

Horticulture—cultivation of fruits and off-season vegetables plays a vital role for the environmental sustainability and economic development of the region (Sati 2004a, b, c, d). The present vegetable production of 90.8 million tonnes is to be raised to 250 million tonnes by 2024–2025 (ICAR 2002). Promotion of protected cultivation of vegetables is another potential approach [see Singh (1998) and Singh et al. (1999)]. There are different ways and means to achieve this target, which include among others, bringing additional areas under vegetable crops, using hybrid seeds and use of improved agro-techniques. Cultivable wasteland may have potential for the development of horticulture, whereas the uncultivable wastelands do not have such potential (Singh 1991). In addition, non-timber forest products such as medicinal plants/herbs, essential oils, fibres/silks, natural dyes/organic products, bamboo/bamboo products, bee/bee products and enterprise-based pollination services can provide the bases for increasing incomes and improving livelihoods. It is commonly observed that the ecological conditions of the region are more suitable for fruit cultivation rather than cereal farming (Atkinson 1889). Along with the cultivation of fruits, off-season vegetables and tea cultivation will boost the regional economy (Sati and Kumar 2004). In the Himalayan region from the valley regions to the northern border, sub-tropical humid and bio-climatic conditions change step by step into temperate, sub-temperate and alpine zones (Atkinson 1889), which are very useful for the cultivation of fruits and vegetables. Likewise, mountain tourism, hydroelectricity and other renewable energy sources may be other resources for enhancing livelihoods. These niche-based mountain products and services hold some of the keys for helping mountain people diversify and enhance their livelihood options while reducing dependency on traditional occupations and the environment.

The development process must also ensure that communities, (especially disadvantaged groups) and geographically excluded areas are not left out of mainstream development. Mountain areas are highly diverse in renewable natural resources and environmental services. The diversity is helping to reduce internal competition in mountain areas and partially offsetting the physical vulnerability of the fragile mountain environment. It requires a highly decentralised areas-based approach (Papola 1996), which has to be distinct not only from approaches for the plains, but should also differ significantly from area to area within the hill region. The biodiversity of the mountains provides important values of agriculture, medicine, food security and industry besides spiritual, cultural and aesthetic and recreational values. In order to meet the present and future challenges meeting sustainability criteria, traditional systems need to be adapted in ways that will enhance crop yields but not at environmental and social costs (Ramakrishnan et al. 1993).