Doctoral Dissertation

**Poverty and
Climate Change in Nepal: Poverty Analysis in Far-Western Rural Hills**

Niraj Prakash JOSHI

**Graduate School for International Development and Cooperation
Hiroshima University**

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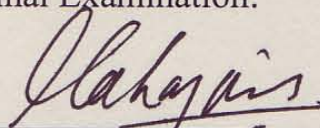
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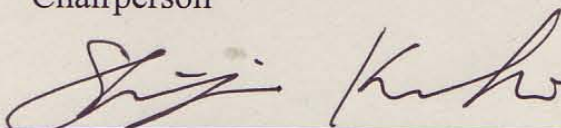**of the Requirement for the Degree of**
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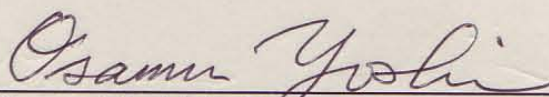
Committee on Final Examination:

Keshav Lall Maharjan, Professor
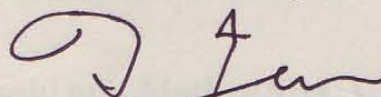Hiroshima University
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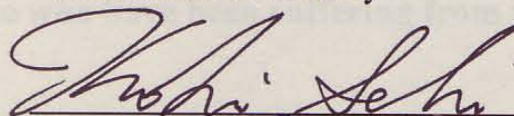
Shinji Kaneko, Professor
Hiroshima University

Osamu Yoshida, Professor
Hiroshima University
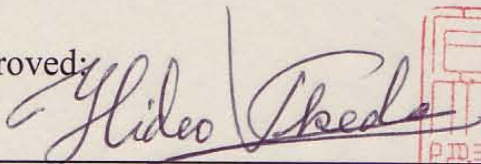
Masahiko Togawa, Associate Professor
Hiroshima University

Koki Seki, Associate Professor
Hiroshima University

Date: _____

Approved:

Date: 2, September 2011

Hideo Ikeda, Professor
Dean
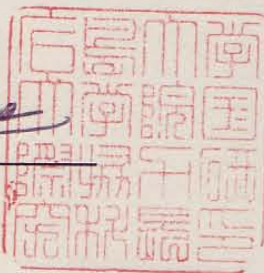
Graduate School for International Development and Cooperation
Hiroshima University

Dedication

Dedicated to my most respectable and beloved

Father Mr. Bhanu Prakash Joshi and Mother Mrs. Dhana Joshi.

This study is also dedicated to those who have been suffering from the years of social

exclusion in Nepal that led them to the destitution.

Summary of dissertation

Nepal is well-known for the richness in natural resources as well as culture including human resources. Unfortunately, the country falls under the category of least developed countries. Poverty, measured both in terms of monetary as well as non-monetary dimensions, is quite persistent in the country. Furthermore, the country, being poor with limited capacity to adapt and dependent on natural resources in greater extent, is highly vulnerable to climate change. Thus it is among the most vulnerable countries to climate change. Due to the severity of the poverty problem in the country, there is plethora of literatures on poverty. However, virtually all of these literatures are based on cross-sectional analysis that make static analysis of poverty and fail to capture the dynamic aspects of poverty. Therefore, this study aims to analyze the dynamic aspects of poverty in relation to socio-economic as well as environmental factors.

The study is based on sustainable livelihood framework. Poverty is affected by several macroeconomic indicators such as growth rate, inflation rate and population growth rate. Similarly, geographic regions such as development regions, ecological zones and rural-urban divide affect poverty. Besides this macro level consideration, micro level variables such as socio-demographic factors also affect poverty. In addition, economic factors such as resource possession affect poverty directly or through livelihoods strategies, which could be either natural resource based like agriculture and forestry or non-natural based like salaried job, remittance and business. Here, economic factors and livelihood strategies are affected by environmental factors such as temperature and rainfall trend, and climate extremes like hailstorm, landslide and flood, which can be attributed to climate change. The impact of environmental factors depends on the geographic location of the

place. With this analytical framework as well as severity of problem in mind, twelve districts representing each of five development regions as well as three ecological zones were selected for the study of poverty. Forty samples from each district were selected from the Village Development Committee (VDC) in the vicinity of headquarters through random sampling. Whereas for the in-depth study of poverty, to capture both static as well as its dynamic aspects, sixty samples, each from two VDCs of poverty-stricken Far-Western Rural Hill district of Baitadi, were surveyed in 2001 and 2007, especially. However, due to the consistency in data quality, 116 households from the first survey (in 2001) were considered for the analysis. For the analysis of poverty dynamics, second wave of survey was conducted in 2007 among the same household that was surveyed in 2001. The second wave of survey, however, could locate only 106 households. Therefore, total sample for the study of poverty dynamics constitutes 106 households. These samples were selected through stratified random sampling techniques in order to represent all strata of the households in the VDCs in terms of caste group as well as resource possession. The data was analyzed using several statistical tools such as frequencies, mean, cross-tabulation, as well as empirical tools such as regression analysis.

The study shows that poverty is quite persistent in Nepal. Such persistence of poverty, especially in the rural areas makes poverty a core issue to be researched in rural Nepal. None of the macroeconomic indicators in Nepal considered under this study are favorable for poverty reduction. Even most of the poverty reduction programs and policies implemented by the government failed to substantially reduce poverty. Besides, new environmental threats that can be attributed to climate change are emerging and adversely affect poverty in Nepal. However, it comes with a remarkable potential to generate significant amount of

revenue from international climate change regimes through mitigation effort, which also has synergy to adapt the adverse climate change impacts in the Nepalese context. The recent trend in climate variables is causing adverse impact on the yield of major summer food crops such as maize, potato and millet. Suppression of these food crops' yield significantly reduces the probability of the country falling into food self-insufficiency.

Poverty analysis based on household level data shows that the problem of food insecurity is more severe in Hills and Mountains. Also, households with higher family size and higher dependency ratio, households headed by female and households having lower resources possession are suffering from higher incidence of food insecurity. Incidence of poverty is significantly high in Far-Western Rural Hills. This is mainly due to higher concentration of female-headed households, higher dependency ratio, seasonal labor migration, low level of resource possession and geographical disadvantages that hinder access to basic social services like transportation, communication, education, and health. These are also the factors responsible for chronic and transitory poverty. Occurrence of natural disasters increases the risk of transitory poverty, i.e., move-into-poverty. Therefore, the provision of income generating opportunities could be helpful to cope with poverty. This helps to reduce dependency ratio based on economically active members to the extent of economically active age groups by ensuring income generating opportunities with regulated working hours as well as regulated wage rate. This is very critical for the poor households whose members are forced to work regardless of the nature of work as well as age in order to meet their basic needs. Expansion of irrigation could be crucial in the generation of employment through commercial agriculture. This also serves as an adaptation program to climate change, which will be very effective in dealing with the transitory poverty. Therefore, any livelihood

intervention to deal with chronic poverty should focus on Melauli, OC households, female-headed households, households headed by a head engaged in agriculture and laboring, marginal famers with small/marginal land holding with limited irrigation access, and higher dependency ratio. Whereas, targeting OC households, households head with low years of schooling, small landholding, households suffering from climate related natural disasters (more common in Melauli) will be crucial in dealing with transitory poverty (or restrict households move into of poverty).

Preface

This dissertation aims to study various aspects of poverty in poverty-stricken Far-Western Rural Hills of Nepal. Basically, it draws on the results from household level data collected through field survey in 2001 and 2007. Various socio-economic variables including environmental factors are related with both static as well as the dynamic dimensions of poverty in the study area. A deep understanding of these aspects of poverty is deemed critical in order to deal with the persistent problem of poverty in Nepal in general and the poverty-stricken region in particular.

   In doing so, this study starts with a general background (Chapter one), which introduces the research problem, and its objectives. Chapter two is about the research design. It provides a discussion on the conceptual framework of the whole study. It also provides detail information on the study area, source and nature of data, and data analysis techniques. Macroeconomic perspective of poverty in the context of Nepal, based on historical information on poverty and several related programs and policies, is analyzed in Chapter three. The outcome of this chapter appears as a review paper in the *Journal of International Development and Cooperation* (2010), Volume 16, Number 2, pp.1-19. This chapter suggests that besides several socio-economic factors, climate change is emerging as an important factor which affects poverty. Therefore, Chapter four highlights several issues of climate change in the context of Nepal, and relates these issues with poverty in Nepal. The results of this chapter were presented at an *International Conference on Climate Change, Livelihoods, and Food Security*, June 9-10, 2009, organized by the Institute of Development Studies, Jaipur, India, and appears as a book chapter (Chapter three) in a book entitled "Climate Change: Asian Perspective" published by Rawat Publication, New Delhi, India.

Chapter five focuses on the quantitative analysis of how climate variables are affecting yield of major food crops of Nepal based on the historical data for more than thirty years. This is helpful as it relates the dwindling food self-insufficiency situation of the country with climate change. A paper based on this chapter was presented at the *60th Annual Meeting of the Association of Regional Agriculture and Forestry Economics (ARFE),* 22nd to 24th October 2010, Kyoto University, Japan. After incorporating the comments received during the conference, the paper was then published in the *Journal of Contemporary India Studies: Space and Society* (2011), Volume 1, pp. 19-26.

Poverty analysis based on household data collected from the twelve nationally representative districts appears as Chapter six. Here, poverty analysis was done using descriptive as well as econometric tools. The outcome of this chapter was presented at the *58th Regional Agriculture and Forestry Economics (ARFE) Conference*, 24th to 26th October, 2008, Kobe University, Japan. The econometric analysis of the chapter was then published in the *Journal of Mountain Science* (2011), Volume 8, Number 3, pp. 403-413, whereas its descriptive analysis was published in the *Journal of International Development and Cooperation* (2007), Volume 13, Number 1 & 2, pp. 209-230.

Chapter seven and eight respectively present detailed study on the static and dynamic aspects of poverty in Baitadi District of Far-Western Rural Hills of Nepal. Part of the results were presented at *The 84th Annual Conference of The Agricultural Economics Society*, 29th to 31st March, 2010, Edinburgh University, United Kingdom, and *The 27th International Conference on Agricultural Economists*, 16th to 22nd August, 2009, Beijing International Convention Center, China. These papers were then published in the *Nepalese Journal of Development and Rural Studies* (2007), Volume 4, Number 1, pp. 16-35 and the *Nepalese*

Journal of Development and Rural Studies (2011), Volume 8, Number 2, forthcoming. Chapter nine constitutes the summary and conclusion of the whole study as well as recommendations, followed by a list of the references, and appendices.

IDEC, Hiroshima University, who were always ready to provide necessary assistance in order to ease my study and daily life in Japan.

Without the active participation of the respondents and their willingness to assist my field survey, important parts of my study would not have been completed. In this regard, I would like to express my appreciation to all the respondents, who consented to participate in my survey and provided me with the required information. I would like to thank my friends; Kishor Dahal, Nabin Khanal, Ram Bahadur Khadka, and Rekha Sapkota, who voluntarily assisted me during my field survey despite the remoteness of the study area. Similarly, I owe special thanks to Mr. Prem Singh Nayak, Mr. Jagadish Chandra Nayak, and other local residents, whose facilitation helped me to familiarize myself with the study areas which were totally new to me. This was very crucial for me to identify sampled household while making second round of survey in 2007, and stay at the survey sites.

Last but not the least, with great respect and honor, I would like to express my most sincere and heartfelt gratitude to my parents, who always have wise dreams for my successful academic achievements. They taught me the value of education, and always encouraged me to achieve the highest possible academic goal. With great pleasure, I would

also like to thank other family members; the eldest sister Neela Joshi (Rai), elder sister Nisha Joshi (Shrestha), younger sister Nita Joshi (Piya), and younger brother Lomas Prakash Joshi for their never ending love. They have always been supportive in my entire educational endeavor. My beloved nieces and nephews have always refreshed me with their cute smile and affections whenever I was stressed. Luni Piya also deserves a special gratitude for her never-ending support and encouragement.

There are many others who have contributed to this work in one way or the other. I also owe acknowledgement to all of them. I hope the underlying limitations will be understood. However, I am the only one responsible for any errors and deficiencies that still remains in this study.

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Niraj Prakash JOSHI
July 2011
IDEC, Hiroshima University

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Abbreviations

AD	Anno Domini
ADB/N	Agriculture Development Bank
AE	Adult Equivalent
AEPC	Alternative Energy Promotion Center
AGDP	Agriculture Gross Domestic Product
AIJ	Activities Implemented Jointly
APP	Agriculture Perspective Plan
B	Beta Coefficient
BNP	Basic Needs Program
CA	Calorie Availability
CBOs	Community Based Organizations
CBS	Central Bureau of Statistics
CC	Climate Change
CDCF	Community Development Carbon Fund
CDF	Cumulative Density Function
CDM	Clean Development Mechanism
CDM-EB	Clean Development Mechanism – Executive Broad
CER	Certified Emission Reduction
CF	Community Forestry
CFC	Cholorofluorocarbons
CH_4	Methane
CO_2	Carbon dioxide
$CO_{2\text{-}eq}$	Carbon dioxide equivalent
COP	Conference of Parties
CPI	Consumer Index
CR	Calorie Requirement
DFI	Depth of Food Insecurity
DFID	Department for International Development
DFO	District Forest Office
DNA	Designated National Authority

DoF	Department of Forest
EC	European Commission
EIA	Energy Information Administration
ERPA	Emissions Reduction Purchase Agreement
Exp.	Exponential
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Fund
FIS	Food Insecurity
FPAN	Family Planning Association of Nepal
FSIS	Food Self Insufficiency
FSS	Food Self Sufficiency
GCM	General Circulation Model
GDP	Gross Domestic Product
GHG	Green House Gas
GLOF	Glacial Lake Outburst Flood
GNI	Gross National Income
GNP	Gross National Product
GOs	Governmental Organizations
ha.	Hectare
HDI	Human Development Index
HFC	Hydrofluorocarbons
HH	Household
HHH	Household Head
ICIMOD	International Centre for Integrated Mountain Development
ICS	Improved Cooking Stove
IFI	Incidence of Food Insecurity
IFPRI	International Food Policy Research Institute
INGOs	International Non-governmental Organizations
IPCC	Intergovernmental Panel on Climate Change
IPRAD	Institute for Policy Research and Development
IWM	Improved Water Mill

kcal	Kilocalorie
Kg	Kilogram
KP	Kyoto Protocol
LSU	Livestock Standard Unit
m.	Meter
masl	Meter Above Sea Level
MOAC	Ministry of Agriculture and Cooperatives
MoEST	Ministry of Environment Science and Technology
MoF	Ministry of Finance
MoPE	Ministry of Population and Environment
MPHBS	Multi-Purpose Household Baseline Survey
MRDEC	Minimum Requirement of Dietary Energy Consumption
N_2O	Nitrous oxide
NESAC	Nepal South Asia Center
NFC	Nepal Food Corporation
NGOs	Non-governmental Organizations
NLSS	Nepal Living Standard Survey
NPC	National Planning Commission
NRs.	Nepali Rupees
OA	Organic Agriculture
^0C	Degree Centigrade
OC	Occupational Caste
PFC	Perfluorocarbons
PGI	Poverty Gap Index
PI	Poverty Incidence
PIN	Project Idea Note
ppb	Part Per Billion
ppm	Part Per Million
PRSP	Poverty Reduction Strategy Paper
PSI	Poverty Severity Index
RCIW	Rural Community Infrastructure Work

REDD	Reducing Emissions from Deforestation and Forest Degradation
REDP	Rural Energy Development Program
R-PIN	Readiness-Project Idea Note
RRR	Relative Risk Ratio
SAAPE	South Asia Alliance for Poverty Eradication
SAP	Structural Adjustment Program
SEIDCP	Survey on Employment, Income Distribution, and Consumption Pattern
SF_6	Sulphur hexaflouride
SFI	Severity of Food Insecurity
Sig.	Significant
SRI	System of Rice Intensification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US$	United States Dollar
VDC	Village Development Committee
WCED	World Commission on Environment and Development
WFP	World Food Programme
WFS	World Food Summit
WHO	World Health Organization

Chapter 1. General background of the study

1.1 Introduction

Nepal is a landlocked country surrounded by two emerging economic powers of the world; China in the North, and India in the South, East and West. Nepal is categorized as a least developed, poverty-ridden, geographically disadvantaged (with only seventeen percent of its land areas suitable for agriculture), economically vulnerable (export of primary products and heavily import based economy), and socially conflicted and politically volatile (suffered civil war for more than a decade) nation.

The mountainous nature of the country provides home for eight out of fourteen peaks of the world over 8,000 meters above sea level (masl) including the tallest peak, Mount Everest, (8,848 masl). Rugged terrain caused by mountainous nature of the country allows only about seventeen percent of the total land area suitable for cultivation (Food and Agriculture Organization & Wood Food Programme, 2007). This constitutes approximately 2.5 million hectares (ha.) of land with a cropping intensity varying from one to three crops per year.

There is a huge altitudinal variation in the country. It ranges from 70 masl in the Eastern region of southern plain (Kechanakalan − Jhapa) to 8,848 masl (the highest peak of the world) in the North. Such altitudinal variation has resulted in diverse climatic belt, ranging from humid subtropical in the southern plains to alpine in the North. Thus, based on the altitudinal and climatic variation, the country is sub-divided into three ecological regions; the Mountains with high Himalayas in the North, Hills with long terraced slopes in the middle, and Tarai with fertile valleys and flat sub-tropical zones. All of these regions stretch from the East to the West (Figure 1.1). These regions, which are also termed agro-ecological zones, provide production niche for different kinds of agriculture products in different

regions. For instance, the Agricultural Perspective Plan (APP) identified the Mountains as having high potential for the livestock sector. In addition, this region has higher potential for vegetable and vegetable seed production. The Hills is designated as the potential area for high value cash crops including fruits, medicinal herbs, and vegetable seeds. Similarly, Tarai is the food basket of the country having huge potential for the production of cereals, especially paddy. In addition, due to the highest proportion of land area suitable for cultivation, the region has huge potential for cash crops like sub-tropical fruits and vegetables (Agriculture Project Service Center & John Mellor Association, 1995).

Figure 1.1 Map of Nepal showing ecological and administrative division

Source: http://www.un.org.np/sites/default/files/maps/tid_188/NatBio00002.jpg

The country is divided into five development regions from the East to the West. Each of these development regions comprises all of the three ecological zones. Therefore,

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development policies are formulated and implemented according to these administrative and ecological zones. Furthermore, the country is divided into seventy five districts (Figure 1.1). Village Development Committees (VDCs) and metropolitan city/sub-metropolitan city/municipality form lower tiers of administrative division. These administrative divisions again consist of nine wards in case of VDCs and number of wards ranging from nine to thirty five in case of metropolitan city/sub-metropolitan city/municipality. Currently, there are fifty eight metropolitan city/sub- metropolitan city/municipality and 3,915 VDCs in the country.

The country is rich, not only in its geographical and ecological variation, but also well-known for its cultural diversity. Nepal is a secular multi-religious country with a majority of its people following Hinduism, which is followed by Buddhism, Islam, Kirat, Christian, Sikh, Jain, Tap jura, Garaute and Bahai respectively (Central Bureau of Statistics, 2007). Nepal, being dominated by the Hindu, its society is classified based on the Hindu Caste hierarchy, where there are four caste groups. The priestly *Brahmin* (Bahun) is at the top of the caste hierarchy with the *Kshatriya* (Chhetri – kings and warriors) just beneath them, followed by the *Vaishya* (merchants) and the *Sudra* (peasants and laborers) respectively. Below the hierarchy are the Occupational Castes (OCs) and untouchables. The OCs, also known as the *Dalit* (oppressed) or lower caste, comprise of the artisan, such as caste involved in smithing (Blacksmith/Ironsmith – *Kami* and Goldsmith – *Sunar*), shoemaking (*Sarki*), tailoring (*Damai*), pottery (*Kumal*) and making drums and performing music (*Badi*) *inter alia*. These castes are socially discriminated as polluters and considered as untouchable, though illegal by law. Outside this caste hierarchy, there is also non-caste Janajati (Indigenous peoples), which can be categorized under several ethnic groups. The country is home to more than 102 such castes and ethnic groups speaking more than ninety

two mother tongues.

The country has an estimated population of 26.4 million for the year 2007, which is growing at the rate of 2.25 percent per annum. Almost eighty six percent of the total population resides in the rural areas with very limited modern amenities such as electricity, communications, hospitals, and clean drinking water (Central Bureau of Statistics, 2008a). Agriculture is the mainstay of livelihood for the majority of its population; around sixty six percent of the total population is involved in agriculture (Ministry of Agriculture and Cooperatives, 2007). However, only around sixteen percent of the total land area is suitable for agriculture (Central Bureau of Statistics, 2003; Pantha & Sharma, 2003), which places Nepal among the country having a higher population density in arable land. Population pressure on arable land is ever increasing. It has increased from 6.7 persons per hectare in 1990-92 to 8.7 persons per hectare in 2003-05, and is ranked sixth in terms of having highest population density in agricultural land (Food and Agriculture Organization, 2008).

The agricultural sector is predominantly subsistence in nature though moving towards commercialization in slower pace especially in the vicinity of urban centers. The country, being prone to natural disasters like landslides, floods, droughts and excessive rain, the agriculture sector is hard hit by the vagaries of climatic conditions. Therefore, the growth rate of Agriculture Gross Domestic Product (AGDP) varies significantly each year. Agriculture contributes only 32.2 percent of the country's Gross Domestic Product (GDP). This has declined overtime from 52 percent in 1985 to 31.3 estimated in 2006/07 (Central Bureau of Statistics, 2008a). This lower share of agriculture on the total GDP, despite the involvement of more than sixty six percent of the economically active population, reflects inefficiency associated with the sector.

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The country ranks 142nd out of 177 countries in terms of Human Development Index (HDI), which aggregates income, education, and health (United Nations Development Programme, 2007a). Around thirty one percent of its population lives below the national poverty line, and inequality is ever increasing. For instance, the value of gini coefficient increased from 0.34 in 1995/96 to 0.41 in 2003/04 (Central Bureau of Statistics, 2005a). The situation is also similar in terms of food security attainment. Despite the predominantly subsistence nature of agriculture, around sixty one percent of farmers are not self-sufficient in meeting their food needs from their farm (Central Bureau of Statistics, 2003). Also forty two districts out of seventy five districts are suffering from food deficit. Thus, Nepal is characterized as a chronically food insecure, and food deficit country with the national undernourishment rate of 40.7 percent (Food and Agriculture Organization & World Food Programme, 2007).

Moreover, Climate Change (CC) is emerging as one of the issues that put all countries in vulnerable situation through increased stress in the economy as a whole. Nepal, being among the poorest countries with huge proportion of its population under poverty, is among the most vulnerable countries to CC as it depends on natural resources to a greater extent. Marginal population with low income, limited institutional capacity and greater reliance on climate-sensitive sectors like agriculture and forestry make the country exposed to higher risk from CC (Regmi & Adhikari, 2007; World Bank, 2008a). Besides Nepal's rugged terrain and steep topography, fragile geological condition makes the country disaster prone, which poses higher degree of vulnerability. Therefore, recent achievements of Nepal in reducing poverty are threatened by adverse impact of CC as well as increased inequality.

1.2 Statement of problem

Poverty remains deep and widespread in developing countries, and even rampant in some

cases. Due to this high prevalence of poverty and the pronounced deprivation in developing countries, issues of poverty and inequality are in the forefront of the global agenda (Chuhan, 2006). Nepal, being no exception, has been undertaking various development efforts to reduce poverty through foreign assistance.

Nepal has been getting huge amount of foreign aid to meet the goal of poverty alleviation since the start of its planned development effort in 1956. Almost all development projects in Nepal were financed by foreign aid till the mid-1960s (Bhattarai, 2007). The total aid increased from 1.95 percent of GDP in the 1960s to 10.39 percent in the 1980s and remained at 4.7 percent in 2008/09, and still finances fifty percent of Nepal's development expenditure (Bhattarai, 2007; Ministry of Finance, 2009).

During the fifth five-year development plan (1975-80), agricultural development received the highest priority in development agenda of Nepal. Such prioritization of agriculture was made as agriculture development was supposed to have positive impact on livelihoods of more than ninety percent of the population who were solely dependent on agriculture for their living. Later, since the eighth five-year development plan (1992-97), poverty reduction became a prime development agenda and the tenth plan (2002-07) was specifically formulated as Poverty Reduction Strategy Paper (PRSP) to mainstream and orients overall development efforts in order to break the poverty trap and economic stagnation for achieving the goal of poverty reduction. However, the achievements are far below the expectation. In contrast, poverty increased at an annual rate of more than three percent resulting into the number of the absolute poor almost doubling between 1977 and 1996 (South Asia Alliance for Poverty Eradication, 2003). Thus, the country remains one of the poorest countries in the world, i.e., the ninth poorest country in the world and the poorest

country outside Africa in-terms of per capita national income (Table 3.2).

Several studies on poverty made since 1977 confirm that an income-based poverty is widespread in the country (Prennushi, 1999). Poverty in the country exists in a wide variation depending on the rural-urban divide, geography, gender and caste/ethnic groups (United Nations Development Programme, 2004). This makes poverty complex and diverse, which should be understood thoroughly to achieve the goal of poverty reduction (Chhetry, 2001). Also, poverty incidence, gap, and severity analysis of the country suggest that poverty is more rampant, deeper, and severe in the rural areas and much worse in the Mid-Western and Far-Western Hills/Mountains (Central Bureau of Statistics, 2005a). Thus, rural poverty remains the core issue of poverty in Nepal, especially for Far-Western and Mid-Western Hills. Moreover, poverty analysis in Nepal is virtually based on cross-sectional data, which cannot reflect the dynamic aspects of poverty.

A recent study on poverty of the country revealed the considerable decline in poverty from 42 percent in 1995/96 to 30.8 percent in 2003/04. But, at the same time, the increasing disparities between the people has also been revealed, which is reflected by the increase in value of gini coefficient for the aggregate consumption level from 0.34 in 1995/96 to 0.41 in 2003/04 (Central Bureau of Statistics, 2005a). Currently, Nepal has the highest level of inequality in the Asia Pacific region (United Nations Economic and Social Commission for Asia and the Pacific, 2007). As any successful poverty reduction program should result on favorable increase in income as well as favorable changes in income inequality, this unfavorable change in inequality, therefore, raises the question on the success of poverty reduction programs of the country (Nissanke & Thorbecke, 2005). Such increasing disparity has serious ramifications on maintaining a sustainable economic growth as well as creates

threats to social stability. The widespread increase in inequality has detrimental effect to the objective of poverty reduction. A large rise in inequality stifles growth and thus, poverty at any given growth rate of GDP falls less rapidly in more unequal distribution than in a more equitable one (Cornia, 2004).

Poverty, being the key factor affecting food security, the situation is also similar from the perspective of food insecurity. Agriculture, the mainstay of life for the majority of the population, is still subsistence in nature and vastly lags behind in modernization with efficient production practice and has to depend largely on nature. Hence, despite this huge dependency in agriculture, sixty one percent of farmers are not self- sufficient in meeting their food needs (Central Bureau of Statistics, 2003). The situation is more severe in the Hills and Mountains; eleven out of sixteen districts in the Mountains, and twenty out of thirty nine districts in the Hill are suffering from the food deficit situation with limited market access (Food and Agriculture Organization & World Food Programme, 2007).

The incidence of undernourishment as measured by the insufficient calorie intake is estimated at 40.7 percent in the country, with the consideration of minimum calorie intake requirement of 2,124 kilocalories (kcal) per person per day set by the National Planning Commission (NPC) (Food and Agriculture Organization & World Food Programme, 2007). The Far-Western Rural Region has the lowest mean dietary energy consumption (2,250 kcal per person per day) compared to 2,405 kcal per person per day of national level. Consequently, this led to the highest incidence of undernourishment with around fifty percent of the population being undernourished in the region. There is also a serious concern for the very high level of malnutrition in Nepal. It is more serious in the Far-Western Mountains and Hills where more than sixty percent of the children are stunted and fifty

percent are underweight in contrast to the Tarai region where only 17.7 percent of children under five suffer acute malnutrition on average (Food and Agriculture Organization & World Food Programme, 2007).

The recent progress in reduction of poverty and food insecurity is attributed mainly to increasing remittances, rapid urbanization, and increased agricultural wages and off-farm employment (Central Bureau of Statistics, 2004). Agriculture sector is still subsistence as huge tracts of arable land is still rainfed, supply of input is not regulated, and the marketing of output is not organized. Therefore, the agriculture sector is experiencing sluggish growth with huge fluctuation over the years as it has to depend on vagaries of climatic conditions. Moreover, diversification in income generating opportunities also got less momentum because the majority of economically active population has to depend on agriculture. Thus, Nepal's recent achievements as well as struggle to cope with the problem of poverty and food insecurity will be challenged by adverse impact of CC such as erratic rainfall, increased temperature and consequent natural disasters (World Bank, 2008a).

1.3 Research rationale

Despite the considerable decline in poverty incidence in the country shown by recent studies, there is marked rise in overall income inequality, which is mainly due to unbalanced growth of the economy. During the period (1995/96 and 2003/04) there was significant increase in the contribution of remittance in the national economy as well as rapid urbanization (Central Bureau of Statistics, 2005a). The serious consequences of increase in disparity such as social tension, less influence of overall growth on the country's goal of poverty reduction, etc. have been well discussed in several literatures such as Zhou & Wan (2003), Cornia (2004), and Nissanke & Thorbecke (2005). These discussions increased the interest of researchers on

empirical studies on the other important aspect of poverty, i.e., inequality. Such empirical studies provide the dynamism of various sources of income on poverty; thereby providing insightful information useful for policy makers in designing and implementing inequality reducing policies vis-à-vis poverty reduction (Adams & He, 1995; Wan, 2001). For this, it is also necessary to understand the dynamics of poverty through the use of panel data.

The issue of poverty is also related directly or indirectly to the problem of food insecurity. The government of Nepal, through successive five-year plans, has undertaken various programs to increase agricultural production and reduce poverty that would consequently address the problem of food insecurity (Baidhya, 2004). However, the failure of the government to meet the target of agriculture growth and poverty reduction in most of the plan periods has raised serious concern of food insecurity and poverty in the country. Although commitments have been made by the government in several international forums regarding food insecurity, including the World Food Summit in 1996 to reduce the number of chronically undernourished people by half by 2015 (Food and Agriculture Organization, 2002), absence of regular monitoring resulted into paucity of information on food insecurity. In most of the literatures, especially in the government documents, food insecurity is assessed in terms of adequacy of the aggregate supply to fulfill the requirement of the total population, for a given time period (Seddon & Adhikari, 2003) regardless of distribution issues based on regional and socio-economic differentiation of households. This implies the lack of understanding of the food insecurity issues on the part of the policy makers and planners (Baidhya, 2004).

The unequal distribution of productive resources (agricultural land in particular), high dependence on agriculture, declining growth of agriculture and other production sectors in

contrast to high population growth, limited opportunities for income generation, and social discriminatory factors have been identified as the factors responsible for the failure of poverty reduction programs in some literatures (Adhikari & Bohle 1999; Blaikie *et al.*, 2000; World Food Programme, 2001; South Asia Alliance for Poverty Eradication, 2003; United Nations Development Programme, 2004; Central Bureau of Statistics, 2005a; Central Bureau of Statistics, 2005c; Joshi, 2008). Indeed, these factors affect the level of household food security but there lacks the study to determine which of the above factors are more critical than others. Besides, most of the studies were concentrated in the peripheral areas of urban centers ignoring the regions where the issues of poverty and food insecurity are more rampant. In addition, there is lack of analysis of poverty and food insecurity at the household level in relation to changing in climate variables.

Considering these facts, this study is designed to address the following research questions

i. How has been incidence of poverty and food insecurity changing over time in Nepal?

ii. How could climate change affects poverty in Nepal?

iii. Do climate variables have any impact on yield of major food-crops, thereby affect national food self-sufficiency?

iv. What are the socio-economic features of rural population and how have been changing over time?

v. What are the dynamics of poverty incidence in the Far-Western Rural Hills of Nepal?

vi. What are the important socio-economic variables that lead to in and out of poverty in the study area?

vii. Are there any impacts of climate change at household level in rural Nepal?

viii. What could be the effective way of dealing with the problems of poverty and food insecurity?

1.4 Research objectives

The general objective and specific objectives of the dissertation is presented in this section.

1.4.1 General objective

In general, this dissertation analyzes socioeconomic and environmental factors associated with the dynamics of poverty in Nepal as well as identifies the potential areas of intervention to deal with the problems of poverty and food insecurity in the study areas.

1.4.2 Specific objectives

To meet the above mentioned general objective, six specific objectives have been set, and are as follows;

1. Study poverty in Nepal from macroeconomics perspectives.

2. Discuss basic aspects of climate change and its relation with poverty in Nepal.

3. Examine the relationship between climate variables and yield of major food-crops.

4. Determine the socio-economic factors affecting food insecurity in Nepal.

5. Make static analysis of poverty and food insecurity in Far-Western Rural Hills.

6. Analyze the dynamics of poverty in the Far-Western Rural Hills.

Chapter 2. Research design

2.1 Definition of the concepts

2.1.1 Poverty

None of the definition of poverty is conclusive without some arguments. It is mainly due to the complexity of the concept and major fault-lines that surround the poverty debate. Individual or household measures, private consumption only or private consumption plus publicly provided goods, monetary or monetary plus non-monetary components of poverty, snapshot or timeline, actual or potential poverty, stock or flow measures of poverty, input or output measures, absolute or relative poverty, and objective or subjective perceptions of poverty are the nine fault-lines, which emerged in the course of poverty debates (Srinivasan, 1993; Maxwell, 1999). Thus, historically, the perception of poverty has evolved and varies tremendously from one culture to another (World Bank, 1990). For instance, male children represent a means of supplementing income and accumulating wealth. Thus, lower number of male children in the family is considered as poor in Bangladesh (Cain, 1977). Similarly, parents of small families are perceived as being poor in India and Indonesia (Mamdani, 1972; Hull, 1975). Whereas, land is directly related to poverty in Nepal as it is the most important source of wealth, status and power (Regmi, 1999).

Lowness of incomes is considered basic to the poverty analysis. Deprivation of basic capabilities propounded by Sen in 1999 is a widely accepted definition of poverty rather than merely as lowness of incomes. The capabilities are inclusive of almost all factors and processes – social, economic, political, and other factors. It could be not having enough food to eat, low standard of living, a high mortality rate, low life expectancy, high rates of unemployment, squalor, illiteracy, social exclusion, marginalization, and persecution

including psychological and physical loss. He further argues that since income is such an important means to capabilities, the two perspectives, lowness of income and deprivation of basic capabilities, is related. Thus, enhanced capabilities in leading a life would tend to expand a person's ability to be more productive and earn a high income.

"Inability to lead a decent life" is a simple formulation, which has almost universally been quoted. However, here 'decent life' can be considered from different perspective. It can be seen in relation to time, space, society, and family, both across and within. Therefore, which particular definition of poverty to be adopted, depends on the situation in which poverty analysis is carried out (Food and Agriculture Organization, 2003).

Notions of relative, subjective, and absolute poverty are quite prevalent in the literature on poverty (Ravallion, 1992; Pradhan & Ravallion, 1998; Prennushi, 1999; Ellis, 2000; Food and Agriculture Organization, 2003; Bhatta & Sharma, 2006; World Bank, 2008d). Objective identification of a 'poverty line' is the starting point of most poverty analysis in order to distinguish the 'poor' from 'non-poor'.

a. Relative poverty

Relative poverty measures the extent to which households' financial resources fall below an income threshold for the economy. The relative poverty line is simply a cut-off point, and is defined in relation to the overall distribution of income or consumption. For instance, the relative poverty line could be set at fifty percent of the country's mean income or consumption. Since the fall in financial resource is assessed based on the given society, it is neither comparable across regions with different income levels, nor it permits ready comparison overtime. The definition of poverty given by European Commission (EC), i.e., 'Poverty is the situation of the people in which resources including material, social and

cultural are so limited as to exclude them from the minimum acceptable way of life in the countries in which they live', is in line with the concept of relative poverty (European Economic Community, 1985). Relative poverty can also be viewed synonymous to measuring inequality. In such context, if the society gets more equal income distribution, relative poverty will fall. Thus, the concept of relative poverty is more applicable in case of developed countries (Food and Agriculture Organization, 2003).

b. A subjective poverty

A subjective poverty is a measure of poverty based on the perception of a person whether the income earned by the person is able to meet his/her basic needs. Thus, subjective poverty line is the minimum level of income that a person feels is required (self-assessed) to meet his/her basic needs including both food and non-food items (Food and Agriculture Organization, 2003). Therefore, this measure can also be regarded as self-reported measures of poverty (World Bank, 2008d). In contrast to absolute poverty measure, this is the perception of the household and also takes into consideration the people living in different regions and for the same people overtime with the same level of welfare. Therefore, a subjective poverty line may differ from one region to another region and from one time to another. This concept of poverty is mainly applicable to developed countries (Food and Agriculture Organization, 2003).

c. An absolute poverty

This measure is based on absolute poverty line. An absolute poverty line is linked to a minimum welfare level necessary for life as a human being. It is set in the monetary term representing the annual income required to allow a household to purchase range of goods and services that are seen as constituting the minimum acceptable way of life. Once the

income required to attain a minimum welfare level necessary is defined, it is possible to distinguish the 'poor' from 'non poor' and also monitor poverty over time. The comparison between 'poor' and 'non poor' is made over time or across groups irrespective of where they live, or all the households are treated in the same way regardless of geographical, economical and other variations. Most of the developing countries and the World Bank use this measure of poverty based on absolute poverty line (Food and Agriculture Organization, 2003).

An absolute measure of poverty in terms of food and non-food poverty will be a concern for this study. The poverty line for the study will be determined based on the price of various consumption items in the study area.

The concept of absolute poverty has evolved overtime in order to encompass a variety of issues moving from its initial treatment as an economic phenomenon (from Rowntree in 1901) to take a number of social phenomenon (to Human Development Index by United Nations Development Programme in 1990 and Amartya Sen in 1999). In the present context, the definition propounded by Amartya Sen is the most commonly used definition. He introduced the concept of "deprivation of basic capabilities" in order to supplement "lowness of income" (Sen, 1999). Thus, poverty has two broad dimensions namely; monetary and non-monetary dimensions. Monetary poverty is a quantitative measure of poverty using information on income or consumption, whereas non-monetary poverty is associated with the insufficient outcomes with respect to health, nutrition, literacy, deficient social relations, insecurity, low self-confidence and powerlessness (United Nations Development Programme, 2005).

The application of monetary dimension of poverty dominates the literature on poverty

(Gradin *et al.,* 2008). Even within the monetary dimension of poverty, there are two measures of poverty i.e., income measure and consumption measure of poverty. We can see the growing evidences in supplementing the income measures with consumption measures. Income-poverty is the most widely used measure of poverty. There is not much dispute on the measure of income to use. Here, poverty line is first established based on the estimated amount of money necessary to meet the basic necessities for a given period in a given location. Households, which are not able to meet the poverty line, are then categorized as poor.

There is a lack of consensus on the measure of consumption to use in case of the consumption measure of poverty (Bryan, 2002; Johnson *et al.,* 2005; Bavier, 2008). Food insecurity is the most important subset of consumption-poverty in the case of developing countries where food is the first and the most important priority for any household (Rhoe *et al.*, 2008). Food insecurity is calculated through a measurement of food consumption and calorie requirement of the sampled households (Maxwell & Frankenberger, 1992). Calorie consumption of a household can be calculated through the calorie conversion of major food items consumed by the sample household (Prennushi, 1999). For a calculation of the calorie requirement, standard calorie requirement per person should be identified first. Then, based on the adjusted family size, i.e., adult equivalent (AE) that takes into account of the age and gender of household members, the total calorie requirement of household should be calculated. Thus, the household whose consumption falls below standard requirement can be categorized under food insecure household. Thus, poverty is regarded as both income as well as consumption (food insecurity) poverty in this study.

Once the poverty line (income or consumption threshold level) is established, the

magnitude of poverty can be assessed through headcount index (poverty incidence), poverty gap index, and squared poverty gap index (severity index). Headcount index is the proportion of the population living below the poverty line. This measure is appealing due to its easy interpretation. Thus, it is the most commonly applied measure of poverty. However, this measure is indifferent as to whether the poor have income/consumption level just below the poverty line or they lie far below the poverty line. In such case, two populations with the same headcount index might differ markedly; in one, the poor are concentrated just below the poverty line, while in the other, they have income/consumption level well below the poverty line. Thus, headcount index is completely insensitive to the degree of poverty.

The second measure, poverty gap index, provides information regarding how far off the poor households are from the poverty line. Thus, it goes some way towards addressing the problem of headcount index. This measure calculates the distance between the income/consumption levels of the poor and the poverty line; the greater the distance (value moving close to 1) the higher will be the poverty gap. The distance is the total resources needed to bring all the poor to the level of the poverty line. In this way, the poverty gap can be used as a measure of the 'minimum amount of resources necessary to eradicate poverty' or the amount that one would have to transfer to the poor under perfect targeting to bring them all out of poverty (World Bank, 2008d).

The squared poverty gap index (severity index) is similar in construction to the poverty gap but it applies different weight to the households below the poverty line depending on their distance from the poverty line. In other words, it takes into account the inequality among the poor. The squared poverty gap index is thus particularly reflects the severity of poverty, and a higher weight is placed on those households who are further away from the

poverty line. Higher the value of the squared poverty gap index (moving towards 1) the more severe will be the poverty.

2.1.2 Food security

World Food Summit (WFS) in 1974 defined food security as "Availability at all times of adequate world supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuation in production and prices".

However, Sen 1981 shifted the discussion of food security from availability towards entitlement and access to food. According to Sen, 1981

An individual's entitlement is rooted in his/her endowment – the initial resource bundle – which is transformed via production and trade into food or commodities which can be exchanged for food. If the entitlement set doesn't include a commodity bundle with an adequate amount of food the person must go hunger.

Thus, he argues that food insecurity affects people who cannot access adequate food because of lack of entitlement irrespective of ample food availability.

In 1983, the Food and Agriculture Organization (FAO) expanded the concept of food security as "*state of being ensured that all people at all times have both physical and economic access to the basic food they need*". The WFS in 1996 further elaborated the definition stating that "*Food security, at an individual, household, national, regional and global levels is achieved when all people, at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*". The same summit noted that 'income poverty is a major cause of food insecurity and sustainable progress in poverty eradication is critical to improve access to food'.

Further the United Nations Development Programme (UNDP) refined the definition of food security as a state of affairs when all the people at all times have physical, social and economic access to sufficient, safe and nutritious food that meet their dietary requirement for an active and healthy life without compromising the productive capacity of natural resources, the integrity of biological systems, or environmental quality (United Nations Development Programme, 2000). After this, the concept of food security revolves around the four important aspects of availability, accessibility, stability in availability and accessibility, and utilization of food by an individual to maintain healthy and active life.

The World Bank has made a distinction between chronic and transitory food insecurities relating it with temporal dimension of food insecurity which is applicable even in the case of income poverty. Chronic food insecurity occurs when an individual or household experience continuous (repeated) inadequate diet for longer period caused by the inability to acquire food. It affects households that persistently lack the ability to either buy food or to produce their own. The transitory food insecurity, on the other hand, is defined as a temporary decline in the household's access to enough food. It results from instability in food prices, food production and household income.

Food insecurity also has spatial dimension which refers to the degree of aggregation at which food security is being considered. It is possible to analyze food security at the global, continental, national, sub-national, village, household, or individual level. However, the application of the concept has been narrowed down from the global context to household in recent days.

Household is defined as "co-residential unit, usually family based in some way, which takes care of resource management and primary needs of its members". Kinship, residence

and resource management for primary needs are the three important elements of the definition (Rudie, 1995). The provision of food is the most important primary needs and thus remains the core task of households (Balatibat, 2004). Therefore, household, as a unit of analysis, offers some distinctive advantages over larger units of analysis, especially in the rural setting where households are the primary unit of production, consumption and exchange (Sandoval *et al.*, 1987). The International Food Policy Research Institute (IFPRI) also recognized the calorie acquisition as an important outcome measure of food security at household level (Hoddinott, 1999).

2.1.3 Livelihoods

Thinking of livelihoods dates back to the work of Robert Chambers in the mid-1980s. The failure of conventional concept to yield the desired effects together with exposure to enormous population pressure leads to the development of the idea of sustainable livelihoods by Chambers, which is intended to enhance the efficiency of development co-operation (Kollmair & Gamper, 2002).

For the first time, however, livelihood, as an integrating concept, was put forward by the World Commission of Environment and Development (WCED) in 1987. The commission defined livelihood as 'a*dequate stocks and flow of food and cash to meet basic needs*'. Adequate stocks and flow of food and cash here refers to the ownership of or access to resources and income-earning opportunities, including reserves and assets to reduce the risks, ease shocks and meet contingencies. The WCED considers sustainable livelihood security as precondition for a stable human population, a prerequisite for good husbandry and sustainable management and a means of reversing or restraining destabilizing process especially rural to urban migration. Therefore, the panel of the WCED 1987 argued that

sustainable livelihood should be an integrating concept.

Chamber & Conway in 1991 developed the perspective of sustainable livelihoods as a concept that also provides the resources and conditions for the enhancement and exercise of capabilities. They proposed the definition with slight modification in the definition proposed by the WCED, 1987, and defined it as follows:

> A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a mean of living: a livelihood is sustainable, which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term (Chamber & Conway, 1991).

Carney (1998) and Scoones (1998) adopted the same definition given by Chamber & Conway in 1991. Carney incorporated the idea of sustainability in the definition: '…maintain and enhance its capabilities and assets both now and in the future' (Carney, 1998). Scoones did the same by saying '… maintain and enhance its capabilities and assets not undermining the natural bases' (Scoones, 1998).

Lipton *et al.* (1996) define livelihood from different perspective. Their view is as follows; since individuals and households create a living from various sources like farming, rural non-farm work and seasonal migration to work away from their homes, livelihood can be summarily defined as the number of days in a year sufficient to produce enough income to keep the household out of poverty, which in the particular text was pegged at 200 days.

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Bagchi *et al.* (1998) define livelihoods as '*the combination of opportunities that constitute bundles of different income sources*'. This definition was developed in the context when economics dominated the development debates and agricultural economists mostly did livelihoods analyses. In these analyses, resources were defined as assets and combinations of these assets with skills and labor in various ways provide an income to the households. In this process, differential access to resources received limited attention. Therefore, various opportunities are provided to access income. Among various opportunities, household, as a unit, chooses to pursue these opportunities, which provide the biggest pay-off.

With these definitions, we can observe that there are two broad approaches to define livelihoods. The first approach defines livelihood with economic focus on production, employment and household income. The second approach, however, has holistic view that unites concepts of economic development, reduced vulnerability, environmental sustainability, while identifying and building on the strengths of the poor.

Thus, in simplest sense, livelihood is a means of gaining a living. Capabilities, equity and sustainability are both end and means of livelihood. A livelihood provides the support for the enhancement and exercise of capabilities, and capabilities enable a livelihood to be gained. Similarly, any minimum definition of equity must include adequate and decent livelihoods for all and equity in assets and access are preconditions for gaining adequate and decent livelihoods. Sustainable mobilization of resources is a value, in itself, and provides conditions for livelihoods to be sustained for future generations. These three pillars of livelihoods are foundation for sustainable livelihoods. Sustainable livelihoods mean the ability to cope with and recover from shocks and stresses, and maintain their capabilities and assets without undermining the natural base (Chamber & Conway, 1991). Therefore, the

concept of livelihood gained wide acceptance as a valuable means of understanding the factors that influence people's lives and well-being, particularly those of poor in the developing world's or a way of conceptualizing the economic activities the poor people undertake in their totality (Carney, 1998).

2.1.4 Climate change

Climate change (CC) refers to a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer (Intergovernmental Panel on Climate Change, 2007a). Natural variability or human-induced increases in Green House Gases (GHGs) are the main factors responsible for CC. Human-induced increase in GHGs, which is also termed as anthropogenic GHGs are the major factors responsible for CC as their concentration in the atmosphere has increased remarkably compared to that of pre-industrial era. Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and F-gases such as perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and chloroflourocarbons (CFCs) are the most prominent GHGs that trap heat and cause global warming or CC (Intergovernmental Panel on Climate Change, 2007a). Fuel combustion, deforestation, transportation, agriculture, urbanization, and industrialization are the main sources of GHGs emissions. A concentration of CO_2 has increased from 280ppm in pre-industrial value to 379ppm in 2005. Similarly, during the same period, the concentration of CH_4 and N_2O has increased from 175ppb to 1,774ppb and 270ppb to 319ppb respectively. The concentration of the total CO_2 equivalent (CO_2-eq) of prominent GHGs is around 455ppm CO_2-eq , which should be stabilized below 550ppm CO_2-eq in order to avoid any harmful irreversible consequence of CC caused by temperature rise by more than 2^oC (Intergovernmental Panel

on Climate Change, 2007a).

There is general consensus among academics that global warming, an indicator of CC, is occurring at the faster pace resulting in sea level rise, glacial retreat, location specific drought and inundation, health risk, biodiversity degradation etc. Variability in climatic variables such as precipitation is another important indicator of CC. All these would bring change with regard to the incidence of natural disasters such as droughts and floods, decline in agriculture production, fisheries and marine life, water resources availability, industry and human health.

2.2 Means of securing livelihoods in rural Nepal

As shown by the reviewed literatures, poverty is basically a rural phenomenon all round the world in general and in developing world in particular. It is, thus, necessary to understand how rural people derive their basic necessities. In Nepal, more than eighty five percent of its population resides in rural areas where development or availability of basic social services like transportation, communication, health facilities, drinking water, education and etc. are either quite limited or absent. Thus, the concentration of poverty is remarkably higher in the rural areas i.e., more than ninety five percent of poor in Nepal resides in the rural areas (Central Bureau of Statistics, 2005b).

The rural households throughout the history of Nepal have followed multiple survival strategies. Farming used to be and still is a main source of livelihoods. Farming essentially consisting of crop, livestock, and forest, each using products and byproducts of the other in an efficient way, is still an important source of living for more than ninety percent of rural population. All these three components of farming were able to supply food, fuel, medicine, shelter, labor, and other needs of the households of different sizes and ethnic/caste groups

(Figure 2.1). Thus, the farm products were consumed directly or indirectly through exchange system, such as by exchange of foods, or by borrowing foods to meet the food needs. The relationship between these farm components has been maintained traditionally for centuries through community participation based on the concept of mutual aids, which also determine sustainability of the system (Maharjan, 2003).

Since the eighteenth and nineteenth centuries, permanent and temporary migration to other areas of the country and beyond became another major strategy adopted by rural households (Adhikari & Bohle, 1999). The poor in search of secured livelihoods and even relatively wealthier Hill farmers in search of economic opportunities were the main causes of migration. Migration among rural households also took place as responses to economic hardships caused by population pressure (Poffenberger, 1980; Adhikari & Bohle, 1999), and land and labor policies that encouraged settlements in malaria prone plain areas of the country (Shrestha, 1990).
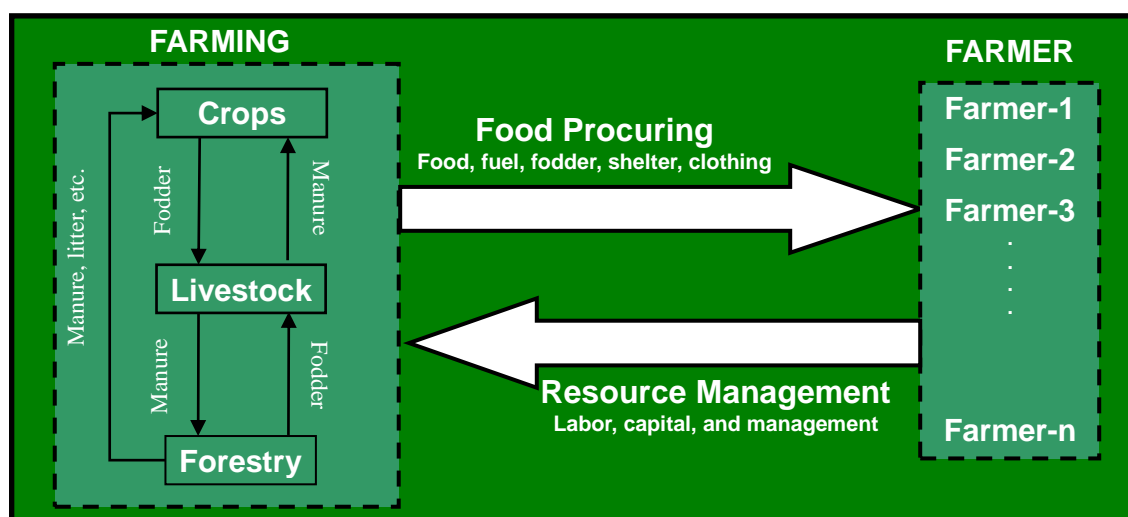
Figure 2.1 Traditional process of securing food in Nepalese rural households
Source: Maharjan, 2003

Vulnerability to subsistence Mountain farming and farming community as a whole was

added due to fragile and marginal nature of the farming system, and inaccessibility. In addition, low literacy rates, very limited access to physical and social facilities, high dependence on fragile agriculture, and low levels of food self-sufficiency at household level further aggravated the vulnerable situation in the areas. Thus, the failure of the integrated use of the subsistence agriculture and natural resources from which they were neither able to generate economic surplus nor were able to find off-farm income employment opportunities resulted in vigorous change in livelihood strategies (Maharjan, 2003). Rapid population growth and degradation of resource base resulted in shifting of their emphasis from subsistence farming to other sources of income to maintain their livelihoods (Adhikari & Bohle, 1999).

Market penetration due to liberalization and globalization also brought considerable changes in livelihoods strategies even in the rural areas. There was gradual breaking up of the isolation of rural people providing them with greater option to secure their livelihoods or diversify their livelihood strategies to gain resilience. Rural people are currently securing their livelihoods through serving the needs of the urban and wealthier households by supplying them with quality village products including both agricultural and non-agricultural products like milk, ghee, herbs, wild foods and stone slate etc. In addition, increased opportunities for seasonal and short-term labor migrations are helping them to meet their livelihood demands. The strategy of securing livelihoods by consuming cheap and low quality food products by selling their home produced quality goods at higher prices is also possible due to market penetration (Adhikari & Bohle, 1999). Thus, securing food through exchange system such as by the purchase/exchange of food or by borrowing food or money to purchase food is common (United Nations Development Programme, 2005). With

this, the farmers turn to non-farm activities, agro-based and or non-agro-based in nature within the rural regions and beyond, creating a new paradigm of livelihood inducing dynamism (Figure 2.2).

Agro-based non-farm activities are food and agro-processing and marketing activities such as processing of rice, milk, meat and other agricultural products, their marketing and transportation. Other non-farm activities are physical construction work relating to irrigation, roads, tailoring, governmental and nongovernmental work, laboring, etc. Non-farm activities beyond rural areas are many and diverse such as government jobs, small and large entrepreneurship, shop-keeping, factory working, transportation, laboring and migratory laboring, etc. (Maharjan, 2003). Most of the households combine these different strategies to minimize risk and optimize the use of natural and economic resources (Müller-Böker & Kollmair, 2000).
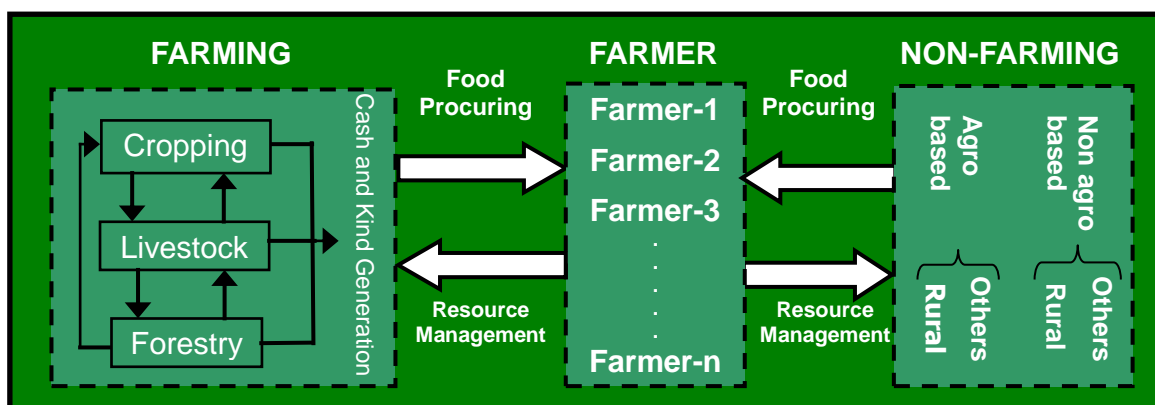
Figure 2.2 Recent dynamism in the process of securing food in rural households
Source: Maharjan, 2003

2.3 Conceptual framework

It has been realized that reducing poverty is not simple. Moreover, rural situations are diverse and evolving. Therefore, the understanding of poverty must adapt to these diversities and dynamisms (Ashley *et al.,* 2003). The failure of previous dominant theories and

practices to deal with such diverse and dynamic situation lost their intellectual and political attraction leading towards the development of sustainable livelihoods framework. The framework emerged through the continuous strengthening with the involvement of range of actors including researchers, practitioners and policy makers (Solesbury, 2003). A sustainable livelihoods framework was developed as a tool to improve the understanding of livelihoods of the poor based on six core principles i.e. people centered, holistic, dynamic, building on strength, macro-micro link and sustainable (Department for International Development, 1999).

Livelihood approach is multiple, diverse, adaptive, flexible and cross-sectorial, and suggest the mismatch between macro level poverty reduction strategies and the realities of micro level livelihoods. The sustainable livelihoods approach to poverty provides a powerful framework within which micro level experiences of poverty and vulnerability can be connected to the policy context that implements the strength and weakness of peoples' own efforts to escape from poverty (Ellis & Freeman, 2005).

Livelihoods framework capture not just only what people do in order to make a living, but also attempts to capture the resources that provide them with the capability to build satisfactory living, the risk factors that they must consider in managing their resources and the institutional and policy context that either helps or hinder them in their pursuit for a viable or improving living. Capability, equity and sustainability thus became the fundamentals of the livelihoods concepts right from the evolution of the concept (Chambers & Conway, 1991).   The concept of capability here well incorporates the capability approach of Amartya Sen, 1985 (Chambers & Conway, 1991; Bagchi *et al.*, 1998).

The analysis in this study is, therefore, based on the sustainable livelihoods framework

developed and adopted by several academic works by researchers for their research on the field of poverty. The whole framework includes five basic components namely; livelihood assets, transformation structures and processes, livelihood strategies, livelihood outcomes, and vulnerability contexts. Each of these components is described below under different subheadings.

Livelihood assets

The detail description of the framework starts with the conceptualization of term assets, which could be understood as resources or capital. These assets are often categorized into five distinct asset types owned or accessed by family members: human capital, social capital (networks and association – involvement in community organization), natural capital (Land, water – drinking water and irrigation, forest), physical capital (infrastructure, tools and equipment) and financial capital (money, saving, income, loan access) (Figure 2.3).
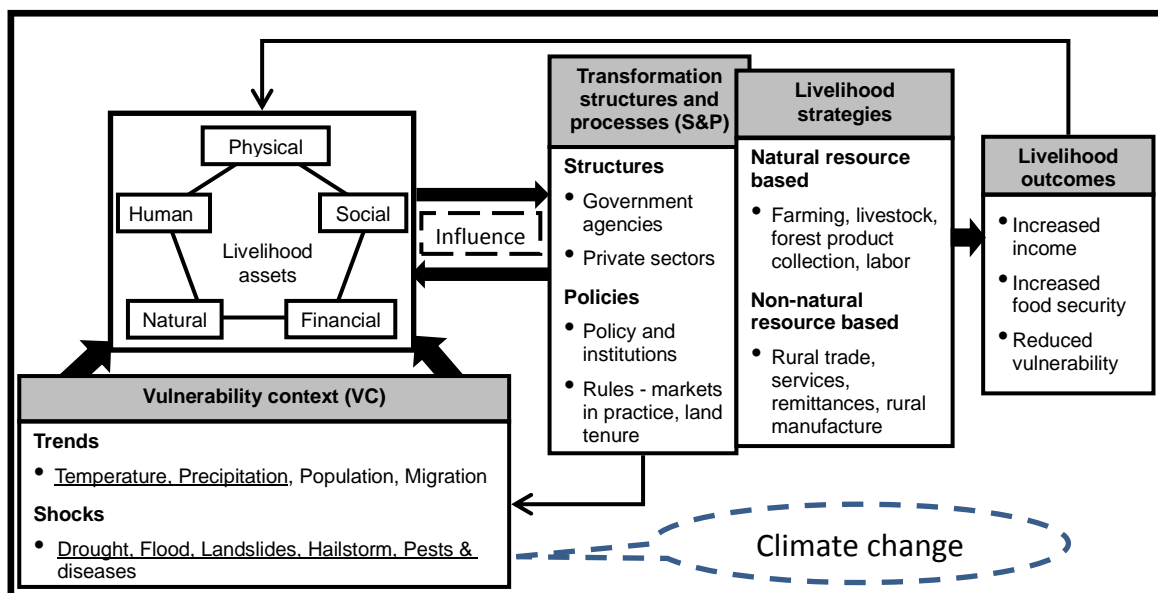
Figure 2.3 Conceptual framework for the study

Adopted from: Department for International Development, 1999; Ellis, 2000

Human assets consist of skills, knowledge, ability to labor and good health, which are

important to the pursuit of livelihood strategies in order to achieve their livelihood objectives (Scoones, 1998; Department for International Development, 1999; Kollmair & Gamper, 2002). The amount and quality of labor available is considered as human assets at a household level. Thus, human assets vary according to household size, skill levels, leadership potential, health status, etc. This asset is a building block for achieving livelihood outcomes. Education, both formal and informal, is a good indicator to assess human capital besides the proportion of able-bodied member in a given family (Department for International Development, 1999).

Social assets are the quantity and quality of social resources upon which people draw in the pursuit of livelihoods. These are developed through networks and connectedness, membership in community organizations, social relations, and access to wider institutions in the society. The level of trust and shared norms that exist between network members determine the quality of networks. These networks are helpful to reduce risks, access services, protect themselves from deprivation, and to acquire information to lower transaction costs (Scoones, 1998; Department for International Development, 1999; Kollmair & Gamper, 2002). Birth, age, gender or caste, etc. quite often determine access and amount of social capital (Kollmair & Gamper, 2002). Social asset can be gauged by counting the number of registered community organizations in a community together with assessing the nature and quality of the community organizations as well as the overall role and participation in the organization (Department for International Development, 1999).

Natural assets consist of natural resource stocks from which resource flows useful for livelihoods are derived (Scoones, 1998; Department for International Development, 1999; Kollmair & Gamper, 2002). Land, water, wildlife, biodiversity, and environmental

resources are some of the important examples of natural capital. It is of special importance for those who derive all or part of their livelihoods from natural resource-based activities. There exists close relationship between natural capital and the vulnerability context. Many of the devastating shocks for the livelihoods such as fires, floods, and earthquakes are natural processes that destroy natural assets (Kollmair & Gamper, 2002). Access, type and quality of natural resources are important characteristics in assessing natural resources.

Physical assets include basic infrastructure, production equipment, and other material such as affordable transport, secure shelter, adequate water supply and sanitation, clean and affordable energy, and access to communication and information that are needed to support livelihoods (Department for International Development, 1999; Kollmair & Gamper, 2002). Access and priority are the key concern for assessing physical assets (Department for International Development, 1999).

Financial assets are cash and other liquid resources that people use to achieve their livelihood objectives. There are mainly two sources of financial assets namely; available stocks and regular inflows of money. Cash, savings, or liquid assets that do not have liability attached can be categorized under available stocks. On the other hand, labor income, pensions and other transfers from the state, and remittances are categorized under regular inflows of money (Scoones, 1998; Department for International Development, 1999; Kollmair & Gamper, 2002). Types and financial services of financial institution in which the household has access, and their saving or credit on such financial institution is very important in analyzing financial assets (Department for International Development, 1999).

Transfer structures and processes

Transfer structures and processes represent institutions, organizations, policies, and legislations that shape livelihoods. Structures could be defined as hardware that includes the organizations both private and public. Structures set and implement policy and legislations, deliver services, purchase, trade and perform all manner of other functions that shapes livelihoods (Department for International Development, 1999). The presence of well working structures is very crucial for sustainable development. Their absence makes simple asset creations difficult; thereby impede access to apply a livelihood strategy (Kollmair & Gamper, 2002). In the context of structures regarded as hardware, processes can be regarded as software that determines the way in which structures and individuals operate and interact. Policy and institutions, rules, norms and values can be regarded as processes. They are very crucial but are also complex. They are crucial because they serve as incentives for people to make choices as they may determine the access to assets or they may enable stakeholders to transform and substitute one type of asset through another. Similarly, they are complex as there are many types of processes operating at variety of different levels that may overlap and conflict between them (Department for International Development, 1999; Kollmair & Gamper, 2002).

Livelihood strategies

Livelihood strategies denote the range and combination of activities and choices that people adopt in order to achieve their livelihood goals (Department for International Development 1999). Livelihood strategies can include various types of production and income-generating activities such as agricultural production, off-farm employment, informal sector employment, etc. or often a complex combination of multiple activities (Kollmair & Gamper,

2002). It could be broadly classified as natural resource based livelihood strategies and non-natural resource based livelihood strategies. Farming, livestock, forest product collection, laboring etc. are some of the natural resources based livelihood strategies, whereas rural trade and services, remittance, rural manufacturing are some examples of non-natural resources based livelihood strategies. Access to overall assets and transformation structure & processes is the determining force for livelihood strategies to be undertaken by rural households. Some of the important rural livelihood strategies in Nepal were discussed under the sub-section 2.2 Means of securing livelihoods in rural Nepal.

Livelihood outcomes

The achievements or output of livelihood strategies are livelihood outcomes. More income that can be associated with income-poverty, and improved food security that can be related with consumption poverty, and reduced vulnerability, which can be linked with sustainability of livelihood assets, are important indicators of livelihood outcomes (Department for International Development, 1999; Kollmair & Gamper, 2002). This dissertation considers income-poverty and food insecurity as the indicators of livelihood outcome.

Vulnerability context

The vulnerability context frames the external environment in which people exists and gain importance through direct impacts upon people's asset status (Department for International Development, 1999; Devereux, 2001). It comprises trends (population, temperature, precipitation, migration, etc.), shocks (drought, flood, landslides, hailstorm, pest & diseases, etc.), and seasonality over which people have limited or no control. Vulnerability context affects people's livelihood and wider availability of assets. However, not all trends and

seasonality should be considered as negative; they may have positive aspects as well. Trends and new technology or seasonality of prices could be opportunities to secure livelihoods (Department for International Development, 1999; Kollmair & Gapner, 2002). Besides, increasing trend in temperature and unpredictable rainfall pattern will increase vulnerability. In addition, shocks like drought, flood, hailstorm, landslide, and increased incidence of insects and pests are some of the factors that increase vulnerability to rural household resulting into negative impacts on livelihood outcomes through loss of the assets.

Interaction of components within the framework

Influenced by each other, livelihood assets and transformation structures and processes determine livelihood strategies that a given household is undertaking. Such livelihoods strategies can be either natural resource based or non-natural resource based. Achievements or outputs of livelihood strategies can be assessed in terms of increased income, improved food security or reduced vulnerability. Livelihood outcomes directly influence the assets and could change their level (size), offering a new starting point for other strategies and outcomes. Achievements of desired livelihood outcomes would result in expansion of livelihood assets, whereas failure to achieve desired livelihood outcomes would result in shrinking of livelihood assets. These livelihood assets could also be affected by vulnerability in which people have limited or no control. In some cases, transformation structures and processes would also contribute to vulnerability context.

2.4 Analytical framework

Based on the preceding section of this chapter, including the basic concepts, means of securing livelihoods and conceptual framework, this dissertation will follow the analytical framework based on Figure 2.4.
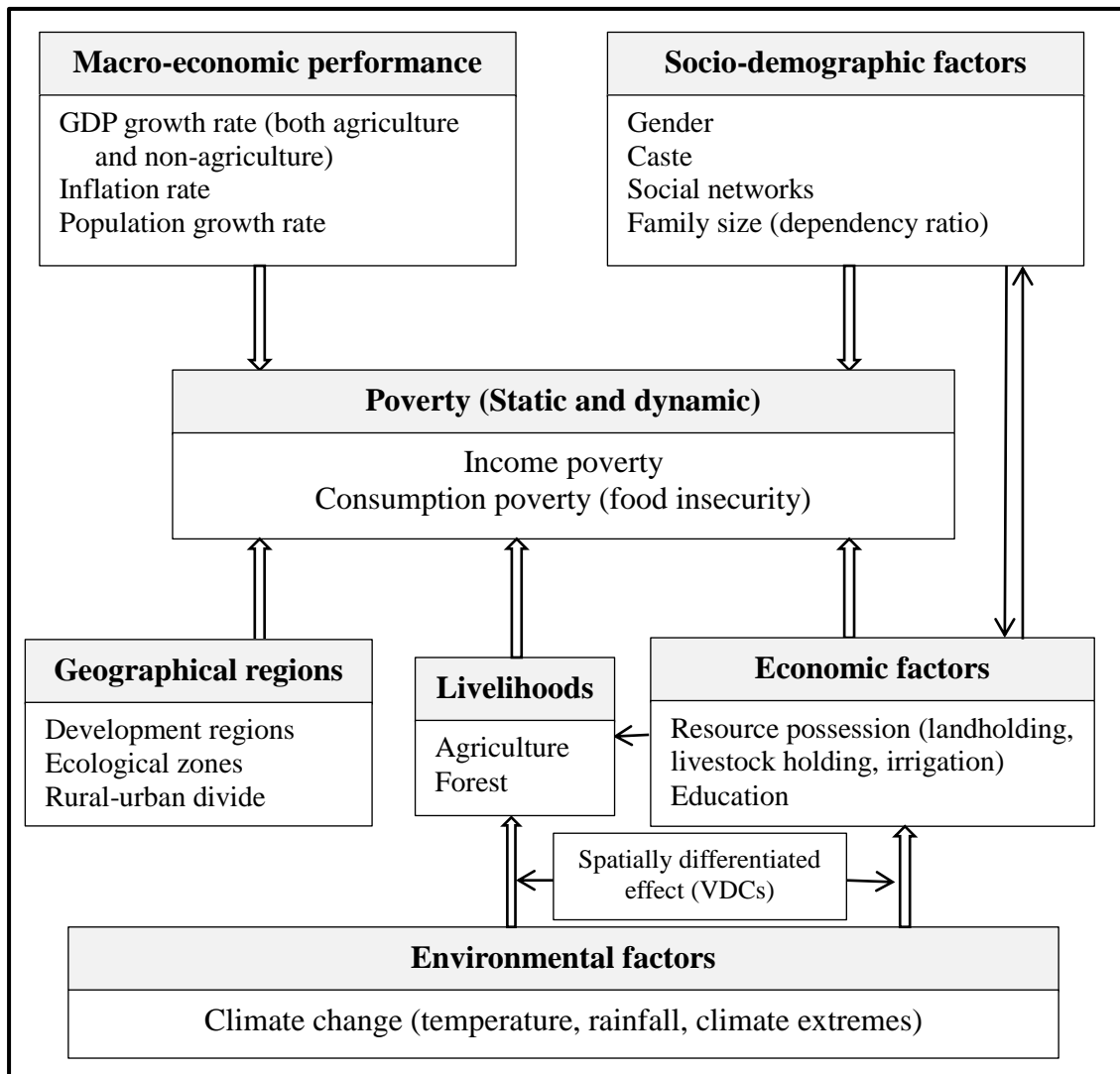
Figure 2.4 Analytical framework of the study

Here, poverty (income poverty as well as food insecurity) is the core issue under study. From macro perspective, the poverty of the country will be affected by several macroeconomic indicators such as GDP (both AGDP as well as Non-AGDP), inflation and population growth. Besides, at the macro level, poverty will also be influenced by geographical variation of the country. At micro level, various socio-economic variables like gender, caste, social networks, family size and etc. will affect both static as well dynamic aspects of poverty. An economic factor is another crucial factor that affects it directly as well through

livelihood strategies as discussed in the conceptual framework. Mostly, the geographic factors, economic factors and livelihood strategies will also be adversely affected by environmental factors. Climate change, which can be attributed to the increasing trends of temperature and rainfall and also climate extremities, will affect poverty.

2.5 Study area

The study area was selected purposively considering the depth of the problem. Initially, twelve districts were selected in order to make the poverty (consumption poverty) analysis throughout the country. Later, a Far-Western Rural Hills region was chosen for the in-depth study of poverty. This region is dominated by *Chhetri*, followed by *Dalit* and B*ahun* caste groups (Central Bureau of Statistics, 2008b). This region falls far behind in terms of HDI (Figure 2.5), which is based on per capita income, health status, and education status of the region (United Nations Development Programme, 2004). Baitadi district from this region was selected for the detail study of poverty in order to capture both spatial and temporal dimension of poverty. This is a remote district with a rugged terrain falling under the category of districts having the lowest HDI (United Nations Development Programme, 2004). *Chhetri* is the dominating caste group in terms of population in Far-Western Rural Hill, followed by *Bahun* and *Dalit* respectively. Similar distribution of caste and ethnicity is reported in the district as well (Maharjan, 2003; Central Bureau of Statistics, 2008b).
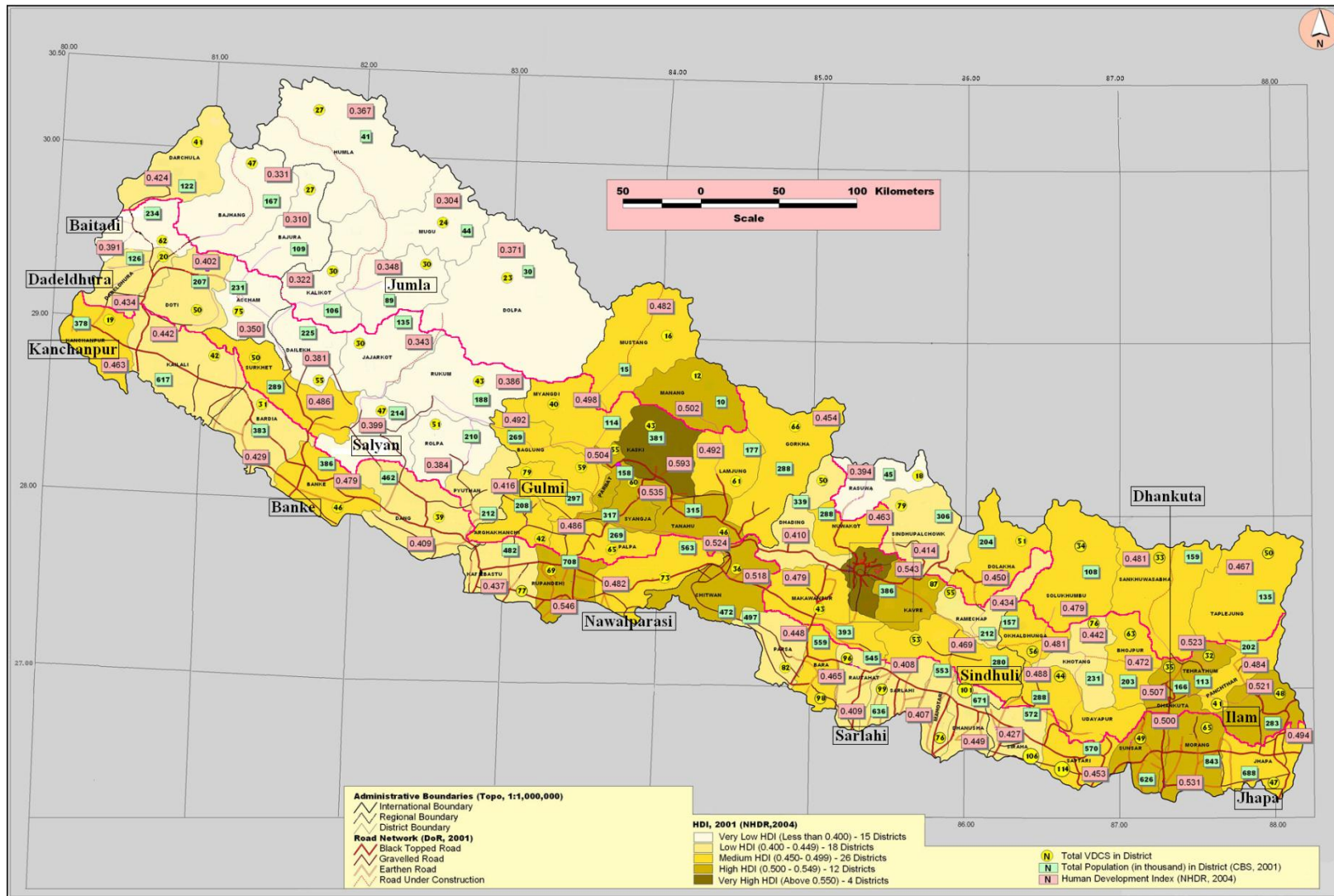
Figure 2.5 Map of Nepal showing sample districts and Human Development Index (HDI) of each district
Source: http://www.dlgsp.org.np/resourcepop.html

2.6 Sources of data

This study is largely based on primary data collected through household survey and secondary data compiled by government agencies. This subsection describes the techniques used in primary and secondary data collection.

2.6.1 Primary sources of data

The study has employed a combination of quantitative and qualitative methods in order to generate primary data. Thus, a sampled household survey with pre-tested semi-structured questionnaire was employed in this study in order to obtain quantitative data at household level. Due consideration was given for the inclusion of variables that were crucial in meeting research objectives during the development of the questionnaire. Thus, the questionnaire incorporated the information on demographic characteristics of households including education attainment and occupation of each members, resource holding, access to several resources, income, consumption expenditures and exposure to climate related natural disasters. Pretesting was done before the field survey was conducted. The enumerators were oriented deliberately on the objective of the survey as well as importance of the information for the research purpose before they were employed. Such data were supplemented by the information obtained from key informants, observations, and informal group discussions.

The process of primary data collection in 2001 in Baitadi was the part of the Grant-in-aid for Scientific Research for a research project entitled "Basic research on sustainable Montane Agriculture in Nepal" headed by Professor Keshav Lall Maharjan, IDEC, Hiroshima University. Similarly, a second round of field survey in Baitadi was conducted in 2007 with the financial assistance from Hiroshima University Partnership for Peacebuilding and Social Capacity (HIPEC), IDEC, Hiroshima University. In 2010, a third round of field

survey in Baitadi was conducted with the financial assistance from Global Environment Leader Education Program for Designing Low Carbon Society (GEL), IDEC, Hiroshima University, which was very crucial for me to incorporate some important aspects of CC at household level in the dissertation.

2.6.2 Secondary sources of data

Literature review on the concerned research issues right from the conception of this research is the source of secondary data. The process continued even before the field survey was conducted as well as at the time of data analysis and preparation of the dissertation. Literature review helped in the identification of the research problem and overall conceptualization of this research. Besides, data compiled by government agencies also served as an input for analysis. The data on climate variables (temperature and precipitation) used for the analysis were purchased from the Department of Hydrology and Meteorology (DHM) of Nepal at monthly basis in raw form. The data on production, area and yield of major food-crops were collected from the Ministry of Agriculture and Cooperatives (MOAC), Nepal.

The principal sources of secondary information were journal articles, books, working papers, research reports, periodicals, theses, government and non-government documents. These publications were produced by different individual researchers, some international institutions and government institutions. Such international institutions are the Food and Agriculture Organization of the United Nations (FAO), the World Food Program (WFP), the International Food Policy Research Institute (IFPRI), the United Nations Development Programme (UNDP), the World Bank (WB), the World Institute for Development Economic Research – the United Nations University (WIDER – UNU), the South Asia Alliance for

Poverty Eradication (SAAPE), etc. Similarly, some of the government institutions are the Central Bureau of Statistics (CBS), the National Planning Commission (NPC), the Ministry of Agriculture and Cooperatives (MOAC), the Ministry of Finance (MoF), the Ministry of Forests and Soil Conservation (MoFSC), and the District Development Committee (DDC) of Baitadi, etc.

2.7 Sampling design

The sound sampling design that includes sampling plan and a suitable sample size is key to the collection of primary data as it justifies the reliability and validity of any research (Tull & Hawkins, 2000).

In order to make poverty analysis at national level, twelve districts, representing each of five development regions and three ecological zones, were selected purposively. Table 2.1 lists the sample districts indicating their affiliation to development regions and ecological belt, which can also be seen in Figure 2.5. The table also gives information on food balance of each district. Field survey in these districts was conducted in 2003.

Table 2.1 Sample size and food balance of the sample districts by development regions

Development Regions	Districts	Sample size	Food balance
Eastern (n = 116)	Ilam (Hill)	37	Negative
	Dhankuta (Hill)	40	Negative
	Jhapa (Tarai)	39	Positive
Central (n = 57)`	Sindhuli (Hill)	29	Negative
	Sarlahi (Tarai)	28	Positive
Western (n = 77)	Gulmi (Hill)	39	Negative
	Nawalparasi (Tarai)	38	Positive
Mid-Western (n = 104)	Salyan (Hill)	39	Positive
	Banke (Tarai)	29	Positive
	Jumla (Mountain)	36	Negative
Far-Western (n = 76)	Kanchanpur (Tarai)	38	Positive
	Dadeldhura (Hill)	38	Positive
Total		**430**	

Source: Subedi, 2003

In order to make in-depth analysis on poverty, Baitadi district from Far-Western Rural Hills was selected purposively. A proper representation of the typical Hill farming system of the country as well as the severity of the issues, i.e., poverty provides justification for selecting this district for in-depth analysis. Baitadi district is composed of sixty two Village Development Committees (VDCs). Out of these sixty two VDCs, two were selected purposively in order to represent ordinary subsistence as well as remote VDC at the national context. Patan VDC has connection with all season motorable road and other basic social services. In contrast, Melauli VDC is a relatively remote VDC having no connection with motorable road and is accessible only through foot and mule trails and limited or no access to other basic social services, (Figure 2.6). Lack of connection to motorable road in Melauli hinders development opportunities, and reliable market for its products and the essential inputs to produce such products.
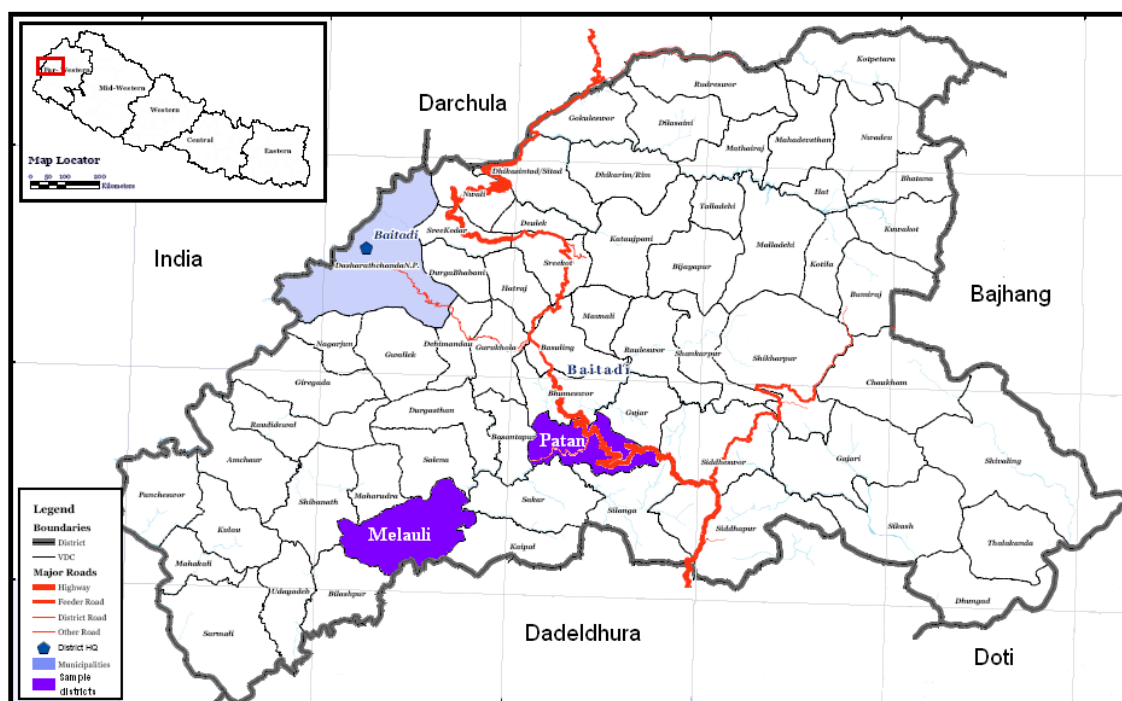
Figure 2.6 Map of Baitadi district showing sample Village Development Committees
Source: http://www.un.org.np/maps/district-maps/far-western/Baitadi.pdf

The general survey of both VDCs in 2001 was made as the first step in order to identify

sample household employing proportional stratified random sampling techniques. The entire

households in the VDCs were stratified based on the information on resource possession i.e.,

landholding (small, medium, and large), and caste group (*Bahun, Chhetri,* and *Occupational*

Castes). Finally, a proportional number of samples from each stratum were selected

randomly. Consequently, samples cover the entire socio-economic groups residing in the

sample VDCs. These samples can capture socio-economic characteristics of the population.

Thus, the sample households could be a true representative of the whole population. The

survey was conducted in 2001, taking household as a sample unit. The household member

who is supposed to have detail information regarding a particular household was identified

as the respondents. To capture the dynamisms within the sample VDCs, repeated survey was

conducted among the same households in 2007. A total number of households (population)

and sample households of two sampled VDC are given in Table 2.2.

Table 2.2 Total number of households and sample households in the sampled VDCs

Village Development Committee	Total household	Sample household	Proportion of sample household to total household (in percent)
Patan	851	60	7
Melauli	701	56	8

Source: Field survey, 2001

2.8 Data analysis

This study is primarily based on quantitative analysis of data generated from field survey and

data compiled from government publication and databases. Quantitative analyses are

supplemented by qualitative information generated through key informants' interviews,

discussions with concerned stakeholders and observations made in the field. On the part of

secondary data analysis, it is based on comparative analysis of results from earlier studies.

Such results are analyzed in relation to the policy and programs undertaken by government in different periods.

For quantitative analysis, raw data generated through field surveys and compiled from several government documents are coded and entered into computer. Data entry and analysis was done using computer software packages such as Microsoft Excel spreadsheets, Statistical Packages for Social Science (SPSS) and STATA.

To get a general overview of data, the initial analysis is based on simple descriptive analysis such as frequencies, percentages, and cross tabulations. The other statistical and econometric tools adopted for data analysis are chi-square test, analysis of variance, partial correlation, and regression analysis. Each of these statistical and econometric tools, together with theoretical understanding in relation to poverty and/or CC, is discussed in more detail in the chapters where they are adopted. In order to incorporate some of the qualitative information on quantitative analysis, suitable indexes are constructed.

Chapter 3. Poverty and food insecurity in Nepal: Macroeconomic perspectives

3.1 Introduction

The perception of poverty has evolved and varies tremendously from one culture to another (World Bank, 1990). However, its definition has evolved overtime in order to encompass variety of issues, moving from its initial treatment as an economic phenomenon (from Rowntree in 1901) to take on a number of social phenomena (to HDI by UNDP in 1990 and Amartya Sen in 1999). At present context, the definition propounded by Amartya Sen is the most commonly used. He introduced the concept of "deprivation of basic capabilities" in order to supplement "lowness of income" (Sen, 1999). Thus, poverty has two broad dimensions namely; monetary and non-monetary dimensions of poverty. Monetary poverty is a quantitative measure of poverty using information on income or consumption, whereas non-monetary poverty is associated with the insufficient outcomes with respect to health, nutrition, and literacy, with deficient social relations, and with insecurity, and low self-confidence and powerlessness.

Nepal remains one of the poorest countries in the world in terms of monetary as well as non-monetary dimension of poverty. It remains the poorest country in South Asia and was ranked the twelfth poorest country in the world in terms of Gross National Income (GNI) with per capita GNI of US$320 in 2006 (World Bank, 2008b). The per capita income though reached US$388 per annum in 2008, the country still remains one of the poorest countries in the world with the wide income disparities, and poor access to basic social services by a large section of the population (Asian Development Bank, 2008). Poverty being cause as well as consequence of food insecurity, the situation of food insecurity is also similar to that of poverty. Indicators of food insecurity became worse once the country shifted from being

food self-sufficient and even net food exporter till the late 1970s to food deficit country since the early 1980s. Even during the food surplus period, most of the districts in Hills and Mountains suffer food deficit. At present, seventeen percent of the population is suffering from malnourishment. The figure is much worse if we consider children underweight-for-age (percent under age five) and children under height-for-age (percent under age five). Around forty eight percent and fifty seven percent of under-five children are suffering from underweight-for-age and under height-for-age respectively. Both the figures are increasing continuously since the UNDP started calculating children underweight-for-age and children under height-for-age in 1990 and 1995 respectively (United Nations Development Programme, 1998; United Nations Development Programme, 2007b).

Such situation prevails in the country despite the fact that it is receiving significant amount of financial as well as technical assistance from several donor countries and multilateral donor agencies since its first planned development effort in 1956. Thus, poverty remains a critical issue to be analyzed. Therefore, this study intends to discuss the historical perspective of poverty and food insecurity incidence based on literature review. In doing so, this chapter starts by giving an overview of macroeconomic indicators overtime, discusses incidence of poverty, inequality, and food insecurity overtime, and describes programs and policies to tackle poverty and food insecurity in the country, and finally draws conclusions.

3.2 Overview of macroeconomic indicators

The growth rate of Gross Domestic Product (GDP) including that of Agricultural GDP (AGDP) as well as non-agricultural GDP, inflation rate, and changes in per capita income are three macroeconomic indicators considered in this chapter. The GDP growth rates were then

related with the population growth rate and inflation rate (Table 3.1).

Table 3.1. Gross Domestic Product and population growth rate, and inflation rate of Nepal for different periods

Variables	Plan period							
	Third 1965-70	Fourth 1970-75	Fifth 1975-80	Sixth 1980-85	Seventh 1985-90	Eighth 1992-97	Ninth 1997-2002	Tenth 2002-07
Real GDP	2.7	1.8	2.2	4.4	4.8	4.9	3.6	3.4
Agriculture	2.9	1.5	-1.1	4.7	4.1	3.0	3.3	2.7
Non-agriculture	2.4	2.2	9.0	4.0	5.5	6.3	3.9	3.8
Inflation	5.1	10.5	5.2	9.7	11.2	9.9	6.5	5.5
Population growth rate	2.05	2.62	2.62	2.08	2.08	2.25	2.25	2.25

Source: National Planning Commission (NPC), 1970; NPC, 1975; NPC, 1980; NPC, 1985; NPC, 1992; NPC, 1998; NPC, 2003; Pantha & Sharma, 2003; NPC, 2007

In Table 3.1, it can be seen that Nepal is experiencing low GDP growth rate, especially marred by the poor performance of agriculture. During these periods, agriculture grew at only around 2.6 percent per annum, which is slightly above the population growth rate of 2.3 percent per annum during the same period. The huge fluctuation in AGDP growth rate is due to high dependence on vagaries of weather condition as only one third of cultivated land is irrigated. Consequently, the growth in agriculture is unpredictable resulting in uncertainty in meeting ever increasing food demand. Besides, during all these period, inflation rate was higher than GDP growth rate, which is not a favorable condition for national poverty reduction. Optimal target of inflation should be less than six percent, which would be the best to minimize the negative impact on long-run economic growth (Khan, 2005). It is also estimated that six percent growth rate is essential to reduce Nepal's high levels of poverty. However, the average inflation rate in Nepal is eight percent. This could have hit the poor disproportionately as they do not hold financial assets that provide protection against inflation. Therefore, despite the achievements of broad macroeconomic stability by the country during these periods, the stability could not translate much in accelerating economic growth, which is key to poverty reduction.

Table 3.2 Changes in per capita Gross National Product/Gross National Income in Nepal from 1976-2007

Year	Per capita GNP/GNI	Ranking from below
1976	120	9th along with Chad, Burundi and Myanmar
1987	160	5th along with Malawi, and Bangladesh,
1988	180	9th along with Bhutan and Lao PDR
1989	180	5th along with Bangladesh, Lao PDR, Guinea-Bissau, and Malawi
1990	170	5th
1991	180	5th along with Bhutan and Guinea-Bissau
1992	170	5th along with Uganda
1993	190	8th
1994	200	10th along with Madagascar
1995	200	9th
1997	210	6th along with Rwanda and Tanzania
1998	210	8th along with Mozambique, and Tanzania
1999	220	8th along with Angola
2000	220	11th
2001	250	13th
2002	230	12th along with Rwanda
2003	240	11th along with Uganda
2004	260	10th along with Chad
2005	270	9th
2006	290	10th
2007	340	12th along with Uganda and Zimbabwe

Source: UNDP, 1990; World Bank, 1990; World Bank, 1991a; World Bank, 1992; World Bank, 1993; World Bank, 1994; World Bank; 1995; World Bank, 1996; World Bank, 1997; World Bank, 1999; World Bank, 2000; World Bank, 2001; World Bank, 2002; World Bank, 2003a; World Bank, 2003b; World Bank, 2004; World Bank, 2005; World Bank, 2006a; World Bank, 2007a; World Bank, 2008c

Per capita income measured in terms of per capita Gross National Product (GNP)/Gross National Income (GNI) increased from US$120 in 1976 to US$340 in 2007 (Table 3.2). It accounts for a mere 3.5 percent annual increase in per capita income between 1976 and 2007. Such increase is in nominal term and is against eight percent of the average rate of inflation. Ranking based on GNP/GNI placed Nepal in twelfth position from the bottom in 2007 along with some other conflict-ridden African countries. This is a slight graduation from its fifth

position from bottom during the late 1980s and late 1990s. However, it remains the poorest country outside Africa since 1991.

All these suggest that the macroeconomic indicators of Nepal, since it started having statistics on it, are not in favorable condition to tackle the overarching problem of poverty incidence in the country.

3.3 Poverty and food insecurity in Nepal

Under this heading, poverty and inequality, nature of poverty, and food insecurity and its nature will be discussed.

3.3.1 Poverty and inequality

It was only during the early 1970s that the issue of poverty started taking root in the minds of the Nepalese planners, policy makers, and political leaders. Such development was mainly due to the failure of the earlier periodic plans to achieve substantial increase in the national income and improvement in the standard of living of the people (National Planning Commission, 1975). Also, the interest of the World Bank on Poverty puts forth by its President in 1973 could have led to such realization (Nunes, 2008). This can be reflected in the Fifth Five-year Plan (1975-1980), in which the problem of poverty was first introduced and thus, agriculture development received the top priority. It was break-through of the previous trend of giving top most priority on infrastructure. Realizing the fact that a huge proportion of the population relies heavily on subsistence agriculture, it was assumed that the problem of poverty can be addressed with the increased domestic agricultural production (National Planning Commission, 1975). It was during the same time (1976-77) that the first carefully documented poverty study in Nepal (Survey on Employment, Income Distribution, and Consumption Pattern – SEIDCP) was undertaken.

Since then, three nationally representative surveys namely; Multi-Purpose Household Budget Survey (MPHBS) in 1984/85 by Nepal Rastra Bank, Nepal Living Standard Survey (NLSS) I in 1995/96, and NLSS II in 2003-04 by the Central Bureau of Statistics were conducted and used to make poverty analysis of the country. Besides, Nepal Rastra Bank conducted rural credit survey in 1991/92 confined within the rural areas. In addition, the World Bank and the UNDP are also active in making research on poverty in Nepal.

Except for the NLSS I and NLSS II, none of the surveys share common methodology. Therefore, they are not directly comparable with each other. However, a comparison made by Lanjouw and Prennushi (1999) through several simulations showed that there is no evidence of decrease in poverty from 1976/77 to 1995/96. Table 3.3 shows the incidence of poverty for different periods in the country. The adjusted comparison also showed that though there is rise in poverty, there is no indication of rise in urban poverty incidence, which means that the increase in poverty is mainly taking place in the rural areas. Similarly, within the given limitations, the perceptible increase in the poverty can be observed through a comparison between the adjusted MPHBS and NLSS I. Here, decline in urban poverty and increase in rural poverty has been reported. Increase in rural poverty incidence was mainly due to increases in poverty incidence in West, Mid-West, and Far-West Regions and in the Eastern Hills that outweighed decline in the incidence in Central Hills/Mountains and Central Tarai (Lanjouw & Prennushi, 1999).

Rural Credit Survey (1991/92) conducted by the Nepal Rastra Bank is directly comparable with NLSS I (1995/96), but the comparison is valid only for rural areas, which is essential from the view point of poverty being predominantly a rural phenomenon in Nepal. The comparison showed that the incidence of poverty reached the highest level with

the rural poverty incidence of around fifty percent in 1991/92.

Table 3.3 Incidence of poverty in Nepal for different periods

Source	Poverty incidence (percentage)		
	Urban	Rural	Nepal
National Planning Commission-SEIDCP(1976/77)	22.2	35.5	32.9
Simulations under alternative assumption			
a) Inflating up the 1977 poverty line to 1995/96 prices using overall index of national urban consumer prices. (NRs. 2 per person per day in 1977 = NRs. 10.97 per person per day in 1995)	15	33	32
b) As in a. but changing definition of consumption for 1996 so as to better match definition applied in 1977	18	38	36
c) Calculating poverty line from the NLSS (1996) data but using a similar methodology to that used for the NPC (1977)	19	42	41
d) As in c) but also changing the definition of consumption in the NLSS (1996) data so as to better match definition applied in 1977	20	44	42
Nepal Rastra Bank-MPHBS(1984/85)[a]	19.2	43.1	41.4
The World Bank (1991)-Based on data of MPHBS (1984/85 in 1988/89 prices) considering NPC poverty line, which is based on income needed to supply minimum calorie requirement)	15	42	40
Nepal Rastra Bank-Rural Credit Survey 1991/92	-	50	-
Central Bureau of Statistics-NLSS I (1995/96)[a]	17.8	46.6	44.6
Central Bureau of Statistics (1996)-NLSS I (1995/96)	21.5	43.3	41.8
Central Bureau of Statistics (2004)-NLSS II (2003/04)	9.5	34.6	30.8

Source: World Bank, 1991b; Lanjouw & Prennushi, 1999; CBS, 2005a

Note: [a] An adjusted poverty incidence in order to make comparable with each other

The cumulative density function (CDF)[1] showed around five percent point lower

incidence of poverty in 1995/96 compared to 1991/92. Despite sign of decline in poverty in

rural areas, regionally, however, there is no indication of increase in consumption level in

Western, Mid-Western and Far-Western Hills of the country; rather there was slight

decline in consumption level. This signifies that the improvement in rural poverty is erratic

in terms of regional balance, and there is no improvement in case of Western, Mid-Western,

and Far-Western Hills of the country.

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[1] CDF describes the probability distribution of real valued random variables X. It reflects the probability that the random variable X takes on a value less than or equal to x.

The sign of improvement in rural poverty was also realized in the NLSS II (2003/04), and being nationally representative survey, the result of the survey also provided the evidence of decline in poverty in the country as a whole. Significant increase in flow of remittance is the main reason for such decline in incidence of poverty despite the fact the country was suffering from severe conflict. The rate of decline in rural poverty compared to urban poverty is remarkably low. Thus, the benefit flow of economic growth and development is skewed more towards urban areas with limited impact on rural poverty.

Trends in inequality can be understood by examining the gini coefficient and the share of income by different income category for the given period. Similar to the trend of poverty incidence, inequality in the country is also increasing. Inequality is even increasing despite the decline in poverty incidence in 2003/04 (Table 3.4). Gini coefficient calculated in terms of per capita income has increased from 0.24 in 1984/85 to 0.41 in 2003/04.

Table 3.4 Income distribution pattern overtime

Share of population	Percentage share of income on			
	1976/77 (SEIDCP)	1984/85 (MPHBS)	1995/96 (NLSS I)	2003/04 (NLSS II)
First quintile (Poorest)	5.9	10.1	5.3	5.3
Second quintile	8.2	14.9	10	8.9
Third quintile	9.1	18.3	14	12.8
Fourth quintile	22.4	22.1	20.4	19.7
Fifth quintile (Richest)	59.9	34.6	50.3	53.4
Gini coefficient	NA	0.24	0.34	0.41

Source: National Planning Commission, 1983; Nepal Rastra Bank, 1989; Central Bureau of Statistics, 1997a; Central Bureau of Statistics, 2004

Note: NA-Not Available

Share of the fifth quintile (the richest) of the population was in the highest level (59.9 percent) in 1976/77, but was reported to be 34.6 percent in 1984/985. Such sharp decline in the share might be the result of extensive infrastructure development (transportation,

communication, irrigation, and industries) during the period throughout the country, which provided the opportunities to the huge mass of population who otherwise would have been critically isolated. There could be flaws in the measurement itself as these were the period of closed economy. Since 1984/85, when the country adopted the stabilization and Structural Adjustment Program (SAP), the trend was reversed; the share has been increasing and reached 50.3 percent in 1995/96 till when the economy was liberalized to a greater extent, which further increased to 53.4 percent in 2003/04. Therefore, this could be the outcome of economic liberalization in the country. Increase in the share of the fifth quintile of the population in 2003/04 was realized at the cost of the decline in the share of the first quintile, second quintile, third quintile, and forth quintile by 47.5 percent, 40.3 percent, 30.1 percent and 10.9 percent respectively. This indicates that the economic growth in the country has failed to be pro-poor.

Till 1995/96, with no indication of reduction in poverty, the higher population growth rate (2.6 percent per annum) for the period (between 1976/77 and 1995/96) suggests huge increase in the number of the poor in the country. Therefore, in order to keep pace with the population growth rate, poverty incidence must be brought down from forty to twenty five percent at least to keep the number of poor constant overtime (Lanjouw & Prennushi, 1999). However, because of the failure to meet above preconditions, the number of poor has almost doubled within the period of twenty years-from 1976/77 to 1995/96 (Table 3.5). In 2003/04, however, decline in the absolute number of poverty was reported even at the poverty incidence of 30.8 percent. This could be due to the fall in population growth rate to 2.25 percent per annum, which was 2.6 percent per annum.

Despite the scant improvement in poverty incidence in the country, increasing disparity

together with the huge increase in poor population has detrimental effect on the objective of poverty reduction. The rise in inequality stifle growth, and poverty fall less rapidly than in the case of a more equitable one (Cornia, 2004). Therefore, increased inequality and rise in a number of poor have serious ramifications on one's ability to maintain a sustainable economic growth together with serious threats on social stability (Zhou & Wan, 2003).

Table 3.5 Number of poor people in different periods

Source	Year	Poor population (in '000')
NPC (SEIDCP)	1976/77	4,897
Nepal Rastra Bank (MPHBS)	1984/85	6,852
World Bank/UNDP (based on MPHBS)	1989	7,694
CBS (NLSS I)	1995/96	9,507
CBS (NLSS II)	2003/04	7,672

Source: Nepal South Asia Center (NESAC), 1998; Central Bureau of Statistics, 2005b

3.3.2 Nature of poverty

Poverty in the country exists in a wide variation depending on the rural-urban divide, geography, gender, and ethnic groups and OCs (United Nations Development Programme, 2005). Poverty incidence, gap, and severity analysis of the country suggest that poverty is more rampant, deeper, and severe in rural areas, and much worse in the Hills and Mountains. Poverty incidence in the rural areas, where eighty five percent of the population lives, is 34.6 percent and accounts for 95.3 percent of the poor in the country. Moreover, the recent decline in poverty incidence is mainly due to the higher decline in urban poverty. Overall, decline in incidence of poverty in urban areas from 1995-96 to 2003-04 is fifty six percent, whereas the figure for rural areas is only twenty percent (Central Bureau of Statistics, 2005a; Central Bureau of Statistics, 2005b). Similarly, poverty rate is highest in rural areas of Mid-Western, and Far-Western Development Regions. Poverty incidences in these regions are 44.8 percent and 48 percent respectively. Also more than twenty five remote districts in the Mid-Western and Far-Western, Hills and

Mountains regions have poverty incidence of forty five to sixty percent. In terms of ecological region, the Hills are experiencing the highest incidence of poverty with 34.5 percent population living below poverty line (Central Bureau of Statistics, 2005b). Poverty in such areas is primarily due to the stagnation in the growth of agriculture, which is the main source of income and employment (National Planning Commission, 2003). In addition, unequal distribution of land, and lack of access to basic social and economic infrastructure is also responsible for the prevalence of poverty in the country (Prennushi, 1999; South Asia Alliance for Poverty Eradication, 2003).

Besides rural-urban, geographical and ecological variation, poverty also greatly varies according to gender. Nepalese society is predominantly patrimonial, where practice of inheritance strictly to the male siblings and traditional gender-based division of labor restrict access to education, skill development, employment and decision-making by female members of many households, especially in rural areas. Department for International Development & World Bank (2006) reported that only eleven percent households have any land in female legal ownership. Similarly, only three percent households have house registered in the name of female member. Despite livestock rearing being traditionally a female task, merely seven percent of households have female ownership of livestock. If all these three types of properties are combined, less than one percent of households have female ownership of all three types of properties. However, female legal ownership of properties got momentum since 2006/07 when the government announced a waive of full transactions one has to pay while registering the properties (two percent and four percent of property value in rural areas and urban areas respectively) if registered in the name of women, disabled persons or members of disadvantaged groups

including indigenous nationalities (Wily *et al.,* 2008).

Traditional gender roles still continue to exist, which has confined around sixty percent of female to involve them in unpaid work. With seventy percent of female population engaged in agriculture, most of the agricultural labors in the country are female. Merely six percent of women are employed in the formal non-agricultural occupation (Central Bureau of Statistics, 1999). Moreover, there exists discrimination even for wages to be paid. Women are paid significantly low compared to male counterparts. For instance, female agricultural labor receives NRs. 47 per day compared to NRs. 63 received by male agricultural labor, female non-skilled non-agricultural labor receives NRs. 54 per day compared to NRs. 104 by male labor, and female skilled non-agricultural labor receives NRs. 126 compared to NRs. 315 by male skilled non-agricultural labor (World Bank, 2006b). This is mainly due to significantly less literacy rate (including adult literacy rate) among the female. Thus, women face much greater economic as well as social insecurity than men and have higher chances to fall under the category of poor. This could also be reflected by the significantly higher proportion of households headed by female falling under the category of poor (Joshi, 2008; Joshi & Maharjan, 2008).

In addition, caste and ethnic divisions are important factors that affect poverty. Most of the poorest of the poor belong to the *Dalit*, and ethnic communities, who have been historically excluded from policy influencing and decision-making opportunities because of their caste and ethnic position (South Asia Alliance for Poverty Eradication, 2003). Such exclusion is mainly due to the dominance of Hindu caste hierarchy in Nepalese society. There is an unequal caste system that divides people into four vertical hierarchies with *Bahun* on the top, *Chhetri* second, *Vaishya* third and *Dalit* at the bottom. Bhattachan *et al.,*

(2004) identify over 200 forms of commonly practiced types of caste-based discrimination in Nepal. Some of the important practices such as discrimination are limiting the *Dalit* to socially sanctioned roles, forcing them to carry demeaning caste-based tasks such as removing the carcasses of dead cattle, refusing to share water sources with them and behaviors intended to avoid any direct bodily contact (practice of untouchability). Thus, caste position attained through birth limits the possibility of upward mobility forcing them to involve in the hereditarily designated occupation like blacksmith, tailoring, laboring etc. Due to this, they continue to lag behind in their income and asset levels, educational achievement and human development indicators, which restrict them from deriving benefit from any new opportunities created by development activities. This is among the reasons why the lowest consumption level exists among low-caste *Dalit* with the highest poverty incidence of forty six percent followed by ethnic communities with the poverty incidence of forty three percent (United Nations Development Programme, 2005).

Poverty also varies according to land ownership and major sources of livelihoods such as own-farm agriculture, agricultural labor, and non-farm activities. Households headed by agricultural wage laborers, and self-employed in agriculture made up the poorest, and second poorest groups respectively (United Nations Development Programme, 2005). Seasonality in agriculture leading to underemployment and absence of regulation regarding the working hours and wages of agricultural workers forced them to work on low wages and unhealthy working conditions further intensifying poverty and hunger among these groups (Aryal & Awasthi, 2004).

Negligence of rural areas of Mid-Western and Far-Western Hills from historic time, being far from the center of power, relatively high population pressure on farm land as well

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as difficult terrain, adverse climatic conditions, and limited infrastructure development hinder development process; thereby impacting on poverty reduction in these regions. It was only in 1972 when the state introduced the concept of regional development. In addition, the pattern of growth in Nepal has not been pro-poor. Most of the growth took place outside agriculture (which is the main source of livelihood for 65.6 percent of the population) and outside the rural areas where 85 percent of the population and 95.3 percent of the poor reside (Central Bureau of Statistics, 2005b). There was six percent growth rate in non-agriculture sector since 1990, whereas the agriculture sector was growing at the annual growth rate of only 2.3 percent per annum, about the same rate as population growth (National Planning Commission, 2003; Ministry of Agriculture and Cooperatives, 2007). Due to these reasons, there is no perceptible improvement in rural per capita income for a long period to make difference in reducing rural poverty.

All these poverty and disparities prevail in the country despite the fact that the country has been implementing poverty reduction policies right from the initiation of development plan since 1956 in the form of infrastructure development. Poverty reduction receives top priority and has been absorbing the significant amounts of foreign aid as a percentage of Gross National Product (GNP) since the Fifth Five-year Plan (1975-1980). However, the achievements are far below the expectation and the country's efforts towards poverty reduction are considered to have failed miserably with unchecked poverty growth till 1995/96, and then creating serious income gap afterwards (South Asia Alliance for Poverty Eradication, 2003; Central Bureau of Statistics, 2005b).

This suggests that poverty in Nepal is a complex and of diverse nature, and is associated with location (with lack of physical and social infrastructure), gender, caste/ethnicity, land

ownership, occupation, and low economic growth. A huge concentration of the poor in rural areas makes rural poverty the core issue of poverty in Nepal focusing on Far-Western and Mid-Western Hills. Therefore, several literatures made recommendations for the study of poverty focusing more on rural poverty in order to gain thorough understanding of poverty in the country, which helps in achieving the goal of poverty reduction through realistic planning. Also to cope with the possible consequences of increasing disparity, a better understanding of the root causes of income disparity within the rural areas became the most important issue (Kakwani, 1977; Adams and He, 1995; Litchfield, 1999; Wan, 2001; Zhou & Wan, 2003; Bourguignon, 2004; Cornia, 2004; Thorbecke, 2004; Nissanke & Thorbecke, 2005). All these led to increasing interest in the sources of income inequality in developing world together with the absolute poverty analysis.

3.3.3 Food insecurity and its nature

It was only in the early 1980s that food security as such entered the formal development agenda of Nepal following the world's attention to the food problem during the late seventies. Therefore, the expansion of agriculture production to meet domestic food demand remained the center of the policy choice since then. Such policy was adopted also due to the agricultural production growth rate being not in pace with the population growth rate and exportable surplus of food crops experienced proportionate dwindling. The Sixth Five-year Plan (1980-85) sets important objectives of fulfilling the minimum needs of the people together with increasing production at faster rate, and increasing productive employment opportunities (National Planning Commission, 1980). Later on, in 1985, following the directive of the King on the occasion of the Silver Jubilee Celebration of the Panchayat System, the program for the fulfillment of the basic needs was prepared and made public.

The document defined basic needs in terms of food (2,250 kcal per capita per day), clothing, housing with kitchen and toilet, education (primary education for all children under the age of ten years and higher education for as many adults as possible), health, and security. The document, however, lacked the quantitative target to be achieved within the given period i.e., from 1985 to 2000 (National Planning Commission, 1985). Furthermore, the program was discontinued due to political change in 1990, transformation from partyless Panchayat system to multiparty democracy.

Despite the target of high agricultural growth, the country which was previously the net food crops exporter started to become a net importer since 1979/80 (Figure 3.1). Between 1974 and 1992, the country experienced a sharp decline in per capita gross food production from 376 Kilogram (Kg) to 277 Kg (Agriculture Project Service Center & John Mellor Association, 1995). Throughout the nineties, the country was under food crops deficit situation. Figure 3.1 depicts that the country started attaining food crops self-sufficiency from 2000 and maintained it till 2004/05. The annual growth rate of food crops production for the period (1975/76 to 2008/09) was 2.26 percent per year, which is below the growth rate of the food crops requirement (3.13 percent) of the country for the given period (Ministry of Agriculture and Cooperatives, 2005a; Food and Agriculture Organization & World Food Programme, 2007). Agriculture in the country, solely being dependent on weather, only fifteen percent of the cultivated land is irrigated year round, is a major factor behind huge fluctuation in the production despite expansion of the area under cultivation during the period (National Planning Commission, 2003). In addition, the supply of essential production input such as improved seeds, fertilizer, and pesticides is not regulated in terms of quality, quantity, and timely availability.
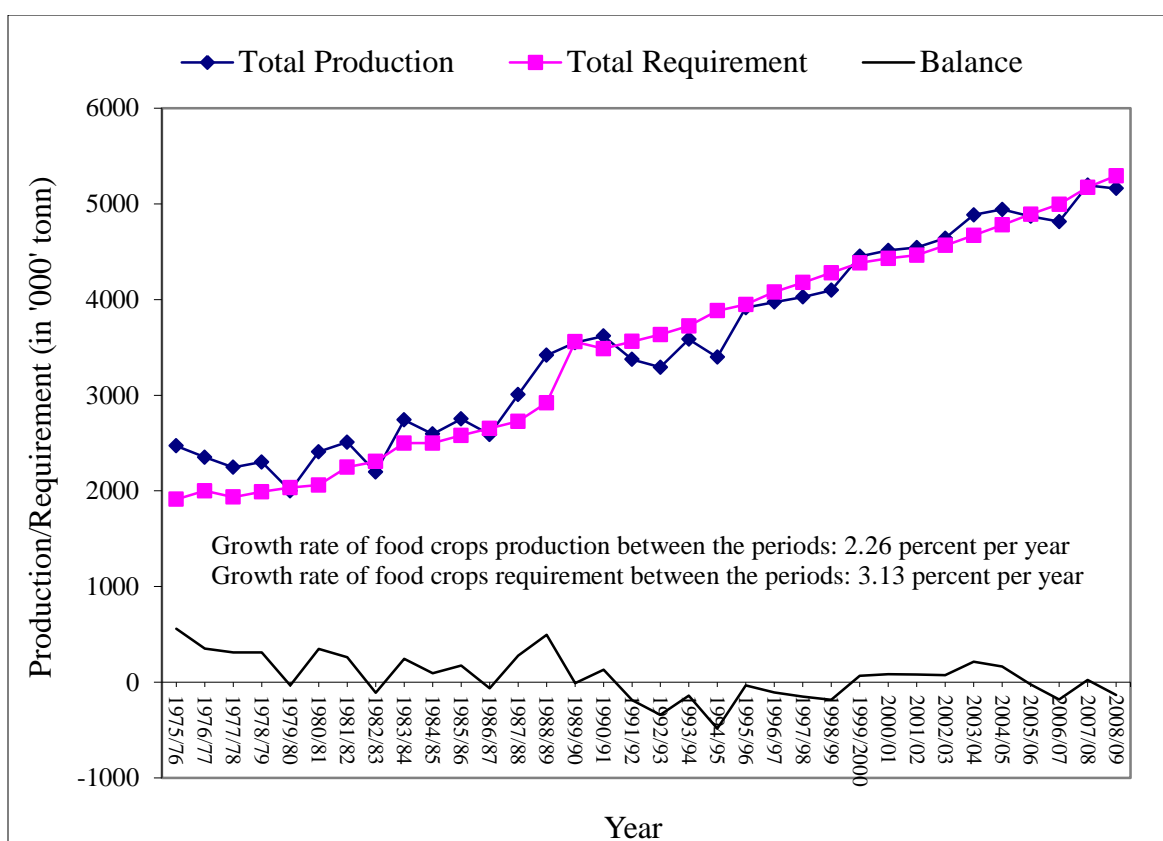
Figure 3.1 Food crops production and requirement of Nepal (1975/76-2008/09)

Source: Central Bureau of Statistics, 1987; Ministry of Agriculture, 1990; Ministry of Agriculture and Cooperatives, 2009

The country, being predominantly agriculture dependent, suffers the ever-rising huge trade deficit with quite higher import growth rate compared to the export growth rate. Food crops deficit simply suggests that the country is facing critical challenge of maintaining food security at the national level. Besides, sixty one percent of the households, for whom agriculture is the dominant means of fulfilling household food demand, were not able to produce sufficient food in their farm even when the country was self-sufficient in food crops (Central Bureau of Statistics, 2003).

Regional variation in production and requirement of the food crops reflect the different situation than the national situation of production and requirement of the food crops.

Throughout the period, even when the country was achieving self-sufficiency of the food crops, Mountains and Hills regions were under food crops deficit situation, where access was further hindered by the limited market access. In the 2001, thirteen out of the sixteen districts in the Mountains and thirty three out of thirty nine districts in the Hills suffered food deficit situation (Subedi, 2003). This led to per capita food crops deficit of forty seven Kg per capita per year in the Mountains and thirty two Kg per capita per year in the Hills, in contrast to food crops surplus of forty five Kg per capita per year at the national level (Pyakurel *et al.*, 2005). In 2006/07, the number of food deficit districts came down to forty four districts, but the total food crops balance reached negative (Food and Agriculture Organization & Wood Food Programme, 2007).

The food crops deficit has been a long term problem in Far and Mid-Western Hills and Mountains. Sixteen out of nineteen districts in Far and Mid-Western Hills of Nepal were suffering food deficit in 2001/02 (Pyakurel *et al.,* 2005). The same situation still prevails in the regions. Food crops deficit simply reflects the chronic food insecurity problem in the regions where production is grossly inadequate and economic access of food is limited by low purchasing power due to almost non-existence of market caused by the very limited or no road infrastructure in the region (Food and Agriculture Organization & World Food Programme, 2007).

The declining productivity of the land in the Hills and Mountains were identified as the main cause of shortfall in domestic production. In addition, huge dependence on the weather due to lack of irrigation facilities, and lack of investment in infrastructure such as roads are contributing to stagnation, if not declining agricultural production in the region (Agriculture Project Service Center & John Mellor Association, 1995; Koirala & Thapa,

1997; National Planning Commission, 2003; Pyakurel *et al.,* 2005; Food and Agriculture Organization & World Food Programme, 2007).

Besides national production and requirement figure, the proportion of under-nourished population can also serve as the indicator of food insecurity in the country. Under-nutrition refers to the condition of people whose dietary energy consumption is continuously below a minimum dietary energy required to maintain a healthy life and carrying out light physical activity (Food and Agriculture Organization & World Food Programme, 2007). The proportion of the undernourished population in the country increased from 20 percent in 1990-1992 to 22.5 percent in 2001-2003. This resulted in significant increase in the real number of undernourished population in the country. It has increased from 3.9 million to 4.1 million within the decade. It further reached 5.6 million from 2001-2003 to 2004 (Table 3.6). Seddon & Adhikari (2003) point out factors such as socio-political structures, which effectively prevent the rural poor from having equitable access to production resources and community assets, persistent degradation of natural resources and community assets, imperfect mechanisms for the distribution of goods and services, conflict, suspension of food aid programs in some districts, and etc. as the major causes of undernourishment.

Similar to the balance of food crops requirement, geographical variation prevails in terms of incidence of undernourishment as well. At the aggregate level of Minimum Requirement of Dietary Energy Consumption (MRDEC), the proportion of undernourished population is the highest in the Mid-Western region with 48.5 percent, which is followed by Far-Western region (47.5 percent). Similar trend is also followed in terms of ecological belt, the Mountains has the highest proportion (46.3 percent) of undernourishment,

followed by the Hills (41.8 percent) and the Tarai with 38.4 percent (Food and Agriculture Organization & World Food Programme, 2007).

Table 3.6 Health indicator of food insecurity in Nepal

Indicator	Number (in million)	Proportion
Undernourishment (Calculated based on MRDEC of 1810 kcal/person/day)		
1990-1992 (average)	3.9	20 percent
2001-2003 (average)	4.1	17 percent
2004	5.6	22.5 percent
2004[*]	10.1	40.7 percent

Source: Food and Agriculture Organization & World Food Programme, 2007; MDG Info, 2007

Note: [*] MRDEC of 2124 kcal/person/day

The per capita mean dietary energy consumption in Rural Far-Western region is reported to be 2,250 kcal/day. This figure is low compared to that in Rural Western region with the per capita mean dietary energy consumption of 2,534 kcal/day, and the national average of 2,405 kcal/day. In case of ecological belt division, the level is the lowest in the Mountains with the consumption level of 2,297 kcal/day, compared to 2,404 kcal/day in the Hills and 2,426 kcal/day in the Tarai. It is also reported that Rural Mountains and Hills in the Mid and Far-Western regions host the very high proportion of population under severe deficit of food energy intake. The crisis situation prevails in the region with more than thirty percent and twenty percent of the rural population consuming less than 1,600 kcal/day in Mid-Western Mountains and Far-Western Hills respectively (Food and Agriculture Organization & World Food Programme, 2007). Such consumption level is substantially lower than the nationally set minimum dietary energy consumption requirement of 2,124 kcal/day (Central Bureau of Statistics, 2005b).

The WHO classified Nepal to be under the crisis level of malnutrition. Nepal is ranked last among 177 countries in terms of the proportion of children classified as underweight

with forty eight percent incidence (United Nations Development Programme, 2007b). Other aggregated malnutrition indicators such as stunting and wasting is also higher in the country. Stunting is as high as forty nine percent and wasting is thirteen percent. Regional variation suggests the highest incidence of stunting, wasting, and underweight in the Mountains and Hills of the Far and Mid-Western Development Regions. In the region, more than sixty percent of the children are stunted and around fifty percent are underweight (Ministry of Health and Population/Nepal, New Era & Macro International Incorporated, 2007). This prevalence is mainly caused by the limited availability of food, and high poverty rates.

3.4 Program and policies to tackle poverty and food insecurity

The Basic Needs Program (BNP), the efforts to increase aggregate agricultural production, the pursuance of poverty alleviation programs, training and income generating programs, subsidies, and food and feeding programs are some of the important initiatives taken by the government of Nepal in order to deal with the problem of food insecurity in the country. Though the BNP contained the important elements of successful poverty alleviation programs, focus on intensification of existing programs often without addressing the reasons of their past failure was considered as the main shortcoming of the program. Later on, especially after the reestablishment of democracy in 1990, the government realized the absence of employment and income generation issues as the important missing components to meet the basic needs in basic needs program. Therefore, the Eighth Five-year Plan (1990-1995) focused on the need for employment generation giving priority to the targeted groups. The important aspect hindering the achievement of poverty and food insecurity in the country, population growth, however, was accorded less priority.

Fertilizer subsidies, credit subsidies, irrigation subsidies, and food subsidies were the

main subsidies program targeted in order to achieve the goal of poverty and food insecurity alleviation through enhanced agricultural production in the country in the past. However, a study on the impact of fertilizer subsidy revealed that the subsidy has very little impact on the poor, mainly because they do not use fertilizer. This is because they practice rainfed agriculture with limited scope for fertilizer use, supplies through government body were unreliable and not available at the key times, and subsidized fertilizer was deflected to India, Kathmandu or went to the better-off class households. Credit subsidies were provided in terms of interest and capital subsidies in order to encourage productive investments in agriculture through the Agricultural Development Bank of Nepal (ADB/N). This program also has little direct impact on the poor. Coupled with low level of education attainment and physical resources possession, the poor have neither the access nor the capacity to use institutional credit, thus less than ten percent of such subsidized credits went to the small farmers (World Bank, 1991b; Prennushi, 1999). Subsidy in irrigation was indirect in nature. The government bears the operating costs of public irrigation scheme. Also grants were provided for capital costs of small irrigation schemes. These were also supposed to have very limited impact on the poor as they possess very small pieces of land, which are basically marginal lands with limited scope for irrigation.

These subsidies were gradually lifted by the government, and distribution was deregulated due to the adoption of SAP in 1985/86, and finally such subsidies were eliminated in 1998/99 and markets were deregulated. The consequences were increased cost of fertilizers leading to the drastic fall in chemical fertilizer use in the 1990s compared to the 1970s level (Subedi, 2006). Per hectare use of fertilizers also showed the declining trend. It came down to twenty one Kg/ha in 2005/06 from twenty six Kg/ha in 2003/04 (Food and

Agriculture Organization & World Food Programme, 2007). Removal of subsidies in shallow tube-well also has an adverse effect on expansion of irrigation. There has been even decrease in ground water irrigation facilities since 1997/1998, which is forcing small holders to rely on monsoon (Subedi, 2006; Food and Agriculture Organization & World Food Programme, 2007). There was also removal of preferential credit and withdrawal of bank branches from the rural areas due to the SAP. Together with the heavy reliance on weather, these factors could have affected the fluctuation in the production of food crops in the country.

Food subsidies are mainly targeted at providing food at below market price to civil servants and the population as a whole in remote areas where there is no connection with land transportation and also no food is available for sale in large parts of the year. It was done by buying food from surplus areas by Nepal Food Corporation (NFC) and was aimed at reducing inter-regional food imbalance. However, guided by political interest, NFC distributed most of the procured foods in the Kathmandu Valley. It usually supplies around five to six percent of the deficit in the rural areas, and beneficiaries most often are government officials and well-off households of the region (World Bank, 1991b; Food and Agriculture Organization & World Food Programme, 2007). Despite inefficiency in the functioning of the NFC, there is growing need for such strategy as the population growth rate continues to outstrip agricultural production and the region still being isolated. However, between 1991 and 2007, the amount of food NFC was handling came down from 34,000 metric ton to 20,000 metric ton per year mainly due to the hindrance caused by the Maoist conflict (World Bank, 1991b; Seddon & Adhikari, 2003; Food and Agriculture Organization & World Food Programme, 2007). In order to improve efficiency in its functioning, the NFC

developed the concept of local grain storage program. A local grain storage program aims to reduce seasonal price fluctuations by providing the opportunity for the poor farmers to hold grain after harvest until prices rise. Also, organization of saving group for poor farmers with rotating loan funds is supposed to provide an escape for stress selling of their crops immediately after the harvest in order to pay debts. However, there lacks initiative in documenting impact of such programs.

Food-for-work or the Rural Community Infrastructure Work (RCIW) program, food-for-education program, mother and child health initiative program, and emergency assistance in natural disasters are other undergoing food and feeding programs with the support from various international donor agencies. Food-for-work program appears to be more successful in reaching the poor in terms of providing rural employment opportunities through rural infrastructure construction and income generation projects that make a payment in kinds – food items (World Bank, 1991b; Rural Community Infrastructure Work, 2003; Seddon & Adhikari, 2003). Currently, the program covers thirty districts throughout the country.

Similarly, a food-for-education program provides a mid-day meal and a take-home ration of oil for girl students in eighteen districts. The program is directed at improving the nutritional status, school enrollment, and attendance by girl children. A Mother and Child Health initiative operating in eleven districts aims at improving the health and nutritional status of pregnant and nursing mothers and their young children by providing essential nutritional food support in the form of monthly take-home ration of fortified food (Food and Agriculture Organization & World Food Programme, 2007). The combined impact of these food and feeding programs is relatively small compared to the magnitude of the food

insecurity problem in the country. Programs of the NFC, and food and feeding program represent less than ten percent of the national food deficit (World Bank, 1991b; Food and Agriculture Organization & World Food Programme, 2007). Also, the coverage of food and feeding program is very much limited. Thus, most of the programs in the country so far are not able to improve food security at the household level in equitable way.

3.5 Conclusion

Nepal, being the poorest country in the world, poverty remains one of its crucial development agenda. Since its Fifth development plan, poverty reduction has been receiving top priority in the name of agriculture development as more than ninety percent of the population then was dependent on agriculture. Therefore, targeting agriculture meant targeting ninety percent of the population, which also accounts more than ninety percent of the poor. From 1992 (Eighth development plan) poverty received the top priority. However, macroeconomic indicators of the country i.e., GDP growth rate and inflation rate show that the country is historically a low growth country with inflation rate always higher than the GDP growth rate. Therefore, macroeconomic indicators are not in favorable condition to tackle the overarching problem of poverty incidence in the country.

Since 1976/77, poverty incidence is in increasing trend in the country. It was only in 2003/04 that some progress in reducing poverty was reported, which was mainly due to the significantly higher inflow of remittance compared to earlier years. Rapid urbanization and an increase in non-farm incomes also contributed in reduction of poverty. This resulted not only in the decline in the proportion of population suffering from poverty, but also decline in the absolute number of population suffering from poverty. However, such decline in incidence of poverty was achieved at the cost of increased inequality. The gini coefficient

increased from 0.24 in 1984/85 to 0.41 in 2003/04. The main reason behind this was imbalanced growth in rural and urban areas. A reduction of poverty in urban areas always remains high compared to that of rural areas. Similarly, poverty incidence always remains the highest in Mid-Western and Far-Western Rural Hills. Also, poverty and food insecurity is highest among female-headed households, *Dalit* and ethnic communities, small landholding households, and households engaged in laboring and agriculture throughout the period between 1995/96 and 2003/04. This is mainly due to unequal distribution of resources such as land, social discrepancy, and lack of access to basic social and economic structures.

There were several programs and policies adopted by the Nepalese government to tackle the problem of poverty and food insecurity ranging from BNP, subsidies program, and food-for-work program to deal with the problem. All these programs either lacked the proper accounting or failed to learn from the past experiences. In some cases, it also failed to focus on target population. For instance, subsidies program mostly benefited the well-offs who are able to apply the subsidized inputs whereas poor households could not apply the subsidized input either due to very small landholding or due to dependency on rainfed agriculture which do not support the use of fertilizer or seeds of high yielding varieties. Also, food support represents only ten percent of the national food deficits and beneficiaries were mostly government officials and well-off households. Therefore, there is need for expanding such programs in more efficient manner focusing on the target population. Besides, as CC is emerging as a growing threat to poverty, understanding the issues related to CC is equally important.

Chapter 4. Issues of climate change and its relation with poverty in Nepal

4.1 Introduction

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer (Intergovernmental Panel on Climate Change, 2007a). Natural variability or human induced increase in greenhouse gases (GHGs) is the main factors responsible for CC. Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and F-gases such as perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6), and chlorofluorocarbons (CFCs) are the most prominent GHGs that trap heat and cause CC (Intergovernmental Panel on Climate Change, 2007b). Fuel combustion, deforestation, transportation, agriculture, urbanization, and industrialization are the main sources of GHGs emission. Marked increase in the concentration of CO_2 from about 280ppm in pre-industrial value to 379ppm in 2005 has been reported. Similarly, during the same period, the concentration of CH_4 and N_2O has increased from 715ppb to 1,774ppb and 270ppb to 319ppb respectively. Total CO_2 equivalent (CO_2-eq) of prominent GHGs is estimated to be around 455ppm CO_2-eq, which if not stabilized below 550ppm CO_2-eq, would lead to the most harmful irreversible consequence of CC through temperature rise of more than 2°C (Intergovernmental Panel on Climate Change, 2007a).

Clear indication of CC on the earth has been reported. Over the last few decades, the temperature of earth surface has been rising and is predicted to rise further if proper attention is not paid. This has caused changes in weather patterns, rise in sea level, and melting of glaciers. In addition, more frequent storm events, increased events of drought, increased number of El-Nino and other adverse climatic situations can also be attributed to the global

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CC. Prediction shows that rise in 2°C temperature is inevitable even if emissions are reduced to less than fifty percent of the current level by 2050. This increase in temperature was determined to be 'an upper limit beyond which the risks of grave damage to ecosystems, and of non-linear responses, are expected to increase rapidly'. However, the current trend of emission, i.e., emission well above 2000 levels in 2100, would lead to 4°C increase in temperature causing unavoidable devastating losses, and excessively higher adaptation costs (Intergovernmental Panel on Climate Change, 2007b).

Such adverse changes in climate put all countries in vulnerable situation through increased stress in the economy as a whole. But the poorest countries and the poorest people within them are the most vulnerable as they are dependent on natural resources to a greater extent. In this decade alone, around 3.5 billion people, almost all from developing and least developed countries, are likely to be affected by climate related disasters. This figure is significantly higher compared to approximately 0.8 billion in 1970s, 1.4 billion in 1980s and 1.9 billion in 1990s. During the 1990s, around 200 million people per year were affected by climate related disasters in developing countries, in contrast to around a million in developed countries. Based on this, the World Bank estimates that people in developing countries are affected at twenty times higher the rate of those in developed countries (World Bank, 2007b; World Bank, 2008a).

Degree of vulnerability to Nepal is even higher due to its rugged terrain with steep topography, and fragile geological conditions, which make the country disaster prone. Besides, marginal population with low income, limited institutional capacity and greater reliance on climate-sensitive sectors like agriculture make the country subjected to higher risk (Regmi & Adhikari, 2007; World Bank, 2008a). Therefore, exposure to risks and low

adaptive capacity to cope with those risks are major factors contributing to vulnerable situation of the country to CC. This justifies the strong need of understanding local CC, and related hazards in order to develop mitigation and adaptation programs to minimize risks at different levels. Adaptation measure is urgently needed to reduce impacts of CC particularly for the most vulnerable section of the population. Therefore, adaptation aspects should not be overlooked. However, as adaptation for CC requires huge economic resources and is at an early stage of development, mitigation is highly cost effective and relevant in the long term together with possible revenue generation for the developing countries like Nepal (Dhakal, 2001; Intergovernmental Panel on Climate Change, 2007a). Therefore, this chapter attempts to analyze different aspects of CC in Nepal such as emission scenario, indications of CC, impacts of CC on poverty and initiatives taken by Nepal towards mitigating the adverse impact of CC in relation to their possible impact on poverty.

4.2 Emission situation of Nepal

Carbon dioxide, CH_4, and N_2O are the major GHGs that contribute to CC in Nepal and, therefore, included in national greenhouse gas inventory of 1990/91 and 1994/95 (Dhakal, 2001; Ministry of Population and Environment & United Nations Environment Programme, 2004). Nepal has a negligible share of these GHGs emission compared to the global community. Per capita CO_2 from fuel combustion in 1997 for Nepal was 0.11 ton, which is very low compared to neighboring countries like India (1.2 ton), China (3.8 ton) and Bangladesh (0.25 ton), and negligible compared to that of USA (20.38 ton) and Japan (9.84 ton) (United Nations Development Programme, 2007b). However, if we see the trend of GHGs emission, it is increasing at higher rate in Nepal. There was 63.5 percent increase in CO_2 emission between the first inventory period (1990/1991) and the second inventory

period (1994/95), which shows annual growth rate of 13.1 percent (Table 4.1). Similarly, annual growth rate of 9.3 percent per capita CO_2 emission was reported between 1990 and 2004 in Nepal, which is significantly high compared to neighboring countries like India (3 percent), China (4.4 percent), and Bangladesh (4.4 percent) (United Nations Development Programme, 2007b).

Growing consumption of fossil fuel is the main reason for such increase. Fuel consumption increased from 4,000 barrels per day to 7,258 barrels per day during 1990-1995 and reached 17,200 barrels per day in 2007, which indicates the annual growth rate of fifteen percent between 1990/91 and 1994/95 (Energy Information Administration, 2009). There was doubling of CO_2 emission from cement production between 1990/91 and 1994/95 (Figure 4.1).

Table 4.1 Green House Gases (GHGs) emission in Nepal from 1990/91 to 1994/95 (in '000' tones)

Green House Gases	Year		
	1990/91	**1994/95[*]**	**1994/95**
Carbon dioxide (CO_2)	995.7	1628	9747
Methane (CH_4)	1005.5	867	948
Nitrous oxide (N_2O)	0.8	31	31
Carbon dioxide equivalent (CO_2-eq)	22360.8	28205	39265

Source: DHM, 1997 (cited in Dhakal, 2001); Ministry of Population and Environment & United Nations Environment Programme, 2004; Intergovernmental Panel on Climate Change, 2007c

Note: [*] Only the source mentioned in 1990/1991 is considered in order to make figure comparative to 1990/91

Mainly, rice production, livestock, and biomass burning are responsible for CH_4 emission in Nepal (Figure 4.1). Methane emission shows some positive signal in terms of emission reduction. This is mainly due to significant reduction in emission from rice production, and biomass burning or manure management. Besides promotion of minimum tillage farming in

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rice cultivation such as System of Rice Intensification (SRI), visible reduction in rice production area from 1.4 million ha in 1990/91 to 1.3 million ha in 1994/95 could also have contributed to the reduction of CH_4 emission (Ministry of Agriculture and Cooperatives, 2005a). However, rising population of ruminant livestock in the same periods resulted in increase in CH_4 emission from livestock through enteric fermentation (Ministry of Agriculture and Cooperatives, 2005a). At the same time manure management as well as replacement of fuel wood achieved through installation of 11,941 biogas plants between 1992/93 and 1994/95 could be the reason behind the significant reduction in CH_4 emission from biomass burning (Laudari, 2008).
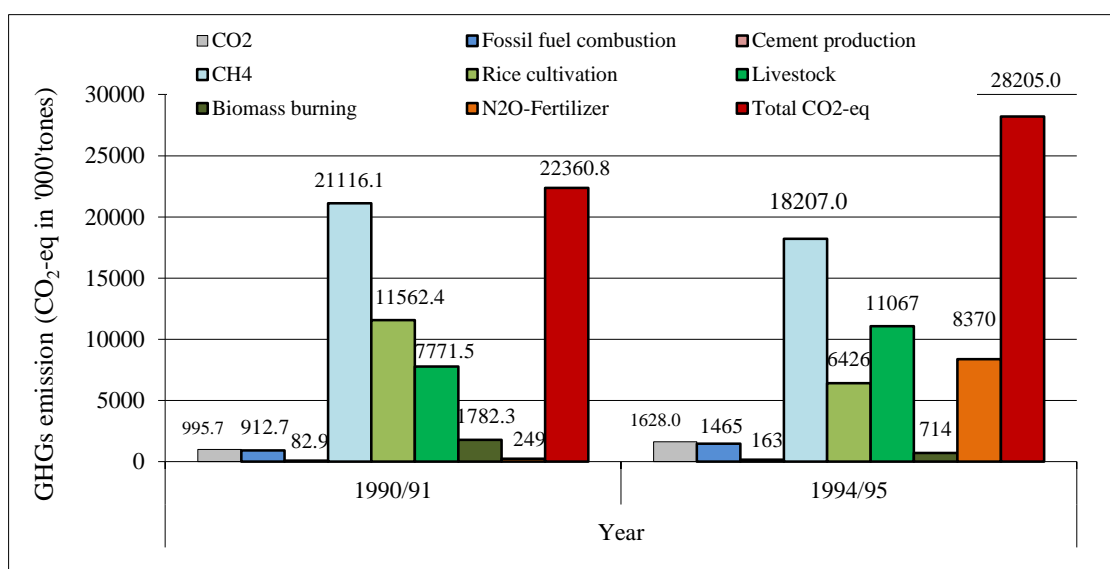
Figure 4.1 GHGs emission from different sectors in Nepal from 1990/91 to 1994/95 (CO$_2$-eq in '000' tones)

Source: DHM, 1997 (cited in Dhakal, 2001); Ministry of Population and Environment & United Nations Environment Programme, 2004; and Intergovernmental Panel on Climate Change, 2007c.

The significant increase in consumption of nitrate fertilizer and marked decrease in consumption of ammonium sulphate resulted in drastic increase in emission of N_2O, despite reduction in the area under rice cultivation. Annual sales of urea increased sharply from 81

thousand tones to 121 thousand tones between 1990/91 and 1994/95 (Ministry of Agriculture and Cooperatives, 2005a). Rice cultivation in Nepal is mostly done under submerged condition. Therefore, the use of nitrate fertilizer (urea) triggered N_2O emission between these periods. Besides, chemical fertilizer in the country is used inefficiently, in terms of dose, method, and time of application.

The rise in total CO_2-eq emission in Nepal can be observed between the same duration. The total CO_2-eq emission reached 28.2 million tones CO_2-eq in 1994/1995 from 22.4 million tones CO_2-eq in 1990/91. This indicates the increase in CO_2-eq emission at the annual rate of 5.8 percent. However, in order to make figure comparative for both inventory periods, some important sources of emission were not considered in Figure 4.1. The complete picture of emission in 1994/95 from different sectors is presented in Figure 4.2. Here, the total emission reaches 39.3 million tons of CO_2-eq. Agriculture has significant bearing on the total CO_2-eq emission. Enteric fermentation in livestock (twenty nine percent), manure management (three percent), rice cultivation (sixteen percent), and agricultural soils (twenty two percent) as components of agriculture altogether emit around sixty nine percent of total CO_2-eq emission. This is followed by land use change and forestry, which contribute around twenty one percent of the total CO_2-eq emission, fuel combustion (eight percent) and waste (one percent). This suggests the importance of agriculture and forestry sectors in any mitigation effort to reduce GHGs emission. Since agriculture and forestry is the most important sources of livelihood for the majority of the poor in the country, mitigation measures on these sectors will have high significance in reducing emission. Further, adaptation measure on these sectors in short term is very crucial to deal with vulnerability caused by CC.
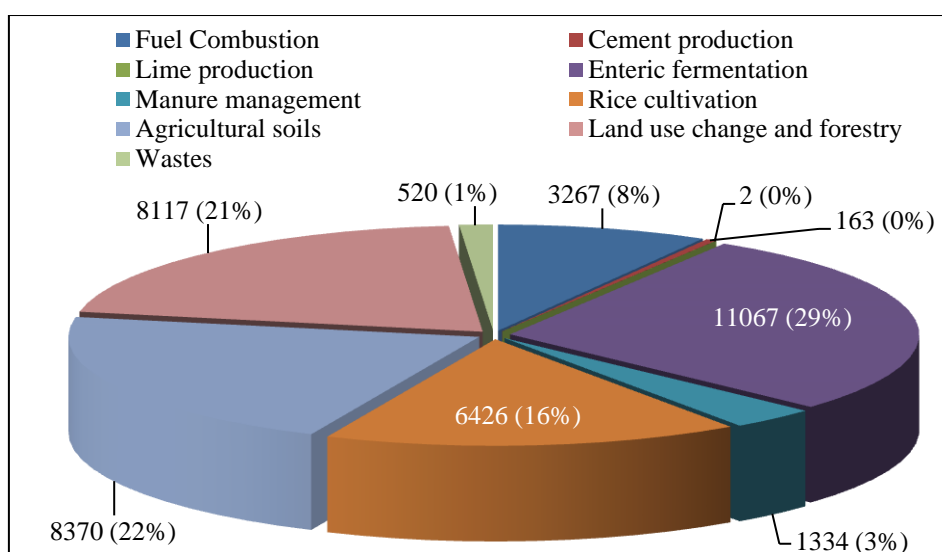
Figure 4.2 CO_2-eq emission from different sectors in Nepal 1994/95 (in '000' tones)

Source: Ministry of Population and Environment & United Nations Environment Programme, 2004; and Intergovernmental Panel on Climate Change, 2007c.

4.3 Indication of climate change

Indication of CC can be assessed mainly in terms of variability in temperature, and precipitation (Shrestha *et al.,* 2000; Intergovernmental Panel on Climate Change, 2007b). Five regional headquarters were chosen considering the altitude, coverage of geographical area, and consistency of data availability to analyze the changes in temperature and rainfall. These locations represent the country from the East to Far-West, and altitudinal variation of 720 meters above sea level (masl) in Surkhet to 2,310 masl in Dipayal. Other locations include Dhankuta (1,445 masl), Kathmandu (1,336 masl), and Pokhara (827 masl). Data on temperature is available from 1976 to 2005 for all locations except Dipayal for which data is available only from 1982 to 2005. Temperatures variability is assessed in terms of annual as well as seasonal trends whereas precipitation variability is assessed in terms of annual trend in these five regions. Winter temperature is calculated based on average temperature for the month of December (of the preceding year), January and February. Similarly, summer

temperature is calculated based on average temperature for the month of June, July and August.

Table 4.2 Coefficient of temperature and rainfall trend in Nepal by region

	Variables	Coefficient	R^2 value	P-value
National	Annual temperature	0.054	0.74	0.00[***]
	Winter temperature	0.06	0.50	0.00[***]
	Summer temperature	0.05	0.70	0.00[***]
	Rainfall	6.1	0.1	0.1[*]
Dhankuta	Annual temperature	0.1	0.79	0.00[***]
	Winter temperature	0.12	0.60	0.00[***]
	Summer temperature	0.09	0.80	0.00[***]
	Rainfall	1.08	0.01	0.79
Kathmandu	Annual temperature	0.06	0.71	0.00[***]
	Winter temperature	0.08	0.54	0.00[***]
	Summer temperature	0.03	0.38	0.01[***]
	Rainfall	6.0	0.07	0.1[*]
Pokhara	Annual temperature	0.03	0.41	0.00[***]
	Winter temperature	0.04	0.28	0.00[***]
	Summer temperature	0.02	0.26	0.00[***]
	Rainfall	13.14	0.05	0.21
Surkhet	Annual temperature	0.03	0.3	0.00[***]
	Winter temperature	0.04	0.25	0.01[***]
	Summer temperature	0.02	0.23	0.01[***]
	Rainfall	4.1	0.02	0.49
Dipayal	Annual temperature	0.06	0.46	0.00[***]
	Winter temperature	0.07	0.38	0.00[***]
	Summer temperature	0.04	0.36	0.00[***]
	Rainfall	-8.3	0.06	0.26

Source: Central Bureau of Statistic (CBS), 1987; CBS, 1993; CBS, 1997b; CBS, 2005d; CBS, 2007

Note: [***], [**], and [*] significant at 0.01, 0.05, and 0.1 level of significance respectively

Nepal has experienced the fastest long-term increase in temperature with 1.6^{o}C increase between 1976 and 2005 (Figure 4.3f), which is very high compared to global temperature increase of 0.6^{o}C in the last three decades (Intergovernmental Panel on Climate Change, 2007b). Trend analysis shows that temperature is increasing at an annual rate of 0.054^{o}C, which is statistically significant (Table 4.2). The rate is higher in winter (0.06^{o}C) compared

to summer (0.05^{o}C). Moreover, several climate models in Nepal shows that warming trend will continue through the 21st century (Table 4.3).
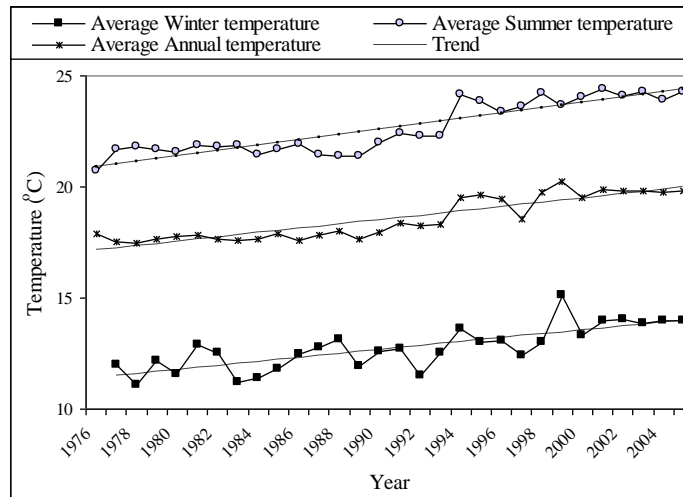
a. Dhankuta
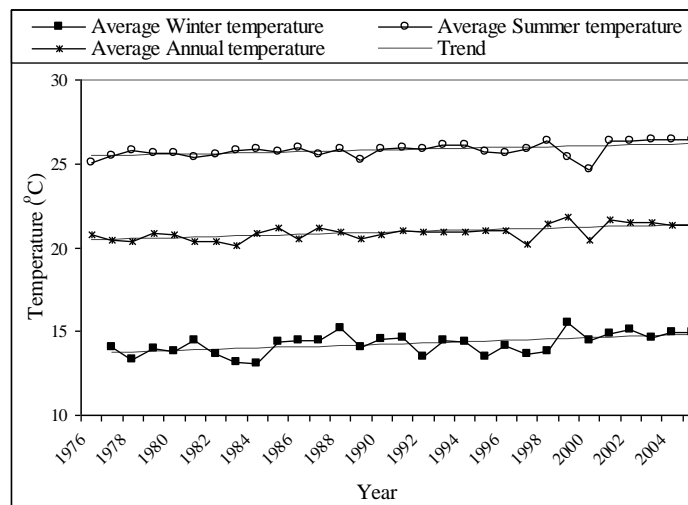
b. Kathmandu
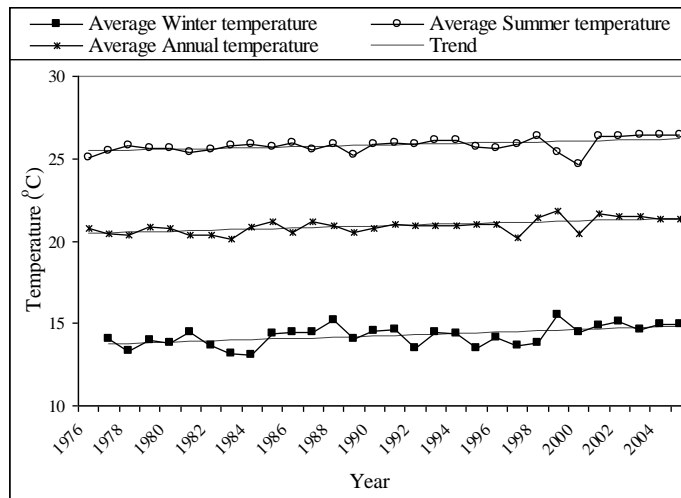
c. Pokhara
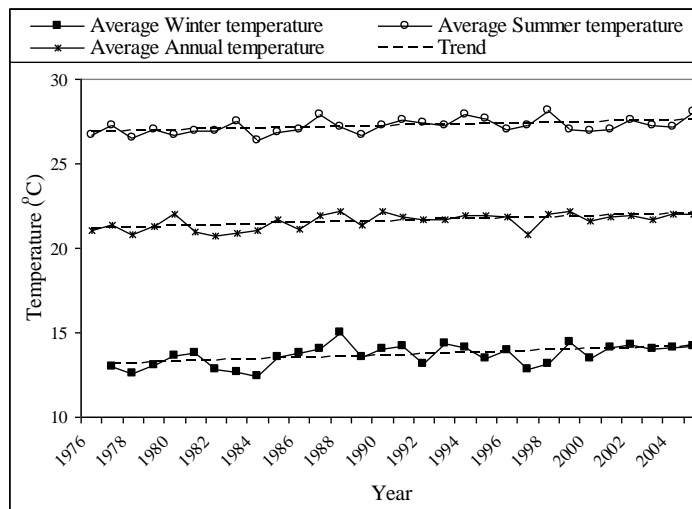
d. Surkhet
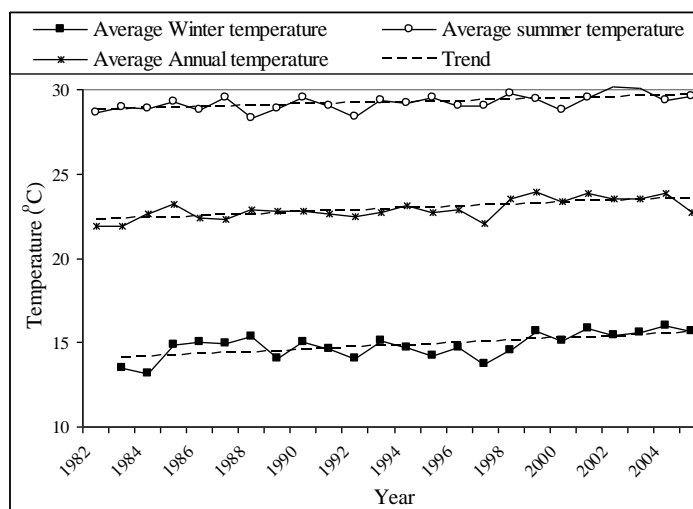
e. Dipayal
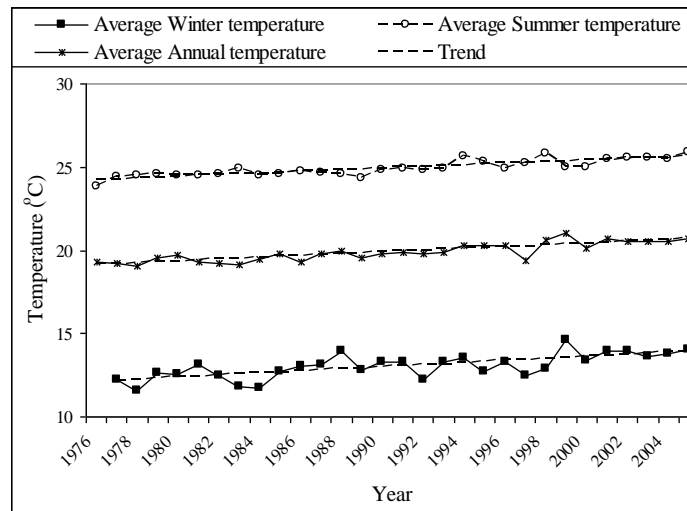
f. National

Figure 4.3 Temperature trends in Nepal

The highest rate of increase in annual temperature is recorded in Dhankuta, followed by Kathmandu, and Dipayal all of which have relatively higher altitude. Surkhet and Pokhara have relatively lower trend coefficients, but still statistically significant. This, to some extent, supports temperature increase faster at higher altitudes than at lower altitudes (Agrawala *et al.,* 2003). Similar scenario can be observed from seasonal breakdown of regional temperature trends as well. Dhankuta has the highest coefficient for both winter and summer temperature trends followed by Kathmandu and Dipayal. In all the cases, we found that temperature increase in winter is higher compared to that of summer. The similar trend will continue in the coming days as well (Table 4.3). Therefore, people are now experiencing more hot summers and warm winters. Similarly, Nepal is experiencing increasing warm days and nights (Baidya & Karmacharya, 2007). Set of figures in Figure 4.3 show the detail temperature trends for all 5 locations including the national average. In all these cases, we can see that temperature is in increasing trend in all locations.

Similar to the temperature, overall global precipitation has also increased by about two percent since the beginning of the twentieth century, which is statistically significant. However, such increase is neither spatially nor temporally uniform. Indian monsoonal rainfall shows the increasing trend since 1974 (Intergovernmental Panel on Climate Change, 2001). Since Indian monsoonal rainfall is the main source of precipitation in Nepal, it also experienced increasing trend of precipitation though it is very erratic over the years (Figure 4.4). A R^2 value is very low for all cases of rainfall trend analyses. Coefficient of trend value shows that annual national average rainfall is increasing. The increase is statistically significant at ten percent level of significance (Table 4.2). Such increase can be attributed to global warming, which results in increase in land-ocean thermal contrast, thereby intensifying monsoon circulation (Shrestha *et al.,* 2000).

In addition, General Circulation Model (GCM) estimates overall increase of precipitation in Nepal (Table 4.3). Seasonal breakdown of estimated precipitation shows that monsoon rain is going to be more intense whereas dry season will be drier. This will be further intensified under a CO_2 doubling condition. In recent days, increasing heavy rainfall event as well as a maximum 24-hour rainfall in the country is in increasing trend (Baidya & Karmacharya, 2007). Monsoon rain, which contributes around eighty percent of total rainfall, is the main source of water borne disaster in Nepal. Therefore, increase in intensity of summer monsoon can be translated into increase in intensity of water borne disasters like flood, landslide, and sedimentation. Consequently, there will be enormous loss of settlements, infrastructure, and fertile top soil that lowers agricultural productivity. These are regular phenomena but have become more intense in recent years.

Table 4.3 Prediction of temperature and precipitation in Nepal (GCM estimates)

Year	Mean temperature increase (°C)			Mean precipitation increase (mm)		
	Annual	Winter	Summer	Annual	Winter	Summer
Baseline average				1433	73	894
2030	1.2 (0.27)	1.3 (0.4)	1.1 (0.2)	71.6 (3.8)	0.6 (9.9)	81.4 (7.1)
2050	1.7 (0.39)	1.8 (0.58)	1.6 (0.29)	104.6 (5.6)	0.9 (14.4)	117.1 (10.3)
2100	3.0 (0.67)	3.2 (1.00)	2.9 (0.51)	180.6 (9.7)	1.5 (25.0)	204.7 (17.9)

Source: Agrawala *et al.,* 2003

Note: Figures in parentheses indicate standard deviation

In addition, topography of the location also dictates rainfall patterns in Nepal. Trend analysis shows the decreasing trend of rainfall in Dipayal from Far-Western Hills of the country, but the coefficient is statistically non-significant. Dipayal is a location having the highest altitude. However, rainfall is continuously increasing in Kathmandu at significant rate. Similarly, rainfall is continuously increasing in Pokhara, Surkhet, and Dhankuta, but the increase is not statistically significant. Pokhara has the highest coefficient, and due to its typical topography it also receives the highest annual rainfall in Nepal.
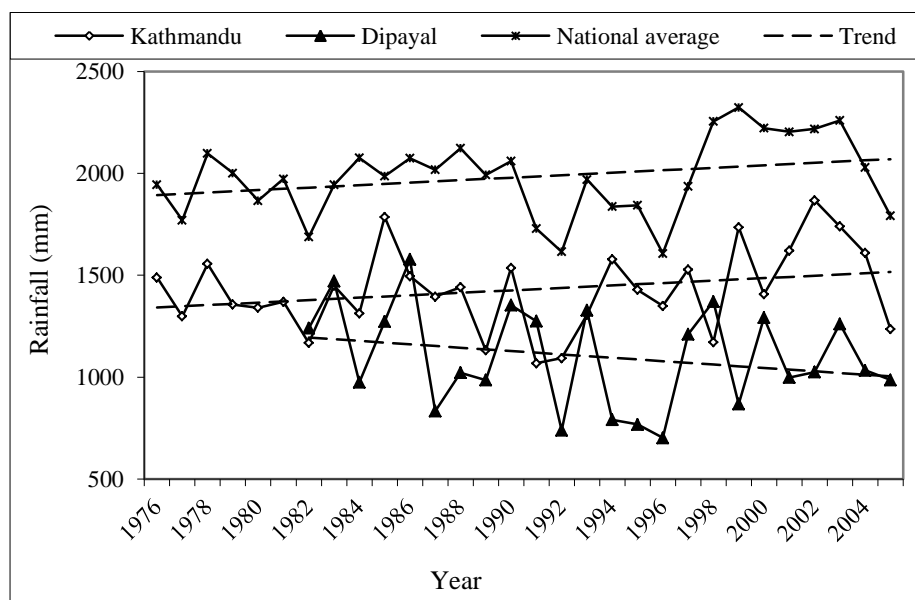
Figure 4.4a
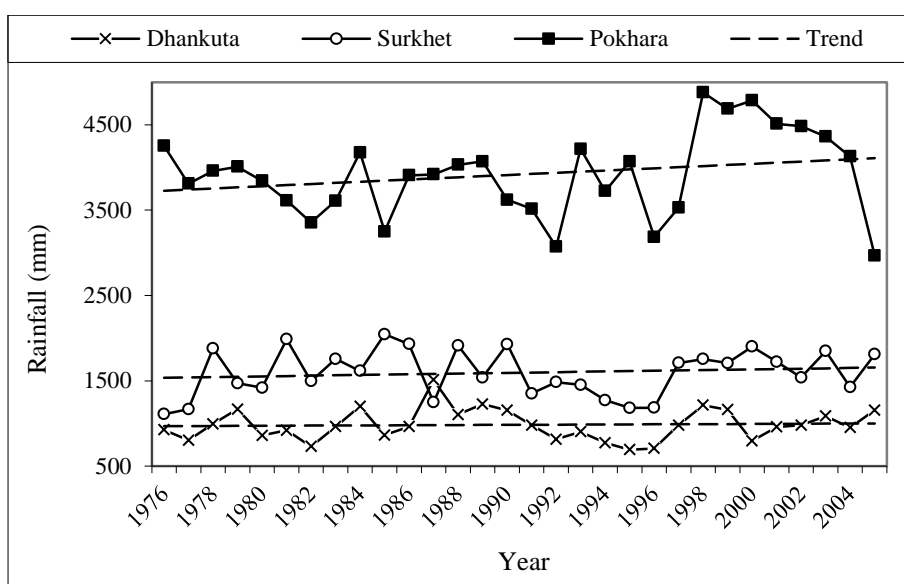
Figure 4.4b

Figure 4.4 Annual rainfall in Nepal by different locations

4.4 Impact of climate change on poverty

Nepal has very negligible contribution on the global CC as it has the lowest per capita GHGs emission in the world. But it is not free from adverse impact of CC. Its fragile geography, predominantly natural resource based livelihoods, and low level of adaptive capacity due to higher incidence of poverty place the country among the most vulnerable countries to CC.

Water resource, agriculture, forestry and biodiversity, and human health are some of the important sectors, which could be adversely affected by CC and consequently aggravate poverty in Nepal. Figure 4.5 shows how two aspects of CC, namely; temperature, precipitation and extreme events, affect poverty in Nepal through water resource, agriculture, forestry and biodiversity, and health sector.

Water resource, which is the most important resource of Nepal having the highest economic potential, is ranked as the most vulnerable sector to CC in Nepal (Agrawala *et al.,* 2003). This sector is affected mainly by variability in temperatures and precipitations. The

rise in temperature causes glacier retreat and subsequent glacier lake formation poses

growing threats of Glacial Lake Outburst Flood.

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┌─────────────────────────────────────────────────────────────────────┐
│                           Climate change                             │
└─────────────────────────────────────────────────────────────────────┘
        │                                         │
        ▼                                         ▼
┌──────────────────────┐              ┌──────────────────────┐
│ Increased temperature│              │  Rainfall variability│
└──────────────────────┘              └──────────────────────┘
        │                                         │
        │                                         ▼
        │                    ┌────────────────────────────────────────────┐
        │                    │ Changed rainfall pattern (drought, flood,   │
        │                    │ landslide)                                  │
        │                    └────────────────────────────────────────────┘
        ▼                                         │
┌──────────────────────────────────────────┐     │
│ Glacier melting - Glacial Lake Outburst   │     │
│ Floods (GLOFs)                            │     │
│ Spread of vector (diseases)               │     │
│ Intense heat and cold wave                │     │
│ Migration of species towards the Polar    │     │
│ Regions                                   │     │
└──────────────────────────────────────────┘     │
        │                                         │
        ▼                                         ▼
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Water: GLOFs, and higher variability of runoff that cause occurrence of water born disasters such as landslides, floods and drought resulting into soil erosion (Loss of soil fertility), loss of personal properties (Land, livestock, standing crops, etc.), Destruction of infrastructures

Agriculture: Decreased crop yield, increased incidence of diseases and pests, deteriorated quality of agro-product

Forestry and biodiversity: Depletion of forest, loss of forest and bio-diversity, increased risk of forest fire

Health: Spread of diseases, loss of lives

Social: Migration

Increase in poverty due to
- Loss of assets
- Loss of livelihoods
- Low agriculture production
- Deterioration of health
- Diversion of resources away from pro-poor program (or to meet basic necessities) in order to cope with climate related disasters

Figure 4.5 Climate change - poverty nexus in Nepal

Nepal has 3,252 glaciers that cover a total area of 5,323 square kilometers (International

Centre for Integrated Mountain Development & United Nations Environment Programme,

2001). These glaciers are retreating at faster rate compared to any other glaciers, and the rate is even higher compared to previous estimates (Pokhrel, 2007). For instance, The Rika Samba Glacier in the Dhaulagiri region is retreating at a rate of ten meters per year, it is crucial to concede that glacial movement is usually measured in millimeters. There are 2,323 glacial lakes in Nepal that cover an area of 75.7 KM^2, of which twenty are reported to be dangerously close to bursting because of global warming (International Centre for Integrated Mountain Development & United Nations Environment Programme, 2001). It is calculated that 1^oC increase in air temperature will lead to disappearance of twenty percent snow and glacier in the glaciated area above 5,000 meters. The figure could be raised to forty percent, fifty eight percent, and seventy percent for 2^oC, 3^oC, and 4^oC rise in air temperature respectively (Ministry of Population and Environment & United Nations Environment Programme, 2004). Disappearance of glacier and snow consequently leads to development of more glacier lakes or swelling of existing glacier lakes and increase potential GLOF hazards in Nepal.

A GLOF comes with enormous destruction. It poses threats to downstream settlements, infrastructure, natural resource, and human lives. Nepal has already experienced twenty five GLOFs in the past (Gum *et al.*, 2009). The Dig Tsho GLOF that occurred in 1985 was the most devastating one. It caused a ten to fifteen meter high surge of water and debris to flood down the Bhote Koshi, and Dudh Koshi River for ninety kilometers in Eastern Nepal. The flood swept the newly built Namche Small Hydel Project, fourteen bridges, wide areas of cultivated land, at least thirty houses among others including livestock and inhabitants (Rana *et al.,* 2000; Alam & Regmi, 2004; Regmi & Adhikari, 2007). Just recently, a collaborative anticipatory planning and management by the government, donors, and experts in GLOF

mitigation is able to reduce the risk of a GLOF from the Tsho Rolpa Glacier Lake. This is the biggest glacier lake situated in the Rolwaling Valley of Eastern Nepal covering an area 1.76 kilometer square. Unless the mitigation effort was taken, the glacier lake would have caused significant destruction claiming more than 10,000 human lives, and huge infrastructure loss including sixty megawatts Khimti Hydropower (Rana *et al.,* 2000).

The higher variability of runoff is another important factor in Nepal that can lead to increased water disaster such as flood, landslide and sedimentation, and more pronounced variations in water availability throughout the year. The available surface water of Nepal is 202 cubic kilometers, which goes down to only twenty six cubic kilometers in dry season (Ministry of Environment, 2010). Uneven distribution of rainfall and glacier retreat is the main reason for such variation that leads to water borne disaster. More than eighty percent rainfall occurs between June and September through monsoon rain that comes from Bay of Bengal. The current trend shows that the monsoon period is shortening, but at the same time the amount of rainfall is increasing, which means monsoon rain is becoming more intense. This is causing the problem of flood and landslide in the wet season and harsh drought in the dry season. The widespread impact of change in hydrological flows has been observed in Nepal. It has impacted many irrigation system, water-powered grain mills, hydropower plants and drinking water supply systems throughout the country (Gum *et al.,* 2009). Thus, people are experiencing more intensive rainfall and subsequent flood and landslide that have direct adverse impact on livelihood assets such as physical, natural, financial, social, and human specially among the poor (Vidal, 2006; Gautam *et al.,* 2007a; Gautam *et al.,* 2007b; Pokhrel, 2007). Therefore, water resource has high significance on overall livelihood of the majority through a number of ways including disasters, hydropower that supplies around

ninety one percent of the nation's power, irrigation, transportation and other several infrastructures.

Agriculture is another important sector to be hard hit by CC as it can be linked to the impact of CC on water, forests, health, and soil temperature. Considering its importance in Nepalese economy, any adverse impact on agriculture will jeopardize the life of many people. Around sixty six percent of the population (Ministry of Agriculture and Cooperatives, 2006), for whom agriculture is the mainstay, will face the high risk of food insecurity due to CC. Since agriculture is heavily dependent on weather condition, this sector will be adversely affected through extreme rainfall, which results in increased runoff variability and soil fertility loss and temperature rise, as well as drought.

Nepalese agriculture is predominantly rain-fed. Therefore, any variations in rainfall patterns will have direct impact on its agriculture. For instance, drought condition will result in decreased crop yields thereby total crop production. In 2005, food production of the country was adversely affected by drought that has caused 2 and 3.3 percent decrease in paddy and wheat production respectively. Nearly, ten percent of agricultural land was left fallow due to rain deficit. Similarly, in 2006, drought in Eastern Tarai resulted in decrease of rice production between twenty seven to thirty nine percent (Regmi, 2007). There were twenty one percent decline in rice production and three percent decline in millet production in the same year. This dragged the country under food self-insufficiency for the first time since it started attaining food self-sufficiency in 1999 (Figure 3.1). Moreover, World Food Programme (2010) identified climate related natural disasters like drought, flood, hailstorm, late/early rain, landslide, and crop pest disease as the major causes of high or severe levels of food insecurity in a number of districts in Far-Western Hills. Those natural disasters have

caused crop losses at thirty to seventy percent among over fifty percent of households (World Food Programme, 2010).

Drought became even worse in 2008/09, which is considered one of the worst in the country's history with least rainfall and widespread across Nepal. It has resulted in decline in production of major winter crops; wheat and barley by 14.5 percent and 17.3 percent respectively. The situation was even worse in some districts of Mid- and Far-West region. They received less than fifty percent of average rainfall during the period of November 2008 to February 2009. Consequently, crop yields dropped by more than half. Thereby, many farmers are exposed to high risk of food insecurity as agriculture still remains subsistence in nature. Similarly, excessive rainfall results in more frequent flood events that not only inundate the agriculture field and destroy the crops, but also destroy farmland and irrigation facilities. This consequently results in decreased agriculture production. Heavy rain and subsequent floods, landslides, and soil erosion are regular phenomena in Mid-Western Tarai, and Western regions of the country. Increased variability in runoff, therefore, is the major source of soil erosion in Nepal that washes away the fertile top soil in the sloppy areas, and sedimentation in inundated land. In both cases, soil fertility loss is the major outcome that consequently leads to production loss in agriculture, which also indicates loss of livelihood for the people who predominantly depends on agriculture.

Agriculture, being part of life science, will also respond to change in temperature. Rise in temperature will affect agriculture through increase in incidence of pests and diseases, and decrease in physiological performance of animal and poultry, thereby reducing crop and animal productions (Intergovernmental Panel on Climate Change, 2007d). However, degree of effects will vary depending upon the altitudes. It is reported that the rise in temperature

under atmospheric CO_2 doubling will initially increase the yield of rice, wheat, and maize in all three ecological regions of Nepal; Mountains, Hills, and Tarai. However, the rise in temperature at 4^oC will cause loss in rice and wheat yield in Tarai, which is considered the grain basket of the country having the highest proportion of land area under cultivation. Although continued increase in yield is reported in Hills and Mountains, it will be obtained at the cost of exhausted soil fertility and likely adverse impacts on nutritional value of the crops. Increase in temperature under increased availability of atmospheric CO_2 leads to vigorous growth of food-crops and reduce the level of soil organic carbon, soil micronutrient, and enhances decomposition by activating the microbial population in the soil thereby decreasing agricultural productivity in the long run (Malla, 2003). Similarly, temperature rise by 2^oC would decrease the quality of meat and milk, hatchability of poultry, and increases the possibility of disease in the livestock (Intergovernmental Panel on Climate Change, 2007d). Besides, temperature rise above 4^oC is detrimental to the existence of life on earth.

Forestry and health are the other sectors to be adversely affected by CC. Changes in temperature and precipitation would alter vegetation patterns of forests. It may cause forest modification through migration of plant and animal species along with other biotic species towards the Polar Regions, changes in their composition, extinction of species, etc. With the increase in temperature, shifting upward of several domestic and wild plants and animal species has been reported in Nepal (Malla, 2008). A study has shown that out of fifteen types of forest categorized by Holdridge model existed in Nepal under existing CO_2 condition; three types will disappear if existing CO_2 concentration is doubled. Tropical wet forest and warm temperate rain forest would disappear, and cool temperate vegetation would turn into

warm temperate vegetation (Ministry of Population and Environment & United Nations Environment Programme, 2004). Such change in vegetation would affect biodiversity in forests of Nepal. In addition, landslides, floods, and water erosions have resulted in massive depletion of forest. At the same time, summer drying and drought increased the risk of forest fire that poses threat to adjacent human settlements. Forest being integral part of livelihood, such depletion of forest as well as loss of biodiversity will hamper the livelihood of huge proportion of population who are dependent on forest based livelihoods, especially ethnic forest dwellers in rural Nepal. This consequently will exacerbate poverty in rural areas.

Climate change has been recognized as one of the major challenges by the World Health Organization (WHO) for the health policy makers, planners, and managers and urged to address the issues before it becomes too late. Intergovernmental Panel on Climate Change (2007d) projects increase in under-nutrition and related disorders, morbidity and mortality due to heat waves, floods, droughts, windstorms, and fire. Similarly, incidence of vector-borne diseases such as malaria, kalaazar, Japanese encephalitis, and dengue in tropical and sub-tropical regions, diarrheal diseases, and cardio-vascular diseases due to increase in ground-level ozone is expected to increase with the higher intensity of CC. The vector-borne diseases are now moving to new regions as mosquito from Tarai and Mid-Hills are being able to survive in High-Hills as well. In 2006, seven out of thirteen Mountain districts of Nepal were classified as malaria prone districts due to the spread of the vector in these areas (World Health Organization, nd). Similarly, incidence of kalaazar is now reported in more than dozens of Tarai districts. In addition, people in Nepal are exposed to death threats due to heat and cold waves. These extreme temperatures claimed more than sixty lives in 2003, which then rose to more than 110 in 2004 (Figure 4.6). Since then, these

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extreme temperatures are continuously claiming lives. Given less than one fifth of population, most of them are poor, has access to modern health services, vulnerability to future CC in health sector is also very high.
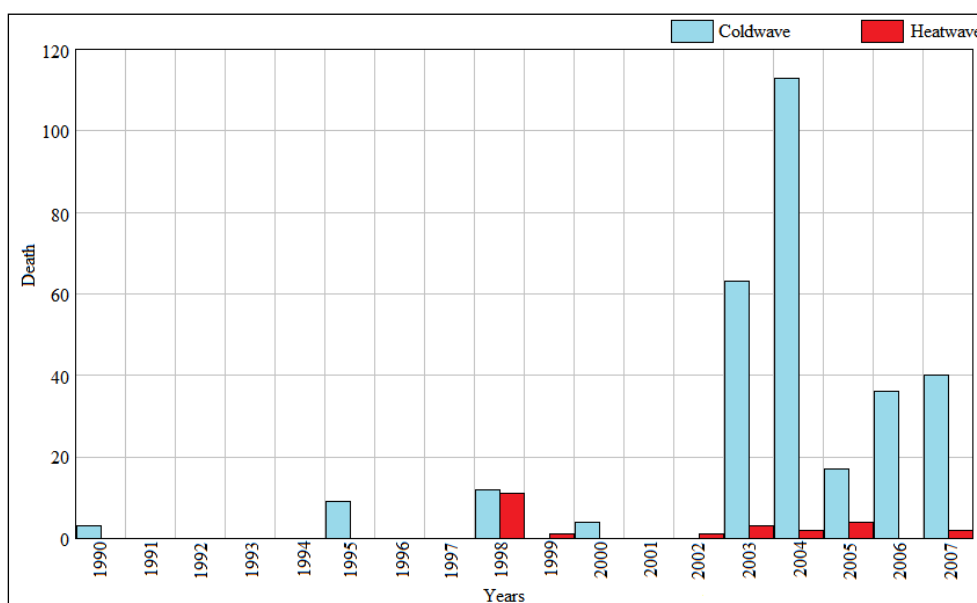
Figure 4.6 Death caused by cold and heat waves in Nepal

Source: http://online.desinventar.org/desinventar/index.php?r=NPL-1250695185-nepal_historic_inventory_of_disasters

Thus, the loss of shelter and infrastructure (physical assets), spread of vector-borne diseases and loss of lives (human assets) displacement of community (social assets), loss of water sources, loss of cultivable land (natural assets), lower saving and higher debt (financial assets) are widespread evident caused by CC in Nepal. All of these factors are responsible for higher vulnerability to CC, which exacerbates problem of poverty especially among the marginal populations, who have very limited resources to cope with the problem.

4.5 Initiatives to cope with climate change and opportunity for revenue generation

Nepal is signatory of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (KP), which are very crucial international legislations with regards to CC. However, the government of Nepal has not yet internalized aspects of

CC in its policy documents. It was only in the Tenth Periodic Plan (2002-2007), that the government of Nepal committed itself to implement treaties on CC and took initiative to assess and control hazards caused by GLOFs taking climate change convention as the basis. The plan also envisaged the poverty reduction by optimal use of natural resources through community participation. The Eleventh Periodic Plan (2007-2010) moves forward in this direction and identify the promotion of carbon trade to achieve benefit from Clean Development Mechanism (CDM) under the KP. The promotion of alternative energy, and management of natural resources especially forest have been identified as means for generating financial resources in the long term through carbon trading (National Planning Commission, 2007).

4.5.1 Promotion of alternative energy

With the objective to promote alternative energy, the government of Nepal has established Alternative Energy Promotion Center (AEPC) as an autonomous body under the Ministry of Environment, Science, and Technology (MoEST), which is also a Designated National Authority (DNA) for any CDM project. AEPC is also the government body designated to negotiate for CDM project in Nepal. Household biogas, micro/mini hydropower, solar energy, Improved Water Mill (IWM) and Improved Cooking Stove (ICS) are some of the prospective projects identified for international carbon trading by the AEPC.

Two biogas projects have already been registered in Clean Development Mechanism-Executive Board (CDM-EB) for carbon trading under voluntary basis in December 27, 2005. The Emissions Reduction Purchase Agreement (ERPA) was signed between AEPC and Community Development Carbon Fund (CDCF)/World Bank in May 3, 2006 for a seven-year crediting period. These two biogas projects cover 19,396 biogas plants,

and have started generating revenue. With the estimated net emission reduction of 4.6 tones CO_2-eq/biogas-plant/year, annual Certified Emission Reduction (CER) from the projects will be around 90,000 CO_2-eq. Therefore, given US$ 7/ton CO_2-eq of carbon price, these projects are generating annual income of approximately US$ 0.65 million until 2012, the end of the first commitment period of the KP. Such revenue generated is expected to reduce dependency on large subsidies provided by the government and external donors. Also, such revenue will help to expand biogas installation in more remote and poorer areas of Nepal.

Considering the importance of biogas in tackling poverty, such expansion of biogas in remote and poorer areas of Nepal can also help in reducing poverty to some extent. Biogas plant can help to alleviate poverty through time saving (approximately four hours/day) and cash saving. Time can be saved from shortened time for cooking in biogas as well as saving time involved in collecting fuel-wood. Similarly, cash savings of NRs. 25,499/HH/year can be achieved through replacement of kerosene for lighting, reduced use of fertilizer, reduced expenses in health due to significantly lower indoor air pollution caused by fuel-wood for cooking and kerosene for lighting and better sanitation (Laudari, 2008). Until 2006/07, there are 185,585 biogas plant installed in the country of which 96.2 percent are operational. Therefore, any effort to bring 178,533 operating biogas plants under the small scale CDM project will generate around US$ 6.2 million per year. This amount can be utilized for massive scaling up of biogas installation among the poor through subsidy and credit. Thus, it will be great support to achieve poverty reduction goal of the country. Moreover, the existing number of biogas installation is only ten percent of total potential (Laudari, 2008). Therefore, there is high scope for dissemination of the installation all over the country, especially in rural areas.

The Nepal Micro-Hydro Project is the second CDM project in Nepal to be registered under CDM-EB, and ERPA was signed on June 29, 2007 by AEPC under CDM-EB of the KP. With the promotion of fifteen megawatt micro-hydro projects, it is expected to generate CER of 324,999 ton CO_2-eq by the end of the project year 2012 of which 191,000 ton CO_2-eq could be sold at the rate of US$ 10.25/ton of CO_2-eq (World Bank, 2007c). Micro-hydroelectricity projects will be developed under Rural Energy Development Programme (REDP); therefore, will operate in the poorest and geographically most isolated areas and will serve the most socially marginalized groups in rural Nepal through off-grid.

This will provide a large number of rural households with electricity for lighting, milling and other needs. Thus, the project will help in poverty alleviation through employment generation as well as direct local environmental benefits through reduction in diesel and kerosene consumption (reduced CO_2 emission), and the use of dry cells (lowering chemical pollution and health hazard) and lead acid cell batteries (reducing pollution and transport cost involved in charging) (World Bank, 2007c). Similarly, Project Idea Note (PIN) for IWM has already been submitted to DNA, and that for ICS was supposed to be submitted to DNA on July 2008. These two CDM projects are very crucial from a viewpoint of poverty reduction as they have rural orientation. Besides, PIN is being prepared for solar energy projects, electric vehicle, landfill solid waste management, and vertical shaft brick kiln.

4.5.2 Forest management

Forestry is another important sector in which about two thirds of the globe's terrestrial carbon is sequestered in the form of standing forest, forest understory plant, leaf and forest debris, and in forest soils together with other non-natural stocks. Nepal has 39.6 percent of total area covered by forest. Vast chunks of the forest are under the control of the government,

and are managed through state mechanism such as District Forest Office (DFO). Conservation of forest is also done by declaring 18.33 percent of total area of the country as conservation area. Some 1.24 million hectares of forest areas are managed through community participation. Similarly, 17,244 hectares of forest are managed under leasehold forest consumer groups covering 28,112 households (Department of Forest, 2007).

The CDM mechanism of the KP recognizes the afforestation and reforestation project to be eligible for carbon trading for the first commitment period. However, despite substantial plantation activities through community-based forest management and leasehold forest management programs, forestry-based CDM has not been initiated in Nepal so far. Therefore, some of the Community Forestry (CF) projects, leasehold forestry projects, private lands, and national forest have potentials to be brought under CDM mechanism if such projects are developed to meet the necessary criteria. They should meet at least the following three criteria; plantation area equal to or greater than 0.5 hectares, the crown coverage should be less than ten percent, and the plantation carried out in 2000 onwards in areas where there had been no forests since 1990.

Most of the forest regeneration activities are taking place on the hilly regions of the country. Therefore, carbon sequestration study done by International Centre for Integrated Mountain Development (ICIMOD) in 2007 in the Himalayas including Nepal could be very much relevant to the Nepalese context in general. The carbon sequestration capacity of Nepalese forest is 6.89 ton CO_2/ha/year (Banskota *et al.,* 2007). The figure is closer to the study done in Tarai region of Nepal that showed the carbon sequestration rate of 7.33 ton CO_2/ha/year (Aune *et al*., 2005 cited on Banskota *et al.,* 2007). These calculations exclude the potential carbon sequestrated in the form of soil organic carbon, carbon in herbs/grass

and litter, and less than five centimeters diameter at breast height. On the basis of biomass data of the country, it is estimated that Nepal can negotiate the price of at least US$ 5/ton CO_2.

Food and Agriculture Organization (2006) reported that in Nepal plantation activities were carried out in 52,000 and 53,000 ha of land on 2000 and 2005 respectively. This also means that Nepal can claim US$ 3.6 million from the plantation activities in degraded land if such plantation was carried out with due consideration to bring under CDM mechanism. Plantation activities in Nepal basically took place in private land, community forest, leasehold forest, and government forest.

By July 2000, plantation on 8,000 ha was done through leasehold forestry, which has reached to 17,244 ha in 2007 (Food and Agriculture Organization, 2000; Department of Forest, 2007). This indicates that between 2000 and 2007, some 9,244 ha of degraded land was brought under plantation through leasehold forestry program. Thus, the modest calculations show that Nepal can generate revenue of around US$ 0.32 million per year only through leasehold forest, which could go up significantly if thorough study is made in this direction. Considering the success of the program in tackling poverty through secure right of land and employment generation, such revenue could be crucial in scaling up the program in around 1.6 million ha of barren lands or grasslands with scattered trees. Thus, afforestation and reforestation project eligible for CDM have economic potential of around US$ 55 million together with its contribution on overarching goal of poverty reduction from its extension in all potential areas.

Exclusion of projects on natural forest conservation under the category of 'avoided deforestation' hinders the possibility of bringing CF of Nepal under CDM mechanism.

However, the recognition of avoiding deforestation by the international community for its higher carbon mitigation benefits and sustainability has raised prospects of Nepalese CF for carbon trading (Intergovernmental Panel on Climate Change, 2007b). Considering a wide coverage of CF and protected areas in Nepal, it could be an important sector for revenue generation through carbon trading. In addition, given that deforestation is being the single most important source of carbon emission, there is unequivocal emphasis for the action to curb deforestation in developing countries as part of a future response to CC.

The international community made an agreement in this direction during the 13th Conference of Parties (COP13) of UNFCCC in Bali in 2007. The proposed Reducing Emissions from Deforestation and Forest Degradation (REDD) policy is a new international legal framework for climate change mitigation, which was emerged during the COP13, and, at present it is in vigorous debate. As it recognizes forest as carbon sources, management of existing forests, and rights of indigenous people who are dependent on forest resources to meet their subsistence needs, it is appealing for carbon trading. It is also considered as a 'road map' for post-Kyoto after 2012 on the role of forest in the global climate budget. It has a provision of compensating developing countries in proportion to the amount of carbon emission that are reduced by halting its national deforestation rate below the baseline.

Analysts suggest that CC, biodiversity, and local livelihoods are three important aspects of forest, which should be addressed by the REDD policy to be more equitable and inclusive. At the same conference, the World Bank launched a forest carbon fund for the REDD initiative called "Forest Carbon Partnership Fund" (FCPF). This fund has dual objectives of building capacity for REDD in developing countries, and testing a program of performance-based incentive payments in some pilot countries. The FCPF can also be

regarded as a precursor to the REDD, like Activities Implemented Jointly (AIJ), which was operated prior to the first commitment period as an experimental phase before the carbon market under the KP started operating (Karky & Banskota, 2009). Nepal is one of the thirteen tropical countries whose Readiness-Project Idea Note (R-PIN) is selected under this fund. After the formulation of full Readiness Plan and its approval, Nepal will be able to implement a prototype of REDD and gain experience and build capacity to operationalize REDD by taking on board CF in an experimental way under FCPF. In addition, with the implementation of the first-ever pilot Forest Carbon Trust Fund, Nepal successfully started generating revenue from CF of three watersheds in Dolkha, Gorkha and Chitwan. A total sum of US$ 95000 was handed over to representatives from those three watersheds as the payments for their successful effort to sequestrate additional 0.1 million tons of CO_2 in 2011 compared to that of 2010 from around 10,000 ha of CF (International Centre for Integrated Mountain Development, 2011). This shows that any successful initiative of developing countries including Nepal to implement REDD would fetch as much as US$ 42.7 million from CF and US$ 82.4 million from protected areas (2.4 million ha excluding buffer zones as these areas are also covered by CF to some extent) annually. Besides, there are also several hectares of land under private ownership, which could be brought under either CDM or REDD.

4.5.3 Agriculture practice

Agriculture in Nepal is predominantly subsistence in nature, with the very low level of external input use such as fertilizers, irrigation, pesticides and improved seeds. Due to heavy energy required for these external inputs, especially fertilizer and irrigation, any effort to reduce the use of these resources or efficient use of these resources could significantly

reduce carbon emission from agriculture and industrial sectors. In this line, SRI with the baseline of methane emission, and Organic Agriculture (OA) with the baseline of nitrous oxide emission could be prospective projects to be brought under CDM. Steps to bring SRI under CDM are already in progress. Therefore, Nepal can claim its share from more than 1,000 ha of area under SRI, which is expanding at higher rate in Nepal from Tarai (60 masl) to Mid-Hills (around 2,000 masl) (Upreti, 2008). Besides, considering tolerance of SRI to adverse climatic influences such as drought, storms, hot spells and cold snaps that results in reduced economic and agronomic risk, and higher yield compared to conventional practice, SRI could be an important practice of adaptation to CC (Uphoff, 2007). Organic agriculture also serves in this direction. Love Green Nepal, an NGO, has taken an initiative to incorporate OA in the carbon market (United Nations Environment Programme, nd). However, there is lack of documentation for area under OA as well their certification mechanism. Therefore, any initiative to bring these practices under CDM through research and development not only generates the carbon credit but also help to adapt against adverse impact of CC among the resource poor farmers.

4.6 Conclusion

Nepal has negligible share of global GHGs emission. However, the rate of emission increase is alarmingly high mainly due to the constantly increasing use of fossil fuels, emission from livestock, and use of N_2O fertilizer. Sector-wise emission shows that agriculture and forestry are two most important sectors contributing almost ninety percent of the total emission. Therefore, any mitigation effort in Nepal should consider these two sectors, which are also the most important sectors for poor people. Despite such low level of emission, Nepal has already shown some indication of CC in terms of rising temperature, variability in rainfall

and more frequent occurrence of climate related natural disasters. Nepal has experienced annual temperature increase of $0.054^{o}C$ from 1976 to 2005 and is expected to increase further. Temperature is increasing at a higher rate in relatively higher altitude. Winter temperature increase is more pronounced compared to summer temperature. Rainfall also shows the increasing trend but degree of variability explained by the trend analysis is very weak.

Increase in temperature and rainfall pattern have negative direct influence on water resources at the highest level followed by agriculture, forest, and health sectors of the country. Increased risk of GLOFs poses threat to important infrastructure in the downstream including settlements claiming enormous amounts of assets and lives of thousands. Similarly, higher variability in run-off results in increased water disaster such as flood, landslide, sedimentation, and more pronounced variations in water availability throughout the year. These kinds of events adversely affect livelihood assets. Agriculture is another important sector, which has direct bearing with the livelihood of more than sixty six percent of Nepalese population. Agriculture, being dependent predominantly on weather condition, will be adversely affected by variation in temperature and rainfall. Crop loss due to flooding, inundation, landslide, and drought is common phenomenon in Nepal these days causing reduced production of major crops. Increased temperature above $4^{o}C$ has negative impact in agriculture, especially in Tarai where significant proportion of cultivable land of Nepal is located. Even in higher altitude improved agricultural productivity can be achieved at the cost of decreased agricultural productivity in the long run.

The impact of CC in forest is alteration of forest composition and thereby loss in biodiversity. Increased temperature will cause migration of forest species towards the Polar

Regions. Nepal may lose three types of forest due to such migration. Also, Nepal is experiencing massive depletion of forest land due to landslides, floods, water erosion, and forest fires. The spread of vector-borne disease to the new regions is the major challenge in the health sector as a consequence of CC. In addition, increased incidence of water-borne disaster and negative impact on agriculture and forest will affect health sector adversely.

Being signatories of major international legislations related to CC, Nepal has prospect to generate revenue through mitigation effort. Alternative energy promotion, forest management, and agricultural practice are potential areas, which can generate revenue from carbon trading. Two biogas projects and one micro-hydro project have been successfully registered and have started generating revenue through CDCF/World bank. Biogas project for CDM cover only ten percent of installed biogas plant of the country, which itself is only ten percent of potential biogas installation. Therefore, there is huge potential to generate revenue from biogas sector through CDM mechanism. Similar is the case from micro-hydro projects as the country is rich in water resources. IWM, ICS, solar energy projects, electric vehicles, landfill solid waste management, and vertical shaft brick kilns are some of the other alternative energy promotion projects under consideration to be brought under the CDM mechanism.

In forest sector, leasehold forest and part of community forest has the prospect to generate revenue from the CDM mechanism under afforestation and reforestation provisions. In the context that Nepal is in the process to prepare full readiness plan that enables it to implement a prototype of REDD, any successful initiative to implement REDD policy would generate more than US$ 122 million from the forest sector alone. System of rice intensification and OA are two agricultural practices that have the potential to be brought under the CDM

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mechanism. These agricultural practices can also be regarded as adaptive measures against adverse impact of CC as they reduce dependency on external inputs as well as improve tolerance against adverse weather conditions. All these prospective areas have multiple functions of mitigation, adaptation as well as economic empowerment of the vulnerable section of the population. Therefore, a proactive role of Nepal in international forum with intense research and development to incorporate these aspects in international negotiations and capacity development of its own in the field is very crucial to deal with adverse impacts of CC and meet its overarching goal of poverty reduction as well. In addition, further research on impact of climate variables on agriculture based on the historical evidence as well as livelihood of rural poor based on the household level data is highly recommended.

Chapter 5. Effects of climate variables on yield of major food crops in Nepal: A time-series analysis

5.1 Introduction

Nepal is a developing country with a majority (63.7 percent) of its population living under poverty (Alkire & Santos, 2010). Huge proportions of its population derive their livelihoods from farm and forest, which are highly dependent on natural phenomena. Besides, disaster prone nature of the country due to its rugged terrain with steep topography, and fragile geological conditions place it among the countries having a high degree of vulnerability to Climate Change (CC). Such high degree of vulnerability poses threats on water resources, agriculture, forestry and biodiversity, and human health. Agriculture has been a major concern in the discussions on CC as food production is essential for sustaining and enhancing human welfare (McCarl *et al.,* 2001; Schmidhuber & Tubiello, 2007).

Climate is a primary determinant of agricultural productivity, especially in the case of developing countries like Nepal where agriculture is basically dependent on natural circumstances against the controlled environmental condition in developed countries. Therefore, CC would influence crop yield, thereby crop production to a greater extent in developing countries. Plausible scenarios in CC i.e., increasing temperature, changes in precipitation, climate extremes like drought, flood and landslides, and higher CO_2 concentrations will directly affect crop yields. In general, temperature increase will reduce yields and quality of food-crops thereby exacerbating vulnerability in food supply. Similarly, changes in precipitation patterns i.e., intensive rain concentrated in a particular month has a devastating effect on crop production (Abrol & Ingram, 1996; Adams *et al.,*

1998; McCarl *et al., 2001*).

Despite such a high degree of vulnerability to CC for agriculture thereby welfare in developing countries, there are limited researches conducted in the case of developing countries (You *et al.,* 2005; Mendelsohn, 2009; Boubacar, 2010; Holst *et al.,* 2010) and very few in the case of Nepal (Malla, 2008). The vast majority of such researches are done in developed countries (Stooksbury & Michaels, 1994; Lobell & Asner, 2003; Chen *et al.,* 2004; Isik & Devadoss, 2006; Kim & Pang, 2009; Carew *et al.,* 2009). There are very limited literatures in the case of developing countries, which are going to be adversely affected by predicted CC (Rosenzweig & Parry, 1994; Stooksbury & Michaels, 1994; Lobell & Asner, 2003; Chen *et al.,* 2004; Isik & Devadoss, 2006; Intergovernmental Panel on Climate Change, 2007a). Therefore, this chapter analyzes the effect of climate variables on yield of major food-crops in Nepal based on historical data. An understanding of the national impacts of recent climate trends on major food-crops would help to anticipate impacts of future CC on food self-sufficiency of the country.

5.2 Methodology

Temperature, precipitation, and solar radiation are the three most widely used climate variables to assess CC and its impact. However, solar radiation has a closer positive correlation with maximum temperature. In general, higher solar radiation leads to a higher maximum temperature and lower solar radiation leads to a lower minimum temperature because of radiative heating and cooling respectively (Peng *et al.*, 2004). This shows the direct correlation between temperature and solar radiation. Therefore, to overcome the possible correlation among the independent variables, this chapter considers only temperature and precipitation. Rainfall is the most important form of precipitation in terms

of meeting water requirement of agricultural crops. Daily mean air temperature is the widely used temperature variable to assess the effects of global warming on grain yield. The use of mean air temperature assumes no difference in the influence of day versus night temperature. However, the inclusion of minimum and maximum temperature in the assessment will capture differential effects of day and night temperature (Peng *et al.,* 2004) as well as climate extremities to some extent.

Simulation models and regression models are widely used to estimate the effects of environmental changes on crop productivity levels. Most studies on the possible impact of CC on crop yields used mainly indirect crop simulation models that make use of crop biophysical simulation. There are relatively limited studies based on regression model (Peng *et al.,* 2004; You *et al.,* 2005; Isik & Devadoss, 2006; Mendelsohn, 2009; Boubacar, 2010). Crop simulation type of study will help to understand the physiological effects of high temperature on crop yield, but not the effects of small increase in temperature associated with global warming (Schlenker & Roberts, 2008). In addition, though it is unequivocal that global warming is inevitable in the coming century, even if emission of Green House Gases (GHGs) is stabilized at current level, there exists debate and uncertainty on the extent of warming as well as other related changes (Intergovernmental Panel on Climate Change, 2007a; Rosegrant *et al.,* 2008). Thus, predictions of the yield changes in response to changes in climate variables, from regression models based on historical climatic and yield data for specific crops are relatively accurate (Mendelsohn *et al.,* 1994; Lobell & Asner, 2003; Lobell *et al.,* 2005; Isik & Devadoss, 2006; Lobell & Field, 2007; Boubacar, 2010). This can be done through application of production function presented as Equation 5.1 (Nicholls, 1997; Lobell & Field, 2007);

$$\Delta Yield = m + r_y \Delta Climate + \varepsilon \;\text{--- (5.1)}$$

Here,

ΔYield is the observed trend in yield, *m* is the average yield change due to management and other non-climatic factors (e.g. increased CO_2), ΔClimate is the observed trend in temperature and rainfall, r_y is the yield response to this trend, and ε is the residual error.

Detrending of the yield and climate variables and using the residuals to calculate quantitative relationships between variation in climate and yield can remove non-climatic influences such as adoption of new cultivars and changes in crop management practices (Nicholls, 1997; Lobell *et al.,* 2005; Lobell & Field, 2007). Detrending can be done by using the first-difference time series for yield and climate variables i.e., the difference in values from one year to the next.

Paddy, maize, millet, wheat, barley, and potato are the major food-crops of Nepal as these crops are used to meet the basic food requirement of its population (Subedi, 2003). Paddy, maize, potato and millet are the main food-crops cultivated during the summer season (from May to August), whereas wheat and barley are the main winter crops cultivated from November to February. Appendix 1 shows the crop calendar of these major food-crops in Nepal.

Due to consistency in the availability of climate data from the maximum number of stations existing in the country, the period from 1978 to 2008 is taken into consideration. A period of more than thirty years is qualified for the study of the impact of climate variables on yield of the food crops as response to CC (Intergovernmental Panel on Climate Change, 2007a). Average national yields of the food-crops for 1978 to 2008 were compiled from different publications of the Ministry of Agricultural and Cooperatives. Similarly, crude

data on climate variables, i.e. temperature and rainfall were obtained from Department of Hydrology and Meteorology, Nepal, on monthly basis from 1977 to 2008. Rainfall data from 235 weather stations distributed along the elevation from 72 to 3,803 masl, and temperature data from forty five stations distributed along the elevation from 72 to 2,680 masl were compiled for the purpose of this study. Rather than using annual averages for each climatic variable, an effective growing seasons for each crop based on the contiguous months within the growing season for major ecological regions were used for the analysis.

5.3 Results and discussion

5.3.1 Trend of food-crops' yield

The yield trend of the food-crops based on the regression coefficient against time shows that time has significant (P-value < 0.00) effect on yield of all the food-crops. However, the trend of yields for the six major food-crops shows very different patterns (Figure 5.1). Potato has the highest regression coefficient against time variable. Yield of potato is growing by 0.26 ton/ha every year. Thus, yield of potato has increased from 5.5 ton/ha in 1978 to 13.3 ton/ha in 2008 contributing the yield growth rate of 3.32 percent. Except for 1985, during which the yield of potato declined sharply, potato yield has been continuously increasing. There is no relation with climate variables for such sharp decline in yield. Wheat also shows better performance in terms of yield growth. With the regression coefficient of 0.035 against time variable, yield growth rate of wheat is 2.32 percent. Yield growth rate of only these two crops is higher compared to population growth rate (2.3 percent) of the country. Yield of paddy and maize is also growing but the growth rate is well below the population growth rate. Yield of paddy and maize is growing at the rate of 1.7 and 1.49 percent respectively. A sharp decline in the yield of paddy and maize in 1982

can be linked to sharp decline in summer rain in the same year. Yield decline in paddy and maize is directly associated with summer rain (Figure 5.1, and Figure 5.2). Yield growth of barley and millet, which are also minor food-crops, are relatively stagnant, growing at the rate of below one percent.
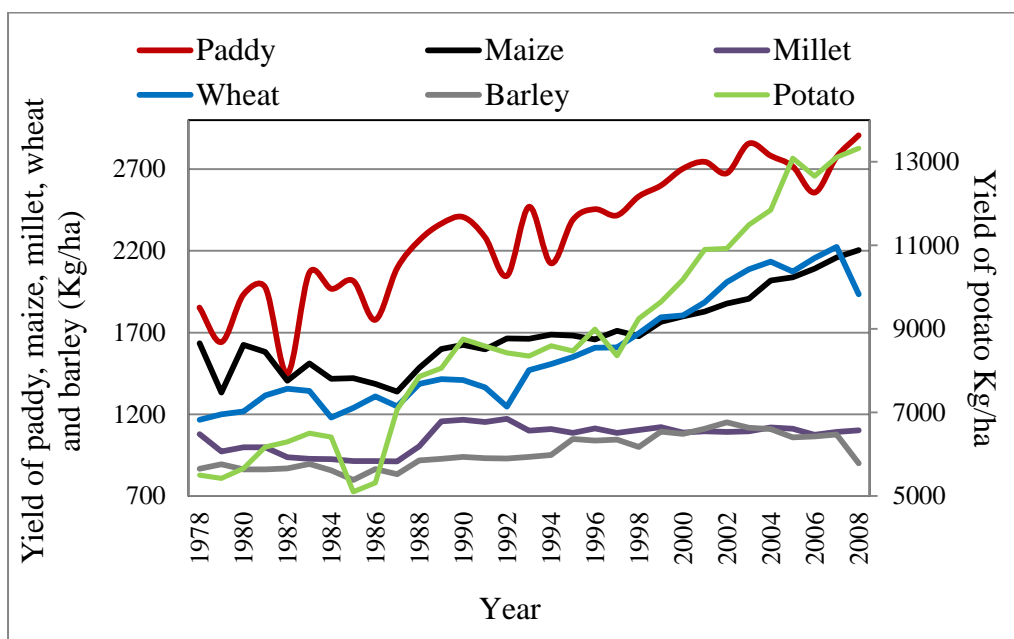
Figure 5.1 Yield trend of major food-crops

Source: Ministry of Agriculture, 1990; Ministry of Agriculture and Cooperatives, 2009

5.3.2 Trend of climate variables

Trend of climate variables are analyzed on a seasonal basis to coincide the growing seasons of the crops considered for the study. Average of temperature for the effective growing season based on the data obtained from all meteorological stations is taken into consideration, whereas in case of rainfall, average monthly rainfall of four winter months added to get total rainfall for the season is considered. Accordingly, trend of minimum temperature, maximum temperature, and rainfall for summer and winter is presented in Figure 5.2 and 5.3 respectively. Here, only maximum temperature for winter and summer season shows significant (P-value < 0.00) increase over time, whereas minimum

temperature and rainfall for both seasons show insignificant association with time variable.
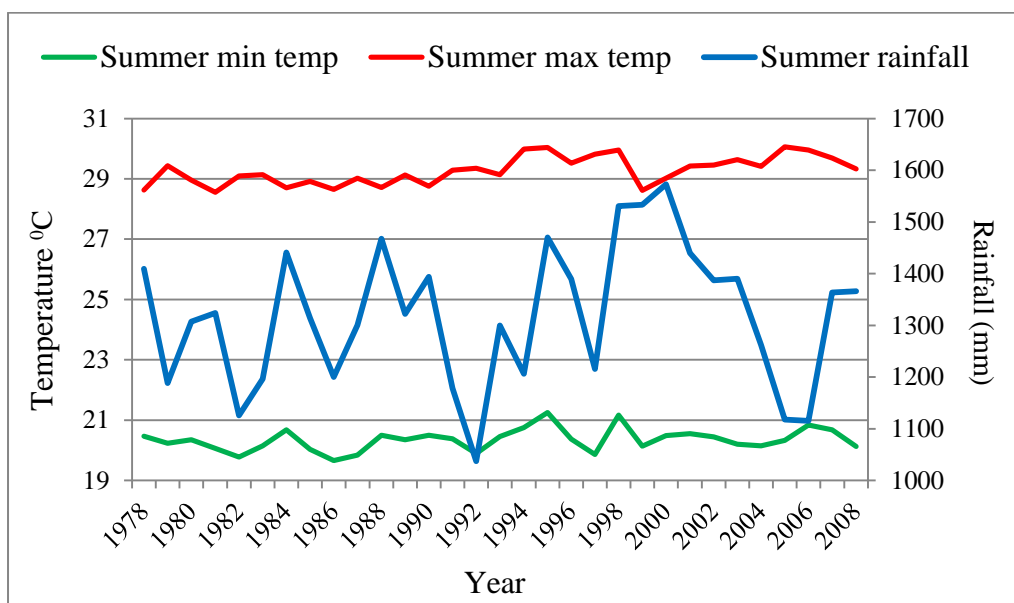
Figure 5.2 Trend of total summer rainfall, and average summer minimum and maximum temperature

Source: Raw data from Department of Hydrology and Meteorology (DHM), Nepal

Note: Summer season includes months of May, June, July and August

Rainfall fluctuates over the years with less degree of predictability. However, it is in increasing trend for summer season, but in decreasing trend for winter. The coefficients suggest that summer rainfall is increasing by 2.2 mm every year whereas winter rainfall is decreasing by 0.63 mm every year. Rainfall in Nepal is concentrated in summer. Around seventy five percent of rainfall occurs during this season. The positive coefficient for summer rainfall and negative coefficient for winter rainfall indicate that rain in summer is becoming more intense, which could hamper yield of summer food-crops due to water-borne disaster like flood and landslides. However, still the relationship between rainfall and yield shows positive correlation, i.e. yield is growing with increase in rainfall and shrink with decrease in rainfall.

Coefficients of temperature for both seasons are positive except for winter minimum temperature. Winter maximum temperature is increasing at a higher rate compared to summer maximum temperature. Summer and winter maximum temperature increased at the rate of 0.03^0C and 0.05^0C each year between 1978 and 2008 respectively. Summer minimum temperature is also increasing every year by 0.01^0C. However, winter minimum temperature is decreasing each year, but at very low rate 0.001^0C every year. Increase in temperature up to 2^0C will increase the food-crops yields in Nepal (Malla, 2008). Therefore, the increase in temperature during the period from 1978 to 2008 i.e. below 2^0C would be favorable for growth in yield of food-crops. However, decline in minimum winter temperature could hamper the yield of winter crops as frost frequency caused by decline in minimum winter temperature influences wheat yield adversely (Nicholls, 1997).
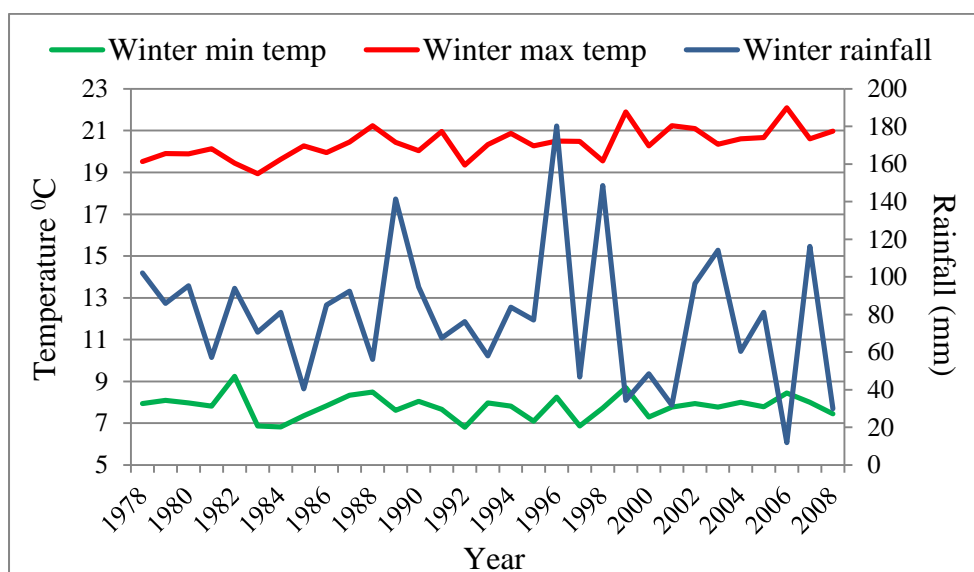
Figure 5.3 Trend of total winter rainfall, and average winter minimum and maximum temperature

Source: Raw data from DHM, Nepal

Note: Winter season includes months of November and December of preceding year and January, and February of succeeding year

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5.3.3 Climate yield relationships

Multivariate regression analysis of first difference in yield of the crops considered for this study is presented separately for both summer crops and winter crops in Table 5.1 and 5.2 respectively.

Table 5.1 Relationship between yield of summer food-crops and summer climate variables

Variable	Paddy		Maize		Millet		Potato	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Sumrain	0.012 (0.004)	0.01[***]	-0.002 (0.002)	0.43	-0.001 (0.001)	0.56	0.003 (0.013)	0.79
Summintemp	-0.15 (0.12)	0.25	0.07 (0.06)	0.32	0.02 (0.03)	0.55	0.21 (0.38)	0.58
Summaxtemp	0.06 (0.11)	0.61	-0.13 (0.06)	0.04[**]	-0.04 (0.03)	0.19	-0.02 (0.35)	0.95
R^2	0.40		0.18		0.08		0.07	

Note: [***] and [**] significant at the 0.01 and 0.05 level of significance respectively, Sumrain – summer rainfall, Summintemp – summer minimum temperature, Summaxtemp – summer maximum temperature, figures in parentheses indicate standard error

The results suggest that the model is able to describe a variation in food-crops yield ranging from forty percent in the case of paddy to only two percent in the case of barley. Though the regression results show very few significant relationships between yield and climate variables, such coefficient can be used to assess real effect of climate variables in change of yield of food-crops considered for this study (Nicholls, 1997). In addition, sign of coefficients give direction of movement of yield against change in climate variable. Climate variables show significant relations with paddy and maize only. The coefficient indicates that paddy yield increase significantly with increase in summer rainfall. Maize yield shows negative relation with summer maximum temperature, i.e., if summer maximum temperature increases yield of maize will decline significantly.

Table 5.2 Relationship between yield of winter food-crops and winter climate variables

Variable	Wheat		Barley	
	Coefficient	P-value	Coefficient	P-value
Winrain	0.003 (0.004)	0.52	0.001 (0.002)	0.69
Winmintemp	0.04 (0.03)	0.15	-0.002 (0.02)	0.87
Winmaxtemp	0.008 (0.03)	0.78	0.01 (0.02)	0.54
R^2	0.17		0.02	

Note: Winrain – winter rainfall, Winmintemp – winter minimum temperature, Winmaxtemp – winter maximum temperature, figures in parentheses indicate standard error

5.3.4 Change in yield due to climate trend

Change in food-crops' yield due to climate variables is calculated using coefficient of the climate variables for the respective crops and observed change in the climate variables during the study period i.e., $\Delta Y_i = (\beta_{1i}*\Delta R) + (\beta_{2i}*\Delta T_{min}) + (\beta_{3i}*\Delta T_{max})$. Here, ΔY_i is observed change in yield of ith crop due to climate variable, and β_{1i}, β_{2i}, and β_{3i}, are coefficient of rainfall, minimum temperature, and maximum temperature of the respective season respectively for i^{th} crop. Similarly, ΔR, ΔT_{min}, and ΔT_{max} are observed changes in rainfall, summer minimum temperature and summer maximum temperature respectively during the study period.

Table 5.3 Change in yield of food crops due to current climate trends in Nepal

Crops	β_1	ΔR	β_2	ΔT_{min}	β_3	ΔT_{max}	ΔYield (Kg/ha)
Paddy	0.012	-4.31	-0.15	-0.34	0.06	0.70	40.82
Maize	-0.002	-4.31	0.07	-0.34	-0.13	0.70	-106.04
Millet	-0.001	-4.31	0.02	-0.34	-0.04	0.70	-30.45
Potato	0.003	-4.31	0.21	-0.34	-0.02	0.70	-97.67
Wheat	0.003	14.25	0.04	-0.48	0.008	1.45	35.09
Barley	0.001	14.25	0.002	-0.48	0.01	1.45	27.80

Note: β_1 – coefficient of rainfall, ΔR – change in rainfall, β_2 – coefficient of minimum temperature, ΔT_{min} – change in minimum temperature, β_3 – coefficient of maximum temperature, ΔT_{max} – change in maximum temperature, ΔYield – change in yield

The current trend in climate variables has contributed positively to the yield of both winter crops namely wheat and barley. In the case of wheat, there is 814 kg increase of yield

during the study period, out of which 35.1 kg is contributed by the current climate trend (Table 5.3). Here, decreasing winter rain and winter minimum temperature offset the positive effect of increased winter maximum temperature. For barley, the current climate trend contributed around fifty percent of the yield increase. Such increase can be attributed to increased winter maximum temperature and decreased winter minimum temperature. In the case of summer crops, only paddy is favored by the current climate trend. It has contributed forty one kg increase in yield in case of paddy. An increase in summer rain and increase in summer maximum temperature have contributed highly in such increase in paddy yield. Other crops especially maize are adversely affected by the current climate trend in Nepal. The adverse impact of increased summer maximum temperature and summer rain are the main factors which caused suppression of yield by 106 kg/ha, and 30 kg/ha for maize and millet respectively. In the case of potato, it is adverse impact caused by increase in summer maximum temperature that offsets positive impact of increased summer rain and summer minimum temperature. Here, the current climate trend suppress the yield of potato by ninety eight kg/ha.

5.4 Conclusion

This chapter analyzed the impact of current climate trend on yield of six main food-crops in Nepal. These food-crops are divided into two groups based on their growing season; summer and winter season crops. The impact was assessed for each crop based on the growing season of respective crop. Yield of potato, wheat, paddy, and maize is in growing trend, but fluctuates over the years, whereas yield of millet and barley, two minor cereal crops, is growing very steadily. In summer, each of the climate variables is in increasing trend, whereas in winter, rainfall and minimum temperature is decreasing. In summer,

increase in rain and maximum temperature has contributed positively to yield growth of paddy. Similarly, increase in wheat and barley yield is contributed by current climate trends. However, increased summer rain and maximum temperature suppressed the yield growth of maize and millet, whereas negative impact of increase in summer maximum temperature outweighed positive impact of increased summer rain and summer minimum temperature in the case of potato.

This chapter thus concludes that food-crops grown in summer are adversely affected by the current trend of climate. Except for paddy, which has high water demand and thrives on water logging condition, other summer crops are adversely affected by increase in rainfall and maximum temperature. On the other hand, though rainfall is at declining trend in winter, increase in temperature has positively contributed to the yield growth of both winter crops. With this, we can recommend that any program dealing with minimizing adverse impact of CC on food-crops production should first consider crops like maize and potato, which are being affected at higher degree compared to other food-crops. Moreover, these two crops are important staple food in the case of Nepal, especially in Mountains and Hills, which are also exposed to higher degree of vulnerability to CC.

The main shortcoming of this study is treating the whole country as one basket despite the huge diversity existing within. Therefore, it is highly recommended to conduct similar studies considering the variation caused by ecological and administrative divisions of the country. In addition, besides assessing the food insecurity at the national level, understanding poverty at household level is also vital to deal with poverty.

Chapter 6. Determinants of food insecurity in Nepal: A binary logistic regression analysis

6.1 Introduction

The mountainous nature of the country allows only about 18 percent of the total land area to be cultivated. However, agriculture remains the mainstay for 65.7 percent of its total population deriving 38.3 percent of total Gross Domestic Product (GDP) (Ministry of Agriculture and Cooperatives, 2005b). Agriculture in the country is still subsistence in nature and the figures reflect the low productivity or less efficient production practice in this sector. Though being subsistence and huge dependence in agriculture especially in the rural areas, 60.8 percent of the total population is not able to produce sufficient food in their farms (Central Bureau of Statistics, 2003). The situation is more severe in the Hills and Mountains; thirteen out of sixteen districts in the Hills and thirty three out of thirty nine districts in the Mountains are suffering the food deficit situation (Subedi, 2003). An average amount of deficit food is forty seven kg per capita in the Mountains and thirty two kg in the Hills (Pyakurel, 2004).

The government of Nepal, since long time, has believed that increased agricultural production through agriculture programs and income generation programs to reduce poverty would automatically deal with the problem of food insecurity (Baidhya, 2004). However, the failure of the government to meet the target of agriculture growth and poverty reduction in most of the plan periods raised serious concern of food insecurity in the country. Commitment has been made by the government in several international forums regarding food insecurity including the world food summit in 1996 to reduce the number of chronically undernourished people by half by 2015 (Food and Agriculture Organization, 2002).

However, an absence of regular monitoring of food insecurity in the country resulted in paucity of information on food insecurity. In most of the literatures, especially in the government documents, food insecurity is assessed in terms of adequacy of the aggregate supply to fulfill the requirement of total population regardless of distribution issues based on socioeconomic differentiation. This implies the lack of understanding of the food insecurity issues involved on the part of the policy makers and planners (Baidhya, 2004). Therefore, this chapter intends to breach the existing literature gap in understanding food insecurity in terms of socioeconomic differentiation in Nepal.

6.2 Theoretical background

Food security is considered as a topic that is not explicitly understood by all (Larson, 2006). Therefore, food security has been defined in different ways by researchers and international organizations resulting in the evolution of around 200 definitions (Maxwell, 1996). Global concerns for food security were realized only after the first global oil crisis in 1973, through the World Food Conference in 1974. The definition of food security evolved at the conference from viewpoints on national food security or an increase in food supply. However, Sen (1981) reported the existence of famine amidst the sufficient food production and recognized the importance of demand side and distribution issue as well. After this, the definition of food security also incorporated aspects of accessibility together with availability. Sen (1981), therefore, puts the possibility that a person may starve if he/she does not have the ability to command enough food. In the same line, Food and Agriculture Organization (1983) expanded the concept of food security to include securing access implying that attention should be balanced between the demand and supply side of the food security. World Bank (1986) proposed the widely accepted definition of food security i.e.

food security is all about "access by all people at all times to enough food for an active and healthy life". After the 1996 World Food Summit, the definition of food security underwent another round of evolution. It came with the most influential definition. The summit believed that "food security is achieved at the individual, household, national, regional and global levels, when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organization, 1996).

The concept of food security has been narrowed down from the global context to household. Household is defined as "co-residential unit, usually family based in some way, which takes care of resource management and primary needs of its members". Kinship, residence and resource management for primary needs are the three important elements of the definition (Rudie, 1995). The provision of food is the most important primary needs and thus remains the core task of households (Balatibat, 2004). Therefore, household, as a unit of analysis, offers some distinctive advantages over larger units of analysis, especially in the rural setting where households are the primary unit of production, consumption and exchange (Sandoval *et al.*, 1987). International Food Policy Research Institute (IFPRI) also recognized the calorie acquisition as an important outcome measure of food security at household level (Hoddinott, 1999). Individual food intake data, dietary diversity and indices of household coping strategies are among the other measures.

Calorie acquisition of household is determined mainly by four factors, namely; food availability, access to food, stability of availability and accessibility, and the degree to which food are nutritious and safe, and can, therefore, be utilized (Food and Agriculture Organization, 2005). Food availability at household primarily depends on the actual

production of food, which is influenced by ecological production potential as well as by available production technologies, and input and output markets. Food aid in the form of *Bista* system [2] (neighbors) as well as program like food-for-work under RCIW also determines the availability of food. If a household cannot produce sufficient food, the income level of the household and the availability of food in the market determine their ability to access food (Sen, 1981; Food and Agriculture Organization, 2005). A number of political, economic and environmental factors, such as stability of the political system, poverty level and natural calamities, and measures to reduce food production variability determine the stability of access to food. Several indicators such as access to proper health care, sanitation, safe water and other basic services have been used as the measures of utilization. The general hygiene and feeding practices along with health status and its determinants can also be used to assess the utilization aspects of food security. However, as it depends on the individual nature of human being and is determined by consumption and absorption capacity of that individual, it remained a complex issue. Therefore, this chapter focused more on the availability and accessibility issues of food security.

Food security production function suggested by Blaylock & Blisards in 1995 is adopted in this chapter to understand food insecurity at household level (Equation 6.1).

$$\text{Food Insecurity (FIS)} = f(H, Q, Y) \text{ --- (6.1)}$$

H is the human capital stock influencing food security; Q is qualitative factors influencing food security, and Y represents resource ownership. Household capital stock influencing

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[2] *Bista* system is the form of patron client relations between upper caste and lower caste in rural areas of the country, in which lower caste provides specific goods and services such as smithing (Blacksmith – *Kami* and goldsmith – *Sunar*), tailoring (*Damai*), and making drums and performing music (*Badi*), as well as construction work to 'upper caste' group (Usually *Bahun,* and *Chhetri*) in return for payment in kind (usually in the form of food-grain) on a customarily 'fixed' basis.

food security could be age of household head, sex of household head, education level of household head, household size as well participation in Community organizations. Qualitative factors include regional variables, ethnicity and occupation. Resource ownerships are landholding and livestock holding as well as access to irrigation and fertilizer use. Resource ownership reflects the resources available to acquire food.

Rose *et al.* (1998) also suggested similar categorization of explanatory variables, which was later adopted by Rodgers III *et al.* (2004). In both cases, they included the price vectors of market purchased foods and vectors of labor time spent on food shopping and meal preparation besides the above mentioned variables. Also, Garrett and Ruel (1999) conceived food security as influenced by assets of the households, prices of the food as well as non-food items and demographic characteristics of household. However, they dropped price vectors of market purchased foods and vectors of labor time spent on food shopping and meal preparation for the empirical analysis. Therefore, in this chapter also aspects of price vectors of market purchased foods as well non-food items and labor time spent on food shopping and meal preparation were not considered. At the same time, some variables such as regional and education variables, partially describe the aspects of prices of the food and non-food items as well as time spent in meal preparation and preservation of food quality while preparing a meal.

6.3 Food security measurement

Food security was measured in four steps. Firstly, food supply at household level for each sampled household was determined based on own farm production. Six major food crops namely; rice, wheat, maize, millet, barley and potato produced in own farms were considered for the calculation of food availability based on the calorie conversion of the respective food

crops (Subedi, 2003). The following variables entered the food availability calculation as additions or subtractions from own production of food crops at household level; food crops obtained from rented out land (+), food crops given out for rented in land (-), food crops exchanged (+/-), food crops marketed (-), food crops used for seeds (-), and food crops used for other purposes such as animal feed (-). Secondly, food requirement was calculated in terms of calorie considering the age and gender of each household member i.e. adult equivalent (AE[3]). Total calorie requirement of 2,344 kcal and 2,144 per person per day in Mountains and Hills, and Tarai respectively were taken into account to calculate the total calorie requirement of a household. It is also reported that these main six food crops contribute 87.3 percent of total calorie supplied in Nepal, and the rest is supplied by the supplementary food taken together with these main food such as *dal* (legumes), and vegetables (Gautam, 1993). Therefore, 2,046.3 kcal per person per day and 1,871.7 kcal per person per day in Mountains/Hills, and Tarai respectively was used to measure required calorie from major food crops for a household to enable an adult to live a healthy and moderately active life (Subedi, 2003). Thirdly, based on the yearly calorie availability and monthly calorie requirement of the household, a food self-sufficiency month for the given household was calculated (Equation 6.2).

$$\textit{Food self-sufficiency months (FSS}_i) = CA_{ai}/CR_{mi} \text{ --- (6.2)}$$

Where,

CA_{ai} = Calorie available in i[th] household for a year

CR_{mi} = Calorie requirement of ith household for a month

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[3] Adult equivalent is aggregate measure of family size that standardize consumption unit within the household taking account age and sex of household members.

The households that have food self-sufficiency months of more than equal to 12 months are categorized as food secured. For those households having food self-sufficiency for less than 12 months, income was taken into consideration as the fourth step to assess food security of food self-insufficient households. The minimum threshold income of NRs. 895.1 at 2002/2003 constant prices per person per month was set as the minimum threshold income level based on the World Bank report (Koirala & Thapa, 1997; Institute of Policy Research and Development 2005). This minimum threshold income differs among households due to different food self-insufficiency months together with different family size (Equation 6.3).

$$Food\ security\ threshold\ income\ (z_i) = FSIS_i * I * FS_i \text{ --- (6.3)}$$

Where,

> $FSIS_i$ = Food self-insufficiency months of ith household
>
> I = Food security income threshold level per person per months (NRs. 895.1 per person per month)
>
> FS_i = Family size of ith household (Adult equivalent)

Now we categorized those households, who were unable to earn food security threshold income level, under food insecure household. Thus, the indicator of food insecurity I_i was defined by

> I_i = 1, if FSS_i < 12 and Y_i < z_i i.e. food insecure
>
> I_i = 0, otherwise

6.4 Empirical model

Food insecurity, being a dichotomous variable, binary logistic regression model is considered as the most appropriate for the econometric analysis. In addition, unlike

discriminant function analysis and logit analysis, both continuous as well as categorical independent variables are applicable in logistic regression model (Gujarati, 1995; Rose *et al.,* 1998; Haile *et al.,* 2005; Garson, 2006; Mutonotzo, 2006). The functional form of logistic regression model can be given as Equation 6.4.

$$Z_i = \ln\left[\frac{P_i}{1 - P_i}\right] = \alpha + \gamma H_i + \delta Q_i + \theta Y_i + \varepsilon_i \quad \text{--- (6.4)}$$

Where Z_i is a log odds, α is constant, γ, δ, and θ are vectors of coefficients and ε_i is an error term. In this equation, coefficient calculates changes in log odds of the dependent, not the changes in the dependent itself. Therefore, to make the interpretation straightforward, interpreting a logit by converting it to an odds ratio using the exponential function is the most common way (Garson, 2006). The functional form of odd ratios can be given as Equation 6.5.

$$\text{Odds ratio} = \left[\frac{P_i}{1 - P_i}\right] = e^{\alpha + \gamma H_i + \delta Q_i + \theta Y_i + \varepsilon_i} \quad \text{--- (6.5)}$$

Here, odds ratio is simply the ratio of the probability that the household will be food insecure to the probability that the household will be food secure. In case of dichotomous independent variables, exponential of the respective coefficient gives the proportion of change in odds for shift in the given independent variable. However, if the independent variable is continuous, both the coefficients and exponential of coefficient is associated with the effect of per unit change in the given independent variable to log odds and odds ratio respectively. In both types of variables, sign of coefficient reveals the direction of change.

Household human capital stock (H) influencing food security such as age, participation in community organization, gender and education level of household head, household size, and

dependency ratio are taken into consideration for this study. Older people are supposed to have more experience in agriculture production practices, basically in rural setting where agriculture is the mainstay. This results in the higher level of food security with the higher age of the household head (Hofferth, 2003; Obamiro *et al.,* 2003). Therefore, age of household head is expected to be positively associated with food security. However, there is also equal possibility of having low tendency of adopting improved technology by the older household head resulting into negative association with food security (Babatunde *et al.,* 2007).

Community organizations are the wider subset of non-profit institutions that operate in the single local community essentially on voluntary basis in order to meet the common interest of all members. Therefore, participation in community organizations on mutual aid basis is considered to strengthen social capital i.e., resource available to individuals through their social behavior and collective action. This has positive association with food security or in other words negative association with hunger (Baidhya, 2004; Martin *et al.,* 2004; Babatunde *et al.,* 2007). Vegetable and dairy farmers' groups that exist in the study area are responsible for marketing of output and input as well as technical support through training provided by government and non-governmental organizations to their group members. Similarly, irrigation water users' groups are community organizations existing in the study area, which responsible for maintaining water canal and resolving water distribution disputes among its members. Besides, women's groups for women empowerment, saving and credit groups for saving and credit, and forest users' groups for management of forest as well as the distribution of forest resources are other community organizations that exist in the study area.

Female-headed households are usually characterized by the lack of labor to cultivate land they own. In addition, they have limited access to resources such as land and human capital such as education as well as skill and knowledge about the farm technology. Moreover, the piece of land they possess is held in the name of male members, which restricts the use of land as collateral in the absence of the male members. These factors limit access to credit and limited involvement in community organizations; thereby increases the risk of food insecurity among the female-headed households (Baidhya, 2004). Education level indicates the knowledge and skill in modern agricultural practice and its adoption resulting in high productivity that leads to high production (Gubhaju, 2000; Bhatta *et al.*, 2006; Thapa, 2008). Higher level of education also opens up opportunities in the off-farm as well as non-farm sectors with high level of income. This justifies the possible positive relationship of education with food security (World Food Programme, 2001).

Household size can be either risk or benefit to the household food security. Large family size requires more food that increases the household's chance of being food insecure (Haile *et al.,* 2005; Babatunde *et al.,* 2007). In the context of agriculture being subsistence and off-farm/non-farm income opportunities being limited in rural areas of Nepal, negative association of family size with food security can be expected. At the same time, there is also a possibility that the large family size may provide more working members decreasing the family's risk of being food insecure. Therefore, to capture the possibility of decreased risk of being food insecure with increase in household size, the quadratic form of household size is also considered. Dependency ratio is the ratio of dependent household members and able-bodied/economically active household members. Dependency ratio is, therefore, expected to be positively associated with food insecurity i.e. higher the number of dependent

member (higher dependency ratio) higher will be the chances of being food insecure (World Food Programme, 2001).

The spatial i.e. ecological zones, ethnicity and occupation variables were taken as the qualitative factors influencing food insecurity in the study. Hills and Mountains of the country are characterized by rainfed agriculture, small land holding, unsuitable climatic condition i.e. low temperature leading to prolonged cropping cycle. Supply mechanism is also underdeveloped due to lack of proper infrastructure such as transportation and communication, and in addition off farm/non-farm employment opportunities in these areas are limited. These factors increase the possibility of having high concentration of food insecure household in such areas. Similarly, with small size of land holding, high dependency on daily wage labor and limited access to basic social services, OC and some indigenous ethnic communities are exposed to the higher risk of being food insecure (Baidhya, 2004). Besides, OCs are also acquiring food crops as a payment in kind on a customarily basis for the various occupational services including laboring provided to the higher caste under *Bista* system is prevalent in rural areas, which is viewed as exploitation of OC (Saul & Rai, 1998; Seddon & Adhikari, 2003; Chandra, 2006). Agriculture in rural areas is predominantly subsistence in nature with small holding and low productivity. Therefore, rural households who are self-employed in agriculture are expected to have positive association with food insecurity (Baidhya, 2004).

Total land holding, irrigation availability, fertilizer use and livestock holding are some of the important variables related to resource ownership (Y). As the food production can be increased extensively through the expansion of areas under cultivation, total land holding plays a significant role in influencing food security of the household (World Food

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Programme, 2001; Haile *et al.,* 2005). Also, livestock holding has been advanced as one of the main criteria for distinguishing food secure households. The proportion of households with livestock is higher among the food secure as compared to the food insecure groups of households (World Food Programme, 2001). In addition, livestock provides insurance in the time of food deficit in household.

Table 6.1 Expected relation of explanatory variables with food insecurity

Variables	Expected sign	References
Human capital stock		
Age	-/+	Hofferth, 2003; Obamiro *et al.,* 2003; Babatunde *et al.,* 2007
Gender (Dummy-1 if male and 0 otherwise)	-	Baidhya, 2004; Mutonotzo, 2006
Education level of Household Head (Dummy -1 if illiterate, 0 otherwise)	+	World Food Programme, 2001; Haile *et al.,* 2005
Family size/Family size square	+/-	Rose *et al.,* 1998; Haile *et al.,* 2005; Mutonotzo, 2006; Babatunde *et al.,* 2007
Dependency ratio	+	World Food Programme, 2001
Participation in community organization (Dummy-1 if participated, 0 other wise)	-	Baidhya, 2004; Martin *et al.,* 2004; Babatunde *et al.,* 2007
Qualitative factors		
Ecological regions (Dummy-1 if Tarai, 0 otherwise)	-	World Food Programme, 2001; Subedi, 2003
Caste/Ethnicity (Dummy-1 if OC, 0 otherwise)	+	World Food Programme, 2001; Seddon & Adhikari, 2003; Baidhya, 2004
Occupation (Dummy-1 if on-farm activity, 0 otherwise)	+	Baidhya, 2004
Resource ownership		
Landholding	-	World Food Programme, 2001; Haile *et al.,* 2005
Irrigation (Dummy, 1 if available, 0 otherwise)	-	World Food Programme, 2001
Fertilizer (Dummy, 1 if use, 0 otherwise)	-	World Food Programme, 2001; Haile *et al.,* 2005
Livestock holding	-	World Food Programme, 2001

Irrigation and fertilizer can be treated as proxy for technology. Irrigation and fertilizer

through increased yield contribute to the overall increase in the agricultural production and to food security (World Food Programme, 2001). The positive correlation can be assumed between the amount of expenses in fertilizer and irrigation, and food security. Therefore, the dummy for access to irrigation and application of fertilizer were considered in the logistic regression model. Variables considered under each of the three broad variable categories together with the expected (sign) relationship of the variables with food insecurity are presented in Table 6.1.

6.5 Data source

Primary data collected through household survey is the main source of data for this chapter. Applying stratified random sampling techniques, twelve districts representing each of the three ecological zones and five development regions were selected.

Table 2.1 (Chapter two) shows the list of sample districts indicating development regions and ecological zones together with their food balance status. Forty samples residing in the VDCs adjoining to the headquarter of each of these districts, selected using non probability sampling techniques, were surveyed using pre-tested semi-structured questionnaire schedule in 2003. Complete response, however, was obtained only from 430 households. The worst security situation of the country during the field survey restricted the accessibility of the researchers to the remote VDCs of the district. Therefore, the chapter may have limitations in representing the hinterland of the country. In addition, due to the use of cross-sectional data possibility of causality not being inferred will always be there (Martin *et al.,* 2004). In such context, control for a number of potentially confounding variables is crucial, which was done in this analysis. But there may still be other confounders, which are beyond control. Data on socioeconomic characteristics of the households, food crop production and income

from different sectors were collected.

6.6 Results and discussion

6.6.1 Descriptive results

First step of food security assessment showed that only 48.6 percent (i.e. 209 households) of households were able to produce sufficient food in their own farms. The rest 51.4 percent (i.e. 221 households) were dependent on the market (Figure 6.1). The food self-insufficiency varied depending on different socioeconomic characteristics. The entire household engaged in daily wage was suffering from food self-insufficiency. However, the entire households under the large landholding category were food self-sufficient. It was reported that 95.5 percent of households among the small landholding category, 90.3 percent among OC and 88.9 percent in Mountains were food self-insufficient, in contrast to this, the figure was 27.9 percent in Tarai. Maharjan (2003) also reported the varying level of food self-insufficiency depending on sample district. It was as high as 97.2 percent in Dalchocki, remote rural area of Lalitpur and as low as forty nine percent in Kalyanpur, relatively accessible rural area of Chitwan. In the remote Far-Western Rural Hills district of Baitadi, around fifty seven percent of households were suffering from food self-insufficiency (Maharjan, 2003). Similarly, in the remote rural Mid-western Hills district of Daliekh around fifty eight percent of households were food self-insufficient (Khattri-Chettri & Maharjan, 2006). Document on National Sample Census of Agriculture reported the figure of around sixty percent food self-sufficiency at the household level with the average landholding of 0.79 hectare (Central Bureau of Statistics, 2003).
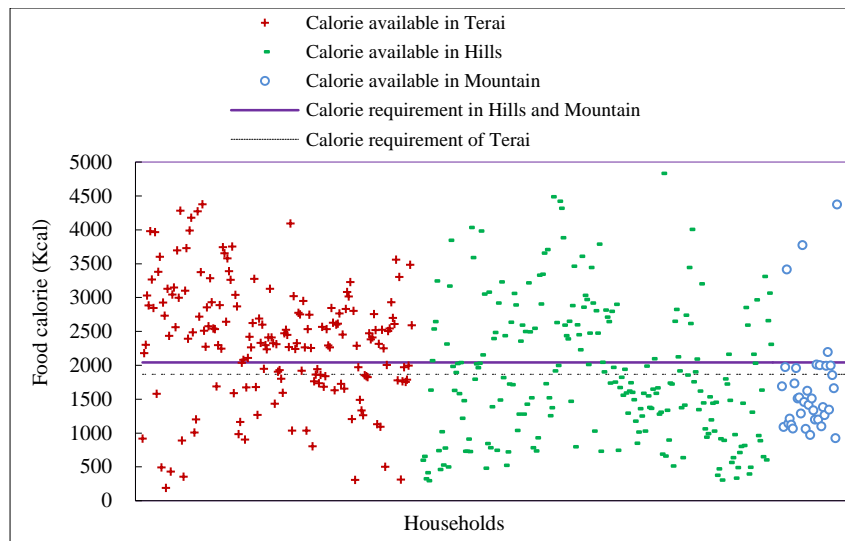
Figure 6.1 Food calorie distributions among households by ecological zones

The attainment of food security threshold income level was crucial for these food self-insufficient households to be food secured. Among food self-insufficient households, forty four were unable to meet food security threshold income level (Figure 6.2). This signifies that 10.2 percent of the total sampled households were suffering from severe food insecurity.
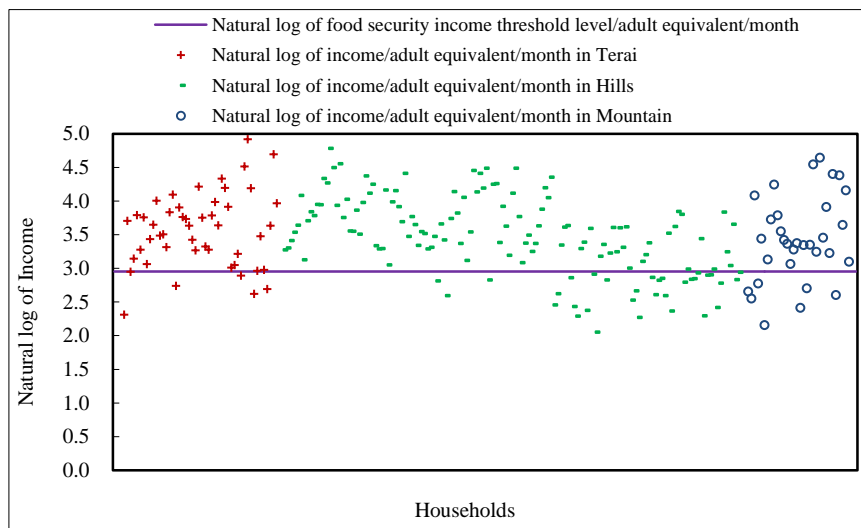
Figure 6.2 Food security threshold income attainments by ecological zones

Table 6.2 shows the household food security status by its socioeconomic characteristics. These socioeconomic variables were also considered for logistic regression model. Average

land holding and livestock holding (Livestock Standard Unit-LSU[4]), were lower for food insecure household compared to food secured households. Also, average age of the household head was lower for food insecure household, but the difference was meager.

Average family size was higher for food insecure households together with the higher dependency ratio (based on both age group as well as economically active family number). Average dependency ratio calculated based on economically active member was higher (1.2) compared to the average dependency calculated based on age group (0.7), which signifies the less involvement of economically active age group in economic activity. This is partly because of engagement in study and partly because of limited opportunity to get involved in economic activity.

Table 6.2 Household socioeconomic characteristics by food security status

Variables	Food secure	Food insecure	Variables	Food secure	Food insecure
Age of HHH (Years)	43.5	42.8	Education (Literate-1, otherwise-0)		
Gender (Male-1, otherwise-0)			*Illiterate (%)*	76.5	23.5
Male (%)	91.1	8.9	*Primary education (%)*	87.6	12.4
Female (%)	79.2	20.8	*Higher education (%)*	93.8	6.2
Dependency ratio (By age group)	0.6	1.1	Average family size (AE)	5.7	6.4
			Dependency ratio (By economically active members)	1.1	1.4
Ecological zones (Tarai-1, otherwise-0)					
Mountains (%)	77.8	22.2			
Hills (%)	86.0	14.0	Caste/ethnicity (Occupational Castes-1, other-0)		
Tarai (%)	97.1	2.9	*Bahun/Chhetri (%)*	90.6	9.4
Occupation (On farm activity-1, otherwise-0)			*Newar (%)*	100	-
On farm (%)	89.3	10.7	*Mongoloid (%)*	90.0	10
Non-farm (%)	94.7	5.3	*Occupational Castes (%)*	74.2	25.8
Irrigation availability (Available-1, otherwise-0)			Average land holding (ha)	1.23	0.61
Available (%)	93.6	6.4	Fertilizer use (Yes-1, otherwise-0)		
Non available (%)	81.3	18.7	*Yes (%)*	95.7	4.3
Community organizations (Yes-1, otherwise-0)			*Average amount (NRs.)*	2455.7	228.0
Yes (%)	93.1	6.9	*No*	80.8	19.2
No (%)	84.6	15.4	Livestock holding (LSU)	4.8	4.1

Source: Field survey, 2003

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[4] LSU is aggregates of different types of livestock kept at household in standard unit calculated using the following equivalent; 1 buffalo = 1 cattle, 1 sheep and goat = 0.33 cattle and 1 poultry = 0.1 cattle (CBS, 2003).

The incidence of food insecurity was the highest among illiterate household head (23.5 percent), household without access to irrigation (18.7 percent) and fertilizer (19.2 percent), female-headed household (20.8 percent) and OC households (25.8 percent). The incidence was the highest (22.2 percent) in Mountains compared to Tarai with mere 2.9 percent of household suffering food insecurity (Table 6.2). However, the chapter also revealed that the depth of food insecurity was quite high among some households in Tarai.

The incidence of food insecurity varies depending on the different socioeconomic conditions. Khattri-Chhetri & Maharjan (2006) reported 22.7 percent of households suffering from food insecurity in the remote rural district of Mid-Western Hills, Dailekh. The food security analysis conducted by the World Food Program, which focused on the vulnerable groups in the country, revealed the incidence of food insecurity ranging from as low as twenty five percent to as high as ninety percent with the overall incidence of sixty percent (World Food Programme, 2001). Income study of the country at the same time revealed that around eighty percent of household achieved threshold income for food security set by World Bank in urban hills and thirty percent among rural households at the time when incidence of poverty was forty nine percent (Koirala & Thapa, 1997). However, during the period from 1996 to 2004, the country was marked by significant drop in incidence of poverty to thirty percent with the eighty percent increase in per capita income. During the same period, subjective assessment of food consumption and health inadequacy declined substantially by twenty one percent and thirty one percent respectively (Central Bureau of Statistics, 2004; World Bank, 2006b). Therefore, though the study concentrated on the vicinity of urban center, the results were in line with the findings of the literature regarding the relationship between food insecurity and its major

socioeconomic determinants. Here, however, age of household head, and livestock holding did not differ much among food secure and food insecure households.

6.6.2 Logistic regression model

Initially, fourteen variables listed in Table 6.2 were introduced in the model. However, only eight variables were found to have significance on food insecurity. The stepwise analysis of model gave the best-fitted model including eight variables (Table 6.3). This was also justified by the insignificant value of Hosmer-Lemeshow's goodness of fit that guided us to accept the null hypothesis i.e. no difference between observed and model-predicted values. Furthermore, omnibus test showed that the dropping of the variables other than those eight variables made no difference in prediction. The dropping of insignificant variable also helped to minimize the possible multicollinearity (Table 6.4 and 6.5).

Out of six variables considered under human capital stock, four variables were found to have significant association with odds of food insecurity. Coefficient of involvement in community organizations and gender of household head (male-headed) was negatively associated with the log odds of food insecurity i.e. for the shift of household from participation in group to non-participation, or household head from male to female, values of log odds decrease by 1.8. The value of exp. (B) is more intuitive i.e. odds ratio increase by 0.17 times that mean reduction in the value of odds ratio (P/1-P) due to increase in value of denominator in odds ratio, which is possible due to decrease in probability of being food insecure. Therefore, we can say that the probability of household being food insecure decreases with the household's participation in community organizations such as saving credits, women group, farmers group and other community organizations, which existed in the study areas. It is also true in the case of male-headed households.

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Family size and dependency ratio were positively associated with the probability of households being food insecure. There is a possibility to reduce the dependency ratio from 1.2 (based on economically active member) to 0.7 (based on economically active age group) through the creation of income generation opportunities that can reduce the incidence of food insecurity significantly. Here, the coefficient of quadratic form of family size dismisses the possibility of decrease in risk of household being food insecure with the increase in family size.

Tarai ecological zone and OC, among the qualitative factor influencing food insecurity, have significant association with food insecurity. The probability of food insecurity was found to decrease with the shift of household from Mountains and Hills to Tarai, and increase with the shift from OC to others. In the case of resource ownership or access to resources, two variables i.e. total land holding and application of irrigation have negative significant association with the probability of household being food insecure.

Table 6.3 Determinants of food insecurity: Parameter estimates from logistic regression model

Variables	B	S.E.	Sig.	Exp. (B)
Involvement in group	-1.77	0.46	0.00**	0.17
Male-headed household	-1.76	0.53	0.001**	0.17
Family size (Squared)	0.043	0.00	0.00**	1.04
Dependency ratio (Economically active members)	0.47	0.21	0.027*	1.6
Tarai	-1.36	0.61	0.028*	0.26
Occupational Castes (OCs)	1.15	0.59	0.05	3.16
Total land holding (Ha)	-3.44	0.65	0.00**	0.03
Irrigation	-1.13	0.42	0.008**	0.32
Constant	1.43	0.72	0.47	4.16
Hosmer-Lemeshow's goodness of fit			0.99	

Source: Field survey, 2003

Note: * and ** significant at the 0.05 and 0.01 level of significance respectively

Table 6.4 shows the correlation between variables included in and variables dropped from logistic regression model. Each of the dropped variables was significantly correlated with

some of the variables included in final model. For instance, farm activity was correlated negatively and significantly with male-headed households and, illiteracy with male-headed households and involvement in group. Age of household head (HHH) was significantly and positively correlated with male-headed households and family size. Similarly, fertilizer use was positively and significantly correlated with Tarai ecological zone and total land holding. At the same time, the correlation between fertilizer use and OC was negatively significant. Livestock holding was positively correlated with the involvement in group and negatively correlated with OC. Therefore, the dropping of these five variables also helped to eliminate possible source of multicollinearity from the model.

Table 6.4 Correlation between variables included in and dropped from logistic regression model

Variables	Male-headed household	Involvement in group	Family size (Squared)	Tarai	Total land holding (Ha)	OC
Farm activity	-0.10*	0.06	0.06	0.08	0.09	0.02
Illiteracy	-0.14**	-0.1*	0.05	-0.06	-0.01	0.09
Age of HHH	0.21**	0.005	0.18**	0.03	.06	-0.06
Fertilizer use	0.04	0.07	0.08	0.48**	0.4**	-0.1*
Livestock holding	0.09	0.2**	0.07	0.02	0.09	-0.1*

Source: Field survey, 2003

Note: * and ** significant at 0.05 and 0.01 level of significance respectively

Table 6.5 Correlation among the dropped variables and food insecurity

Variables	On farm activity	Illiteracy	Age of HHH	Fertilizer use	Livestock holding	Food insecurity
On farm activity	1	0.06	0.11*	0.13**	0.12*	0.05
Illiteracy	0.06	1	0.22**	-0.01	0.02	0.13**
Age of HHH	0.11*	0.22**	1	0.001	0.12*	-0.02
Fertilizer use	0.13**	-0.01	0.001	1	0.17**	-0.24**
Livestock holding	0.12*	0.02	0.12*	0.17**	1	-0.05
Food insecurity	0.05	0.13**	-0.02	-0.24**	-0.05	1

Source: Field survey, 2003

Note: * and ** significant at 0.05 and 0.01 level of significance respectively

Also, the correlation coefficient among the five dropped variables together with food insecurity shown in Table 6.5 resembles the high possibility of multicollinearity with its inclusion in the final model. Among these five dropped variables, illiteracy and fertilizer use

was found to have significant correlation with food insecurity. Illiteracy had the positive significant correlation with food insecurity while fertilizer had negative significant correlation with food insecurity. Besides, on-farm activity was positively correlated with food insecurity, and negatively correlated with age of household head and livestock holding. The correlation, however, was non-significant.

6.7 Conclusion

In the wake of very limited empirical study on determinants of food insecurity, this chapter made the empirical study on the determinant of food insecurity in the country. The first step of a two-step estimation of food insecurity revealed that 51.4 percent of the households were unable to produce sufficient food crops in order to fulfill the household's calorie requirement. A second step of food security assessment showed that 10.2 percent of the households were suffering from food insecurity i.e. neither they were able to meet their household calorie requirement from the farm produce of food crops nor they were able to meet food security income threshold level. In this sense, they are suffering from severe food insecurity. Higher proportion female-headed households characterized by the absence of able-bodied male members were suffering from severe food insecurity due to the limited access to their own private resources as well as common resources. In addition, significant proportions of the female-headed households were illiterate.

Illiteracy was also positively associated with food insecurity. The incidence of chronic food insecurity was 23.5 percent among the illiterate household head. Family size of the food insecure household was higher compared to food secure households. Dependency ratio based on economically active population was significantly higher than that of economically active age population. This signifies very low proportion of economically active age group

involved in economic activities. Therefore, we can significantly reduce the incidence of severe food insecurity through the provision of income generating opportunities to economically active age group; thereby reducing the dependency ratio from 1.2 (based on economically active population) to 0.7 (economically active age group). This can also be justified by logistic regression analysis, which shows the highest significance of dependency ratio after landholding on food insecurity. Fertilizer use also differed significantly between the food secure and food insecure households. More than nineteen percent of households not using fertilizer on their farm were suffering from severe food insecurity, whereas only 4.3 percent of households using fertilizer were severely food insecure. In the case of application of irrigation the result was also similar.

The higher proportion of households involved in on-farm activity was suffering from severe food insecurity. Among the household involved in on-farm activities, almost fifty percent of households involved in daily wage laboring were under severe food insecurity. High concentration of illiterate households and female-headed households partly due to limited off-farm income opportunities, and low levels of access to production input like irrigation and fertilizer resulted in higher incidence of severe food insecurity among OC households and households residing in Mountains.

Land holding of food secured household was almost double than that of food insecure household and landholding also has significant influence on attainment of household food security. However, in the context of limitation of any intervention to tackle the problem of resource distribution specially land; increase in efficiency of the land use could aid in coping with the problem of food insecurity. In addition, access to these production resources including land, credit facilities, technology transfer and market access could be enhanced

through the participation of deprived household in different community organizations. Multipurpose farmers' groups, irrigation water user's groups, forest users' groups, saving and credit groups, and women groups were some of the community organizations. Participation of households in such community organizations especially in Hills and Mountains, as well as in Tarai, will help to cope with the problem of food insecurity through collective initiative of community members based on mutual aid. Households suffering from severe food insecurity such as OC, female-headed households, households with illiterate household heads and small holding farmers or landless households engaged in daily wage laboring should be targeted. It is well realized that together with the lack of money, lack of social networks and support included in social capital which can be built through participation in community organization is the root cause of poverty making the households suffer from severe food insecurity. Therefore, further in depth studies on poverty in order to capture its static and dynamic aspects together with effectiveness of community based organizations to improve poverty situation in rural area are highly recommended.

Chapter 7. Relationship between income-poverty and food insecurity in Far-Western Rural Hills of Nepal: An empirical analysis.

7.1 Introduction

Nepal remains one of the poorest countries in the world in terms of monetary as well as non-monetary dimension of poverty. It remains the poorest country in South Asia and ranks as the twelfth poorest country in the world in terms of Gross National Income with per capita income of US$320 in 2006 (World Bank, 2008b). The per capita income though reached US$388 per annum in 2008, the country still remains one of the poorest countries in the world with wide income disparities, and poor access to basic social services by a large section of its population (Asian Development Bank, 2008).

Poverty in the country exists in a wide variation depending on the rural-urban, geographical, gender, and caste/ethnic division. This makes poverty and food insecurity complex and diverse. Therefore, poverty should be understood thoroughly to achieve the goal of poverty reduction. Moreover, incidence, gap, and severity analysis suggest that poverty is more rampant, deeper, and severe in rural areas, and much worse in the Mid-Western and Far-Western Hills/Mountains (United Nations Development Programme, 2005). Thus, rural poverty especially in the Mid-Western and Far-Western Hills/Mountains remains a core issue of poverty in Nepal. This necessitates the detailed study of poverty at household level and factors affecting it in the region. Understanding the problem from micro perspective could be a crucial input for designing effective poverty reduction programs. Therefore, this chapter analyzes household poverty situation through incidence, depth, and severity and its relationship with household's various socio-economic variables. Besides, this study is the first of its type that shows the relationship between income and consumption

measures of poverty in Nepal.

7.2 Methodology

Considering the intensity of the problem, Baitadi district from Far-Western Rural Hills of Nepal was selected for this study. Household survey was conducted among 116 households selected through stratified random sampling in two VDCs of the district using pre-tested semi-structured interview schedule. The questionnaire incorporated information on demography of households including education and occupation of each members, resource holding, occupation, income, and consumption.

The application of monetary dimension of poverty dominates the literature on poverty (Gradin *et al.,* 2008). Here, the crucial question, which measure to use, income or consumption, arises while making quantitative analysis of poverty. Both of these measures have their own pros and cons. Therefore, there is growing evidences in supplementing the income measure with consumption measure in the studies of poverty (Bryan, 2002; Bavier, 2008; Gradin *et al.,* 2008). But, supplementation of income measure with consumption measure in poverty analysis does not exist in Nepalese case.

Income-poverty is the most widely used measure of poverty. Here, poverty line is established based on the estimated amount of money necessary to meet the basic necessities for a given period in a given location. Households, which are not able to meet the poverty line with their income, are categorized as poor. In this chapter income-poverty, is based on the poverty line established by Nepal Living Standards Survey (NLSS[5]) I and II (Central Bureau of Statistics, 2005b). These surveys consider the temporal and spatial dimensions as

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[5] NLSS I and NLSS II were conducted in the year 1995-96 and 2003-03, respectively. These are the highly authenticated government documents on poverty that applied the Living Standards Measurement Survey developed by the World Bank.

well as sum up food and non-food poverty line while establishing poverty line. Thus, a poverty line of NRs. 7,857 per person per year at the current price of 2001 for the sample district is calculated considering the poverty line of the Rural Western Hills in order to make income-poverty analysis (Appendix 2).

However, in case of consumption-poverty, there lack consensus on the correct measure of consumption to use (Bryan, 2002; Johnson *et al.,* 2005; Bavier, 2008). Food insecurity is the most important subset of consumption-poverty in the case of developing countries where food is the first and the most important priority for any household (Rhoe *et al.,* 2008).

Food insecurity is calculated through a measurement of food consumption and requirement in calorie unit of the sampled households (Maxwell & Frankenberger, 1992). Calorie consumption of a household is calculated through the calorie conversion of major food items consumed by the sample households (Prennushi, 1999). Whereas, for a calculation of calorie requirement, standard calorie requirement of 2,344 kcal per person per day for Mountains/Hills of Nepal set by NPC based on WHO guidelines is considered (Subedi, 2003). Then, based on the adjusted family size, i.e., adult equivalent[6] (AE) that takes age and gender of household members into account, total calorie requirement of the household is calculated. Thus, the household whose consumption fell below standard requirement is categorized as food insecure household.

The magnitude of poverty is assessed through head-count ratio, poverty gap index, and severity index in order to assess and analyze incidence, depth, and severity of poverty respectively (World Bank, 2008d). The assessment was done separately for both income and

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[6] Adult equivalent (AE) is average measure of family size that standardizes consumption unit within the household taking age, and sex of household members into account (Appendix 3).

consumption-poverty analyses. The following formulas were used to measure the incidence, depth, and severity of poverty.

$$PI = \frac{n}{N} \; X \; 100 \qquad\qquad \text{--- (7.1)}$$

$$PGI = \frac{1}{N} \sum_{i=1}^{n} \left[\frac{z_i - y_i}{z_i} \right] X \; 100 \qquad \text{--- (7.2)}$$

$$SI = \frac{1}{N} \sum_{i=1}^{n} \left[\frac{z_i - y_i}{z_i} \right]^2 X \; 100 \qquad \text{--- (7.3)}$$

Where,

PI = Poverty incidence

n = Number of poor households

N = Total number of sample households

PGI = Poverty gap index

z_i = Poverty line/calorie requirement of ith household

y_i = Income/calorie consumption of i_{th} household

SI = Severity index

7.3 Results and discussion

7.3.1 Socio-economic characteristics and resource distribution

The proportion of the female-headed households in the study area is 15.5 percent. The proportion is higher in Melauli with 19.6 percent households headed by female compared to 11.7 percent in Patan, but the difference is statistically non-significant (Table 7.1). Caste-wise distribution of the sample households shows that *Chhetri* is the most dominating caste group in both the VDCs in terms of population. Education attainment also differs

significantly in two VDCs. Illiteracy of household heads (HHHs) is quite prevalent in Melauli. More than forty one percent of the HHHs are illiterate compared to 13.3 percent in Patan. The figure is just reverse for attainment of college education and school education by the HHHs.

Table 7.1 Social characteristics of sample households

Variables	Patan	Melauli	Total
Gender of HHH *P-value = 0.23*			
Male	53 (88.3)	45 (80.4)	98 (84.5)
Female	7 (11.7)	11 (19.6)	18 (15.5)
Caste *P-value = 0.00*****			
Bahun	25 (41.7)	8 (14.3)	33 (28.4)
Chhetri	30 (50.0)	40 (71.4)	70 (60.4)
Occupational Castes (OCs)	5 (8.3)	8 (14.3)	13 (11.2)
Education of HHH[7] *P-value = 0.00*****			
Illiterate	8 (13.3)	23 (41.1)	31 (26.7)
Literate	13 (21.7)	17 (30.4)	30 (25.9)
School education	28 (46.7)	11 (19.6)	39 (33.6)
College education	11 (18.3)	5 (8.9)	16 (13.8)
*Average year of schooling (P-value = 0.00***)*	*7.0*	*3.8*	*5.5*
Occupation of HHH *P-value = 0.02****			
Agriculture	37 (61.7)	32 (57.1)	69 (59.5)
Salaried jobs	18 (30.0)	8 (14.3)	26 (22.4)
Business	2 (3.3)	5 (8.9)	7 (6.0)
Laboring	3 (5.0)	11 (19.7)	14 (12.1)
Family size category – AE *P-value =0.62*			
Small (1-5 Members)	20 (33.3)	23 (41.1)	43 (37.1)
Medium (>5-10 Members)	31 (51.7)	27 (48.2)	58 (50.0)
Large (>10 Members)	9 (15.0)	6 (10.7)	15 (12.9)
Average family size(AE)(P-value =0.33)	*6.3*	*5.7*	*6.0*
Landholding category *P-value =0.11*			
Small (Less than 0.5ha)	12 (20.0)	21 (37.5)	33 (28.5)
Medium (0.5-2ha)	47 (78.3)	34 (60.7)	81 (69.8)
Large (>2ha)	1 (1.7)	1 (1.8)	2 (1.7)
*Average land holding (ha.)(P-value =0.05**)*	*0.87*	*0.73*	*0.8*
Overall	60 (100)	56 (100)	116 (100)

Source: Field Survey, 2001

Note: Figures in parentheses indicate percentage, *** and ** significant at 0.01 and 0.05 level of significance respectively

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[7] Education of HHH is categorized into four categories on the following basis; Illiterate – cannot read and write, literate – attained informal education or formal education up to fifth grade and can read and write, school education – attained formal education from sixth grade to tenth grade, and College education – attained formal education above tenth grade.

Agriculture is the most dominant occupation in the district. Difference in distribution of households by occupation of HHHs in two VDCs is statistically significant. The higher concentration of small landholding households (37.5 percent) with insufficient food production in Melauli results in higher proportion (19.7 percent) of HHHs involved in daily wage laboring. This is also a reason for relatively lower proportion of HHHs engaged in agriculture in Melauli. Involvement of individuals in salaried jobs is related with the attainment of secondary and college education. Therefore, the higher proportion of HHHs in Patan (thirty percent) is involved in salaried jobs compared to Melauli (14.3 percent).

Fifty percent of households come under the medium family sized households having more than five to ten members followed by small (less than five members) and large (more than ten members) family sized households. The distribution of households by family size does not differ significantly in the two VDCs (Table 7.1). In case of landholding, households with medium holding (0.5-2.0 ha.) constitute the highest proportion of the households i.e., seventy percent. A proportion of small holding (less than 0.5 ha.) households in Melauli are significantly higher compared to that of Patan. Landholding size is also significantly higher in Patan, i.e., 0.87 ha and 0.73 ha in Patan and Melauli respectively.

Resource distribution of the sample households by caste group is presented in Table 7.2. Resource distribution between caste groups as well two VDCs differs significantly. Landholding, irrigation coverage, and schooling year of HHHs are significantly lower in Melauli. Rugged terrain with limited infrastructure development such as lack of transportation, communication, market, and other social services including school is the main reason for such discrepancy.

Similarly, there is a significant difference in resource distribution among the caste groups.

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OC households have the lowest level of resource holdings. Landholding, irrigation coverage, and schooling year of HHHs are significantly lower for OC households. Occupational Caste households also have relatively low livestock holding.

Table 7.2 Resource distribution among different caste groups

	Resource	Caste			Total	P-value
		Bahun	**Chhetri**	**OC**		
Patan	Landholding (ha)	0.81	1.00	0.43	0.87	0.03**
	Irrigation coverage (percentage)	46	35.1	29.4	44.0	0.09*
	Livestock holding (LSU)	4.2	4.4	3.9	4.3	0.92
	Family size (AE)	6.6	5.9	6.9	6.3	0.48
	Schooling year of HHH	7.6	7.6	0.8	7.0	0.01***
	Dependency ratio[8]	1.3	1.2	0.8	1.2	0.5
Melauli	Landholding (ha)	1.1	0.72	0.37	0.73	0.01***
	Irrigation coverage (percentage)	22.2	26.9	19.0	26.7	0.07*
	Livestock holding (LSU)	4.6	4.0	3.7	4.0	0.69
	Family size (AE)	6.6	5.5	5.7	5.7	0.50
	Schooling year of HHH	5.1	4.0	1.3	3.8	0.04***
	Dependency ratio	1.6	1.1	1.0	1.3	0.02**
Overall	Landholding (ha)	0.88	0.84	0.39	0.80	0.00***
	Irrigation coverage (percentage)	40.3	34.6	27.7	35.7	0.07*
	Livestock holding (LSU)	4.3	4.1	3.8	4.1	0.79
	Family size (AE)	6.6	5.7	6.2	6.0	0.18
	Schooling year of HHH	6.9	5.5	1.2	5.5	0.00***
	Dependency ratio	1.4	1.2	0.9	1.2	0.24
P-Value[†]	Landholding (ha)	0.16	0.01***	0.57	0.09*	
	Irrigation coverage (percentage)	0.02**	0.00***	0.09*	0.00***	
	Livestock holding (LSU)	0.72	0.50	0.77	0.58	
	Family size (AE)	0.97	0.43	0.49	0.18	
	Schooling year of HHH	0.19	0.00***	0.58	0.00***	
	Dependency ratio	0.36	0.26	0.05	0.98	

Source: Field Survey, 2001

Note: ***, ** and * significant at 0.01, 0.05 and 0.1 level of significance respectively and [†] P-value for the distribution between two VDCs

Dependency ratio, calculated based on the economically active and economically non-active members in the household, is lower for OC in both VDCs. Lower dependency ratio among

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[8] Dependency ratio is the ratio of economically non-active member to economically active member (members with age between 15-60 years involved in any sort of income generating activity).

OC is due to their economic distress. Such distress forced each members of the household, regardless of age, to involve themselves in any sort of income generating opportunities in order to meet their basic needs, especially food, at the least. Therefore, lower dependency ratio here reflects their economic hardship rather than economic strength. Education, being the foundation for achieving overall welfare, disparity in overall welfare existing between caste groups and location itself can be explained by disparity in education.

7.3.2 Poverty situation

Situation of income-poverty and consumption-poverty that includes incidence, gap/depth, and severity is presented in Tables 7.3 and 7.4 respectively. Income-poverty shows higher incidence, depth, and severity of poverty compared to food insecurity. This could be due to the inclusion of non-food expenses while constructing income-poverty line, whereas consumption-poverty considers only the food needs. In addition, the nature of consumption itself, which is relatively continuous compared to income, could be another reason for such difference.

The difference in case of Melauli is not so high compared to that of Patan. The shortcoming of income-poverty measure to take into account of spatial factor (difference in two locations due to various levels of infrastructure development and access to market) may be the main reason behind this. As price of marketed goods in Melauli is quite high compared to Patan, due to extra cost involved in labor intensive transportation of goods through porter or animal power, poverty line would be higher in Melauli compared to Patan. Therefore, income-poverty line constructed for the Rural Western Hills, which is supposed to cover food and non-food items, could not cover the aspects evenly in the district, especially the different situational nature of consumptions in places such as Melauli. Thus,

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the construction of location specific income-poverty line is very crucial. Therefore, the adoption of poverty line for the whole region i.e., Rural Western Hills as done by NLSS I and NLSS II could mislead the understanding of the issues of poverty and its dynamics.

Table 7.3 Income-poverty incidence, gap index, and severity index in the study areas according to different socio-economic variables

Variables	Patan			Melauli			Overall		
	PI	PGI	PSI	PI	PGI	PSI	PI	PGI	PSI
Gender									
Male	41.5	22.1	15.2	55.5	27.2	16.7	47.9	24.4	15.9
Female	71.4	40.9	28.6	72.7	41.1	27.1	72.2	41.0	27.7
P-value	*0.14*	*0.06**	*0.06**	*0.30*	*0.09**	*0.07**	*0.06***	*0.05***	*0.08**
Caste									
Bahun	44.0	22.0	16.0	50.0	33.1	25.0	45.5	24.7	18.2
Chhetri	43.3	22.8	13.9	55.0	27.0	16.9	50.0	26.7	17.4
OC	60.0	26.3	17.9	87.5	41.2	21.7	76.9	34.1	18.7
P-value	*0.78*	*0.9*	*0.9*	*0.20*	*0.5*	*0.6*	*0.14*	*0.67*	*0.98*
Education									
Illiterate	87.5	32.1	17.8	69.6	42.3	28.8	74.2	39.7	26.0
Literate	38.5	25.3	18.8	64.7	33.2	20.6	53.33	29.8	19.8
School	42.9	24.5	17.6	45.5	10.2	3.0	43.6	20.5	13.5
College	27.3	16.6	11.5	20.0	4.9	1.2	25	13.0	8.3
P-value	*0.06**	*0.8*	*0.9*	*0.15*	*0.01****	*0.01****	*0.01****	*0.02***	*0.09**
Occupation									
Agriculture	59.5	28.5	18.3	68.8	36.3	22.8	63.8	32.1	20.4
Salaried jobs	11.1	8.4	6.5	12.5	11.1	9.8	11.5	9.2	7.5
Business	50.0	48.2	46.1	40.0	2.3	0.2	42.9	15.4	13.3
Laboring	66.7	51.4	39.6	72.7	37.6	22.2	71.4	40.6	25.9
P-value	*0.01****	*0.05***	*0.07**	*0.02***	*0.03***	*0.06**	*0.01****	*0.00****	*0.09**
Family size category									
Small	45.0	21.1	13.6	56.5	20.6	10.6	51.2	20.8	12.0
Medium	32.3	15.6	10.1	59.3	37.1	25.9	44.8	25.6	17.4
Large	88.9	61.0	46.9	66.7	32.9	18.2	80.0	49.8	35.4
P-value	*0.01****	*0.00****	*0.00****	*0.9*	*0.18*	*0.09**	*0.05***	*0.01****	*0.01****
Landholding category									
Small	58.3	21.2	14.8	61.9	71.7	51.5	57.6	35.9	25.7
Medium	42.5	25.5	17.6	55.9	29.6	18.6	49.4	27.3	18.1
Large	-	-	-	100	28.3	17.5	50.0	25.7	16.5
P-value	*0.42*	*0.7*	*0.7*	*0.64*	*0.37*	*0.3*	*0.73*	*0.9*	*0.87*
Total	**45.0**	**24.2**	**16.8**	**58.9**	**29.9**	**18.8**	**51.7**	**27.0**	**17.7**

Source: Field Survey, 2001.

Note: ***, ** and * significant at 0.01, 0.05 and 0.1 level of significance respectively, PI – Poverty incidence, PGI – Poverty gap index and PSI – Poverty severity index.

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Table 7.4 Incidence of food insecurity, depth index, and severity index in the study areas according to different socio-economic variables

Variables	Patan			Melauli			Overall		
	IFI	DFI	SFI	IFI	DFI	SFI	IFI	DFI	SFI
Gender									
Male	30.2	6.2	2.1	51.1	11.2	3.9	39.8	8.5	2.9
Female	42.9	5.1	0.8	63.6	9.1	2.0	55.6	7.6	1.6
P-value	*0.50*	*0.8*	*0.6*	*0.45*	*0.7*	*0.4*	*0.21*	*0.8*	*0.4*
Caste									
Bahun	24.0	5.1	1.8	75.0	13.6	4.2	36.4	9.5	3.7
Chhetri	30.0	4.1	0.9	45.0	7.8	2.2	38.6	6.2	1.6
OC	83.3	20.1	8.1	75.0	23.3	9.6	76.9	16.4	5.8
P-value	*0.05[**]*	*0.02[**]*	*0.02[**]*	*0.13*	*0.03[**]*	*0.02[**]*	*0.03[**]*	*0.04[**]*	*0.04[**]*
Education									
Illiterate	62.5	11.7	4.2	65.2	13.4	4.9	64.4	12.0	4.1
Literate	46.2	7.9	2.2	58.8	12.2	4.1	53.3	9.1	2.6
School	28.6	6.1	2.0	36.4	10.0	2.9	30.8	6.6	2.2
College	-	-	-	20.0	8.0	2.7	6.3	4.2	1.5
P-value	*0.02[**]*	*0.23*	*0.48*	*0.10[*]*	*0.9*	*0.09[*]*	*0.00[***]*	*0.25*	*0.5*
Occupation									
Agriculture	40.5	6.7	1.8	62.5	11.3	4.5	50.7	8.4	2.3
Salaried jobs	5.6	0.8	0.1	12.50	5.8	1.3	7.7	2.3	0.5
Business	50.0	27.6	15.3	40.0	10.3	3.0	42.9	15.9	6.2
Laboring	66.7	16.6	6.3	63.6	15.7	6.2	64.3	16.0	7.6
P-value	*0.03[**]*	*0.00[***]*	*0.00[***]*	*0.06[*]*	*0.6*	*0.4*	*0.00[***]*	*0.02[**]*	*0.00[***]*
Family size category									
Small	15.0	2.2	0.4	26.1	4.8	1.4	20.9	3.6	0.9
Medium	32.3	5.2	1.6	66.6	12.7	4.0	48.3	8.7	2.7
Large	66.7	18.0	7.0	100	25.2	9.5	80.0	20.9	8.0
P-value	*0.02[**]*	*0.00[***]*	*0.01[***]*	*0.00[***]*	*0.01[***]*	*0.02[**]*	*0.00[**]*	*0.00[***]*	*0.00[***]*
Landholding category									
Small	50.0	8.7	2.9	61.9	13.9	4.5	57.6	12.3	3.9
Medium	27.7	5.6	1.8	50.0	7.9	2.4	37.0	6.5	2.0
Large	-	-	-	-	-	-	-	-	-
P-value	*0.26*	*0.67*	*0.8*	*0.38*	*0.1*	*0.25*	*0.06[*]*	*0.1*	*0.1*
Total	**31.7**	**6.10**	**1.96**	**53.6**	**10.8**	**3.5**	**42.2**	**8.4**	**2.7**

Source: Field Survey, 2001

Note: [***], [**] and [*] significant at 0.01, 0.05 and 0.1 level of significance respectively, IFI – Incidence of food insecurity, DFI – Depth of food insecurity, and SFI – Severity of food insecurity

Income-poverty shows that poverty is significantly related with gender of HHH, family size, education and occupation. Consumption-poverty shows significant relation with all of the variables considered. Characterized by the low level of resource possession and relatively higher family size, female-headed and OC households are suffering from significantly

higher incidence, gap/depth, and severity of poverty. Also, given limited employment opportunities and smaller landholdings, large family sized households have significantly higher incidence, gap/depth, and severity of poverty.

Education and occupation are closely related to each other. Most of the illiterate households are also the ones who are engaged in laboring, agriculture, and petty business. Therefore, significantly higher proportions of households whose HHH are illiterate and engaged in laboring or agriculture are trapped in poverty with significantly higher gap/depth, and severity. In case of landholdings, incidence, gap, and severity do not vary significantly for income-poverty, i.e., even the larger landholding households are suffering from income-poverty. But in terms of consumption-poverty, a significant association of poverty with landholding is revealed, i.e., incident, depth, and severity are significantly higher for small landholding households.

7.3.3 Relationship between poverty and food insecurity

Income-poverty and consumption-poverty are significantly correlated with each other in both the study VDCs (Table 7.5).

Table 7.5 Relationship between poverty and food insecurity

VDCs		Poverty	Food insecurity		Total	P-value
			Food insecure	Food secure		
Patan	Income-poverty	Poor	14 (51.9)	13 (48.2)	27 (45.0)	0.01***
		Non-poor	5 (15.2)	28 (84.8)	33 (55.0)	
		Total	19 (31.7)	41 (68.3)	60 (100)	
Melauli		Poor	21 (64.6)	12 (36.4)	33 (58.9)	0.07*
		Non-poor	9 (39.1)	14 (60.9)	23 (41.1)	
		Total	30 (53.6)	26 (46.4)	56 (100)	
Overall		**Poor**	**35 (58.3)**	**25 (41.7)**	**60 (51.7)**	**0.00*****
		Non-poor	**14 (25.0)**	**42 (75.0)**	**56 (48.3)**	
		Total	**49 (42.2)**	**67 (57.8)**	**116 (100)**	

Source: Field Survey, 2001

Note: Figures in parentheses indicate percentage, *** and *significant at 0.01 and 0.1 level of significance respectively

Degree of correlation, however, is weaker in Melauli. This is mainly due to mismatch between income-poverty and consumption-poverty in Melauli, especially for income-non-poor households. Here, a significantly higher proportion of income-non-poor households are suffering from food insecurity. This is mainly due to constraints in income poverty measure i.e., unable to capture spatial differences. For instance, price of goods is significantly higher in Melauli due to higher cost involved in labor intensive transportation of goods either by using porters or animals. This suggests that consumption poverty measure is more relevant in making poverty comparison between the two VDCs if the construction of location specific poverty line demands extra cost and efforts. In addition, consumption poverty measure captures several aspects of poverty, which income-poverty measure cannot, such as borrowing and bartering, common phenomena in rural Nepal.

7.4 Conclusion

This chapter revealed that the distribution of landholding and irrigation coverage, which is also very crucial resources for agriculture based livelihood, is skewed more towards higher castes such as *Bahun* and *Chhetri*, and households in Patan. In addition, both *Bahun* and *Chhetri* are well-off in terms of educational attainment, which again is closely related to occupation. Therefore, a significantly higher proportion of OC households and households in Melauli, characterized by smaller landholding, lower irrigation coverage and lower educational attainment, and engagement in either laboring or agriculture, are suffering from significantly higher incidence, gap/depth, and severity of poverty. Family size and gender of HHH are other important factors that have significant effect on poverty.

Both the income and consumption measures of poverty reflect the higher existence of poverty in the study area. But the higher incidence, gap, and severity shown by the income

poverty measure support the nature of income-poverty discussed in the literatures. Relative closeness of income-poverty and consumption-poverty in Melauli suggests that income-poverty, which is supposed to cover both the food and non-food aspects of poverty, is not an appropriate measure. This holds true especially when common income-poverty line is considered for two locations overlooking their situational differences. Therefore, considering the wider aspects covered by consumption-poverty such as consumption through borrowing, bartering and using saving, it can be concluded that the use of consumption poverty measure is suitable for making both spatial and temporal comparisons of poverty. The conclusion should be further verified through the application of both poverty measures in longitudinal data to capture temporal dimension of poverty, advantages of which over cross-sectional data is widely acknowledged. Therefore, it is recommended to make poverty analysis using longitudinal data, in order to capture wider aspects of both measures as well as poverty itself.

Chapter 8. Poverty dynamics in Far-Western Rural Hills of Nepal: Evidence from panel data

8.1 Introduction

Incidence of poverty in Nepal is increasing overtime (Lanjouw & Prenusshi, 1999). With continuous effort to tackle poverty since 1956, it is only recently that poverty incidence has been reported to be declining (between 1995/96 and 2003/04) (Central Bureau of Statistics, 2005a; Central Bureau of Statistics, 2005b). Despite such decline, with the poverty incidence of 30.8 percent, Nepal still falls among the countries having the highest incidence of poverty. Thus, poverty remains a critical issue to be analyzed.

A substantial number of literatures can be traced on Nepalese poverty issues, which suggest it common features such as poverty being concentrated in Mid-Western and Far-Western development regions and Hills and Mountains agro-ecological zones (United Nations Development Programme, 2005; Central Bureau of Statistics, 2005a; Central Bureau of Statistics, 2005b). Similarly, the literatures also suggest poverty as purely a rural phenomenon as it hosts around 95.3 percent of Nepal's total poor (Central Bureau of Statistics, 2005b). Besides these geographical divisions, several socio-economic factors also determine the incidence of poverty in Nepal (South Asia Alliance for Poverty Eradication, 2003; Central Bureau of Statistics, 2005a; Central Bureau of Statistics, 2005b; Food and Agriculture Organization & World Food Programme, 2007; Joshi, 2008; Joshi & Maharjan, 2008).

Despite substantial literatures on Nepalese poverty, virtually all of them are based on cross-sectional data that provide information on static poverty, thus fail to differentiate important dimensions of poverty i.e. temporal dimension of poverty. As differential

treatment through different policy would be required to deal with chronic and transient poverty, temporal dimensions of poverty is deemed necessary for a better understanding of poverty. For instance, transient poverty is better tackled by policies that assist with consumption smoothing, whereas chronic poverty may call for income transfer or programs that enhance the poor's earning capacity (Lipton & Ravallion, 1995). Similarly, such differentiation will be crucial for policy makers as those suffering from the chronic poverty are the ones that are most vulnerable and, therefore, need special attention by any poverty related program (Mendola *et al.*, 2009). Therefore, this chapter attempts to capture the dynamics of poverty in poverty-ridden Far-Western Rural Hills of Nepal employing two years panel data in order to quantify the effect of several socio-economic factors in moving in-and-out of poverty in Far-Western Rural Hills.

8.2 Temporal dimensions of poverty: Transient and chronic poverty

Poverty analysis based on the cross-sectional data does not provide information on mobility of poor, in-and-out of poverty, over time i.e., poverty dynamics. However, understanding poverty dynamics is crucial in distinguishing chronic and transient poverty. Thus, transient and chronic poverty is two temporal dimensions of poverty. This can be operationalized by utilizing households' poverty status in different years of the panel, where information of the same households is collected overtime. Such repeated collection of the information provides valuable information about net changes in poverty i.e. the extent of movements of households in-and-out of poverty. The distinction of poverty into chronic and transient poverty could be helpful for policy purposes, as different policy responses are likely to be effective for chronic and transient poverty differently. There are mainly two methods to distinguish chronic and transient poverty, namely; the 'spells' and 'components' approach

(Yaqub, 2000).

The distinction between permanent components of a household's income from its transitory variation is made in "component" approach, which helps to identify the chronic poor, those having permanent component below the poverty line. Inter-temporal average for the household is a common approach to identify the permanent component (Jalan & Ravallion, 1998). Here, a household is deemed to be chronically poor if its inter-temporal average is below the poverty line. In case of transitory poor, inter-temporal average for the household is above the poverty line, but it should fall below the poverty line at least once during the period under consideration. If it never falls below the poverty line, the household is never a poor household (McCulloch & Baulch, 1999). Beside this, Jalan & Ravallion (2000) outline two conditions to be fulfilled by a household in order to be in 'transient poverty'; first, the household must fall below the poverty line at least once during the period under consideration, and second, the household's standard of living must be observed to vary over time within the period under consideration. However, even a household that is found to be poor at all the period under consideration can experience variability in standard of living over the period, and have transient component of poverty, thus does not correspond to the concept of chronic poverty (Jalan & Ravallion, 1998; McCulloch & Baulch, 1999; Jalan & Ravallion, 2000; McKay & Lawson, 2003). Therefore, the 'component' approach demands good quality data supplemented by several round of panel survey overtime and cannot be properly captured using only two waves of panel data (McKay & Lawson, 2003).

'Spell' approach, on the other hand, simply identifies the chronic poor based on the number of spells of poverty they experience during the period under consideration (McKay & Lawson, 2003). This approach can be best applied even in two waves of panel data (Arif &

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Bilques, 2007). The application of poverty transition matrix can give four categories of changes in poverty between two waves (1st and 2nd waves). The followings are the categories;

    i)   Always non-poor (non-poor in both waves)

    ii)   Move-into-poverty (non-poor in 1st wave but poor in 2nd wave)

    iii)   Move-out-of-poverty (poor in 1st wave but non-poor in 2nd wave), and

    iv)   Always poor (poor in both wave).

As shown in Table 8.1, this can broadly categorized into three categories 'non-poor' (i), 'transitory poor' (ii and iii), and 'chronic poor' (iv).

Table 8.1 Poverty transition matrix showing categories of changes in poverty

		1st wave	
		Non-poor	**Poor**
2nd wave	**Non-poor**	'Always non-poor' Non-poor	'Move-out-of-poverty' Transitory poor
	Poor	'Move-into-poverty' Transitory poor	'Always poor' Chronic poor

8.3 Data source and methodology

This sub-section describes the sources of data for the panel data analysis in the study area and the methodology to analyze the data.

8.3.1 Data source

As deemed necessary to study the dynamics of poverty, the chapter is based on the household surveys conducted for the two waves in Baitadi district of Far-Western Rural Hills of Nepal in order to collect panel data. One hundred and twenty households in the first wave from two Village Development Committees (sixty each), namely; Patan and Melauli, were surveyed in the year 2001. However, due to missing of some important information in the first wave, four samples were dropped, all of which were from Melauli. Similarly, due to migration of few

households from the study, the second wave of survey conducted in 2007 could only locate fifty six households in Patan and fifty households in Melauli (Table 8.2). Thus, altogether, 106 panels are considered in this chapter.

Table 8.2 Sample size in two waves

Year	Patan	Melauli	Total
2001	60	56	116
2007	56	50	106
Attrition rate	6.7	10.7	8.6

Migration to market centers is the main reason for the attrition in both VDCs. This shows that migration rate is high in Melauli compared to Patan, which was mainly due to the remoteness of the VDC that push the household to the place having better basic social services like transportation, communication, health, education etc. All the households migrated from Patan were the non-poor in 2001, whereas only two out of six migrated from Melauli were poor in 2001. This suggests a higher tendency of non-poor to move out of the remote village to relatively accessible market centers.

8.3.2 Data analysis

A poverty line established by the two waves of Nepal Living Standard Survey i.e., NLSS I in 1995/96 and NLSS II in 2003/04, for Rural Western Hills were used to establish the poverty line in this chapter. The poverty lines established by NLSS I and NLSS II for Rural Western Hills are NRs 5,403 and NRs 8,901 respectively. Based on the growth rate of poverty line between these periods, poverty line for 2001 was interpolated and for 2007 was extrapolated. These figures are then compared with the poverty line calculated based on consumer price index taking 1996 as the base year. Due to the growth rate being constant, the poverty line based on growth rate follows the linear path whereas the changing consumer price index overtime follows a non-linear path. However, as shown in Figure 8.1, both of the poverty

line moves close to each other. Therefore, to capture both aspects, i.e. growth rate of poverty line as well consumer price index, average of these two poverty lines is used to study the poverty dynamics in this chapter (Appendix 2).
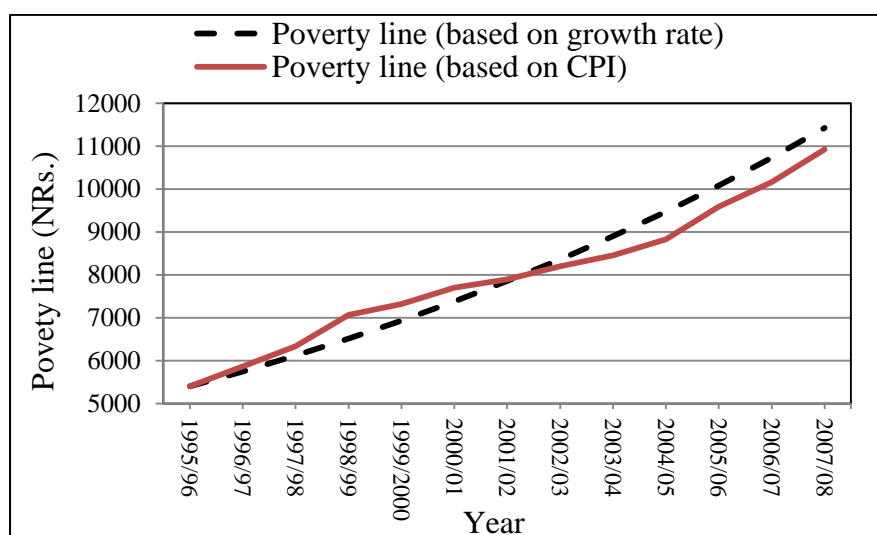
Figure 8.1 Derivation of poverty line using change rate of poverty line (between 1996 – 2004) and consumer price index

Source: Central Bureau of Statistics, 2005b; Ministry of Finance, 2010

The use of incidence of poverty for the two periods helps to differentiate households into three categories (Table 8.1). These categories of poverty are then related to different socio-economic characteristics of particular households as part of the descriptive analysis through cross-tabulations. Empirical analysis is also undertaken in order to establish the empirical relations of poverty with different socio-economic characteristics.

8.3.3 Empirical model

Multinomial logistic regression provides an appropriate tool when the dependent variable has more than two categories and such categories have no natural ordering (Wooldridge, 2002; Hamilton, 2009). Therefore, multinomial logistic regression model is applied to make an empirical assessment of how the chronic and transitory poor are different from the non-poor households in terms of various socio-economic characteristics.

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The multinomial logistic regression model with 'j' categories of dependent variables can be expressed as

$$\left[\frac{\Pr(y=i)}{\Pr(y=j)}\right] = e^{X\beta^{(i)}} \quad \text{--- (8.1)}$$

Where, $j = 3$ (chronic poor, transitory poor, and non-poor); i^{th} category = chronically poor or transitory poor, and j^{th} category = non-poor category, which is regarded as base category; X and $\beta^{(i)}$ are vectors of explanatory variables. If we call the ratio in equation 1 the relative risk and assume that X and β^i are vectors equal to $(x_1, x_2, \ldots x_k)$ and $(\beta_1^{(i)}, \beta_2^{(i)}, \ldots, \beta_k^{(i)})$ respectively, the ratio of the relative risk for a one-unit change in x_n can be denoted as Equation 8.2.

$$\frac{e^{\beta_1^{(i)}x_i + \ldots + \beta_n^{(i)}(x_{n+1}) + \ldots + \beta_k^{(i)}x_k}}{e^{\beta_1^{(i)}x_i + \ldots + \beta_n^{(i)}(x_i) + \ldots + \beta_k^{(i)}x_k}} = e^{\beta_n^{(i)}} \quad \text{--- (8.2)}$$

Thus, the exponential value of a coefficient is the relative-risk ratio for one-unit change in the corresponding variable. Here, risk is measured as the risk of transitory poor or chronic poor relative to non-poor. Since there are three categories of the dependent variable, there will be two non-redundant logits, chronic poor/non-poor and transitory poor/non-poor. The coefficient obtained in multinomial logit regression gives the log of the ratio of two probabilities $[\Pr(chronic\ poor)/\Pr(non-poor)]$ or $[\Pr(transitory\ poor)/\Pr(non-poor)]$ (as shown in equation 1), for one unit change in explanatory variable. In simple words, the standard interpretation of the multinomial logit is that for a unit change in the explanatory variable, the logit of chronic poor or transitory poor relative to non-poor is expected to change by its respective parameter estimate (coefficient) given other variables in the model held constant. The sign of the coefficient here gives the

direction of change in probability. For instance, a positive sign indicates increase in probability to be chronic or transitory poor over non-poor.

When the model is written in an exponentiated form, the explanatory variable of interest is evaluated at x+δ and at x for transitory or chronic poor relative to non-poor, where δ is change in explanatory variable we are interested in (δ is traditionally set to one i.e. change in one unit of explanatory variable), while the other variables in the model held constant (Equation 8.2). Taking their ratios would reduce to the ratio of two probabilities, which can be termed as relative risk. Thus, the relative risk ratio (RRR) can be interpreted as the expected change in relative risk ratio of transitory or chronic poor relative to non-poor for one unit change in explanatory variable given other variables in the model held constant. Thus, the RRR value greater than one indicates a positive association between the explanatory variable and transitory or chronic poor relative to non-poor, while the RRR value less than one shows the negative association.

Explanatory variables used for the empirical analysis are caste, age of household head, gender of household head, family size, dependency ratio, education of household head, occupation of household head, landholding, irrigation coverage, livestock holding, dummy for VDC, involvement in CBOs, number of CBOs involved, extent of participation in CBOs, type of CBOs, and occurrence of destructive natural disaster (either landslides, flood, drought, hailstorm). Observations of all these explanatory variables for 2001 are taken into consideration for the empirical analysis.

8.4 Results and discussion

8.4.1 Poverty transition between 2001 and 2007

Poverty transition matrix is an important tool to categorize the sample households into

temporal dimensions of poverty, i.e., non-poor, transitorily poor (moving in and out of poverty), and chronically poor. The result shows that 21.7 percent of sample households are chronically poor. Significantly higher proportion (thirty two percent) of the households in Melauli suffers chronic poverty compared to that of Patan where only 12.5 percent of the households are suffering from chronic poverty. In contrast, significantly higher proportion (44.7 percent) of households in Patan remains non-poor in both surveys compared to Melauli (twenty percent).

Table 8.3 Poverty transition matrix in sampled VDCs

| VDC | | Poverty | 2007 | | |
			Non-poor	**Poor**	**Total**
2001	Patan	Non-poor	25 (44.7)	5 (8.9)	30 (53.6)
		Poor	19 (33.9)	7 (12.5)	26 (46.4)
		Total	44 (78.6)	12 (21.4)	56 (100)
	Melauli	Non-poor	10 (20.0)	8 (16.0)	18 (36.0)
		Poor	16 (32.0)	16 (32.0)	32 (64.0)
		Total	26 (52.0)	24 (48.0)	50 (100)
	Overall	Non-poor	35 (33.0)	13 (12.3)	48 (45.3)
		Poor	35 (33.0)	23 (21.7)	58 (54.7)
		Total	70 (66.7)	36 (34.0)	106 (100)

Source: Field survey 2001 and 2007

Note: Figures in parentheses indicate percentage

Thirty three percent of the households managed to move-out-of-poverty between the survey periods. The proportion is more or less the same for both VDCs. However, the proportion of the household who move into poverty is higher in Melauli. In Melauli, sixteen percent of the households move into poverty whereas in Patan, only 8.9 percent of the households move into poverty (Table 8.3). Thus, 44.7 percent, 42.8 percent and 12.5 percent of the households in Patan are non-poor, transitory poor and chronic poor respectively. Similarly, twenty percent, forty eight percent and thirty two percent of households in Melauli are non-poor, transitory poor and chronic poor respectively. This suggests that a problem of chronic

poverty is severe in Melauli, a relatively remote VDC. In overall, the figures are 33 percent, 45.3 percent and 21.7 percent respectively for non-poor, transitory poor and chronic poor.

8.4.2 Socio-economic factors associated with poverty dynamism

Distribution of different types of poverty in two VDCs is significantly different (Table 8.4). The detail description on this is provided in Section 8.4.1.

Nepalese society is divided based on the Hindu caste hierarchy in which the priestly *Brahmins* (*Bahun*) are at the top followed by the *Kshatriya – Chhetri* (kings and warriors), the *Vaishya* (merchants) and the *Sudra* (peasants and laborers). Beneath everyone are occupational groups, which are considered untouchables and are called *Dalit* (oppressed). Bhattachan (2004) mention that there are above 200 forms of caste-based discrimination commonly practiced in Nepal. Some of the common practices include limiting the so-called lower castes or OC to socially-sanctioned roles such as forcing them to remove the carcass of dead cattle, refusing to share water sources with them and behaviors intended to avoid any direct bodily contact i.e., the practice of untouchability (Department for International Development & World Bank, 2006). Such discrimination is more severe in the less developed regions of the country, especially Mid- and Far-Western regions, which was widely observed even during the field survey by the author of this dissertation. Thus, the OC or *Dalit* households have been socially disadvantaged for a long time and are still being disadvantaged. This is the reason why the nature of poverty is significantly associated with caste. Fifty percent of OC households are suffering from chronic poverty. This figure is significantly higher if compared with *Bahun* (16.7 percent) and *Chhetri* (17.7 percent). Around twenty one percent of OC households move into poverty. This figure is also significantly higher compared to other caste groups like *Bahun* (6.6 percent) and *Chhetri*

(12.9 percent). In contrast to this, none of the OC households were non-poor in both surveys. Also, only relatively low proportion, 28.6 percent of OC households escaped out of poverty in 2007 compared to other caste groups like *Bahun* (35.5 percent) and *Chhetri* (30 percent). This suggests that both transitory and chronic poverty are more prevalent among OC households. Age of households shows non-significant association with the nature of poverty.

Gender of households is associated with accessibility of important resources to the households. A female-headed household is characterized by the lack of labor to cultivate land, the household owns. Besides, female rarely have legal ownership of assets such as land, livestock and house in their name (Department for International Development & World Bank, 2006). Thus, limited access to resources consequently limits their access to credit and also limits their involvement in community activities. This consequently increases the risk for female-headed households to fall into poverty. This study finds that gender of household head is significantly related with the nature of poverty. Female-headed households suffer a significantly higher proportion (35.3 percent) of chronic poverty compared to male-headed households (19.1 percent), whereas significantly lower proportion (11.9 percent) of the female-headed households were non-poor for both surveys compared to their male counterpart.

Family size was not significantly different in 2001 among four categories of poverty. However, in 2007, it differs significantly. There is increase in family size among the household who are non-poor and move-out-of-poverty. Thus, family size of the households who are non-poor and move-out-of-poverty were significantly higher compared to the households who were chronically poor and moved into poverty in 2007.

The nature of poverty also significantly differs with occupation of household heads. Only

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the household with its head engaged in agriculture and laboring are suffering from chronic poverty. A significantly higher proportion of households engaged in salaried job (seventy five percent) and business (fifty percent) are non-poor for both years. All types of occupation that the household heads are engaged have contributed households in moving out of poverty. However, because of the very high proportion of households with their heads engaged in agriculture and laboring are suffering from poverty, higher proportions of households with their heads engaged in agriculture and laboring managed to move out of poverty. This is mainly due to the increase in wage rate of both agricultural as well as casual laborer. The wage rate has increased from NRs. 70 to NRs. 150 for agricultural, and from NRs. 120 to NRs. 200 for casual laboring between 2001 and 2007 respectively. Increase in wage rate is mainly attributed to reduced supply of labor in the study areas mainly due to greater tendency of youth to migrate to urban areas, India or other countries.

Land is a very important factor of production in the context of rural Nepal where agriculture is the major source of livelihood. Historically, land has formed the principal symbol of social status and the principal source of economic power (Regmi, 1999). Therefore, ownership of land has meant control over a vital factor of production. Thus, landownership is a crucial factor that determines poverty in rural Nepal. Average landholding differs significantly with different categories of households for both years. In both years, average landholding is significantly higher among the households who are non-poor and move-out-of-poverty.

Table 8.4 Socio-economic characteristics of sampled household by nature of poverty

Variables	Nature of poverty				P-value	
	Non-poor	Move-out-of-poverty	Move-into-poverty	Chronic poor	χ^2	t-stat
Village Development Committee						
Patan	25 (44.7)	19 (33.9)	5 (8.9)	7 (12.5)	0.014[**]	-
Melauli	10 (20.0)	16 (32.0)	8 (16.0)	16 (32.0)		
Caste						
Bahun	14 (46.7)	9 (30)	2 (6.6)	5 (16.7)	0.02[**]	-
Chhetri	21 (33.9)	22 (35.5)	8 (12.9)	11 (17.7)		
OC	0	4 (28.6)	3 (21.4)	7 (50)		
Age of HHH (Years)						
2001	50.5	48.1	52.8	54.6	-	0.30
2007	51.8	50.7	55.8	53.0		0.50
Gender of HHH						
Male	33 (37.1)	28 (31.4)	11 (12.4)	17 (19.1)	0.1[*]	-
Female	2 (11.85)	7 (41.2)	2 (11.85)	6 (35.3)		
Education of HHH (Years of schooling)						
2001	8.3	4.7	4.1	2.4	-	0.00[***]
2007	9.7	6.7	3.8	4.5		0.00[***]
Family size (AE)						
2001	5.8	6.4	5.9	6.4	-	0.74
2007	6.2	7.5	5.4	5.6		0.014[**]
Occupation of HHH						
Agriculture	13 (20.6)	26 (41.3)	7 (11.1)	17 (27.0)	0.00[***]	-
Salaried job	18 (75.0)	3 (12.5)	3 (12.5)	-		
Business	3 (50.0)	2 (33.3)	1 (16.7)	-		
Laborer	1 (7.7)	4 (30.8)	2 (15.4)	6 (46.1)		
Landholding (ha.)						
2001	1.9	1.27	0.7	0.68	-	0.04[**]
2007	2.0	0.96	0.49	0.74		0.05[**]
Irrigation coverage (%)						
2001	42.8	37.6	24.9	25.5	-	0.02[**]
2007	44.2	35.5	34.9	34.5		0.5
Operational landholding (ha.)						
2001	1.12	0.83	0.97	0.97	-	0.47
2007	1.78	0.87	0.52	0.75		0.09[*]
Livestock holding (LSU)						
2001	3.68	4.4	4.2	4.7	-	0.33
2007	3.62	4.6	2.8	3.7		0.02[**]
Dependency ratio (by age)						
2001	0.36	0.89	0.77	0.98	-	0.00[***]
2007	0.62	0.62	1.17	0.79		0.01[***]
Dependency ratio (by economically active family members)						
2001	0.87	1.58	0.77	1.55	-	0.00[***]
2007	1	0.98	1.39	1.32		0.07[*]
Participation in CBOs (no.)						
2001	0.51	0.63	0.69	0.47	-	0.71
2007	1.26	1.17	1	1.17		0.72
Level of participation						
2001	1.85	1.71	2.44	1.83	-	0.75
2007	3.43	3.34	3.69	3.3		0.90
Climate related natural disaster						
Yes	18 (25.0)	21 (29.2)	12 (16.6)	21 (29.2)	0.008[***]	-
No	17 (50.0)	14 (41.2)	1 (2.9)	2 (5.9)		

Source: Field survey, 2001 and 2007

Note: [***], [**] and [*] significant at 0.01, 0.05 and 0.1 level of significance respectively, and figures in parentheses indicate percentage

Irrigation coverage differed significantly in 2001, with the non-poor household having significantly higher proportion of irrigation coverage (42.8 percent) followed by household move-out-of-poverty (37.6 percent). With the access of irrigation even by the poor households, irrigation coverage did not differ significantly in 2007. Though households own land, it is not necessary they cultivate the land. There is common practice of land renting in or out. Share cropping and mortgaging land are two most common ways of renting in and renting out land. Under sharecropping, provided all the necessary inputs like seed, fertilizers, and irrigation from the harvest of the main product, the remaining products are distributed equally among the landowner and cultivator. In case of mortgaged land, the land owner receives certain amount of money from the cultivator, for which the cultivator gets the right to cultivate the land. In such case, the landowner does not have claim over the harvest. Such rights rest on the cultivator until the landowner payback the principal amount. Thus, under such arrangement, the profit that cultivator makes from the piece of land is viewed as the interest for the principal amount. This system of renting in and out land makes the difference between the total land a household owns legally and the land a household cultivates (operational land).

Operational land was not significantly different among different category of poverty in 2001. However, in 2007, it was highest among the non-poor households followed by the households who moved out of poverty. There is a huge reduction in operational land among the household who moved into poverty, whereas among the chronically poor household such reduction was only a relative. Operational land holding is higher than the total landholding among the households who moved into poverty and are always poor. However, the total landholding size is bigger than the operational landholding size for households who were

never-poor and who moved out of poverty. This shows that the chronic poor households and households who move in poverty are the ones who rented in land from the households who moved out of poverty and who were never poor. Since the significant proportion of the main product goes to the landowner under share cropping, which is the common practice for chronically and transitory poor households, higher operational landholding cannot be translated into higher production of agricultural product.

Livestock holding was not significantly different among different nature of poverty in 2001. But in 2007, livestock holding became significantly higher among the households that moved out of poverty. It was lowest among the households who moved into poverty in 2007. Moreover, small livestock like goats serve as an important means to cope with the situation of poverty. Thus, it can be said that whenever a household suffers deficiency in income to meet basic needs, they sell the livestock, which means reduction in size of livestock holding.

Dependency ratio shows the proportion of dependent members to independent one in the household. It can be measured both in terms of economically active age group as well as in the involvement of the members in economic activity. Dependency ratio based on economically active members is higher compared to the dependency ratio based on economically active age groups in all cases. This suggests that not all the economically active age group family members are engaged in economic activities. This reflects the lack of reliable employment opportunities in the study areas. Dependency ratio based on both criteria is significantly lower among the households who are non-poor and who moved into poverty. A lower dependency among the households who moved into poverty is, in fact, due to the distress involvement of many of the household members in any sort of income generating activities regardless of age and gender of the member. Dependency ratios have

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increased for the households who moved into poverty.

Participation in CBOs has increased significantly between 2001 and 2007. During 2001, most of the CBOs were non-functional due to the threats posed by the Maoist insurgency. Local government established by the Maoist strongly opposed the function of externally funded CBOs in the study areas. However, after the peace process in 2006, several NGOs and INGOs, and also GOs have established CBOs in the study areas. Farmers' groups and saving and credit groups are the major two types of CBOs established by the GOs, NGOs, and INGOs in the study areas. Farmer' groups were established with the main objective of commercializing agriculture by efficient management of input as well as output through groups. Similarly, saving and credit groups that involve women groups were established in order to empower women through several community activities as well as mobilization of saving and credit. Similarly, 'professional' groups like groups of traditional healers were organized by the Family Planning Association of Nepal (FPAN), in order to disseminate modern knowledge about maternal health among the locale. This is done by providing training to the members of such organizations. These groups were also active in mobilizing saving and credits. Besides, there were already established Community Forestry User's Groups (CFUGs) in the study areas. Therefore, participation in CBOs increased significantly in 2007 compared to 2001. In both years, however, participation in CBOs was not significantly different. The same is true in case of the level of participation of members in the CBOs.

Lastly, relating nature of poverty with occurrence of climate related natural disasters, it shows that significantly higher proportion of households (29.2 percent) who suffered climate related natural disasters falls under chronic poverty. This constitutes 91.3 percent of chronic

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poor household suffering from climate related natural disasters. Only 5.9 percent of chronic poor household did not suffer any climate related natural disasters. In contrast, significantly higher proportion (fifty percent) of household who didn't suffer climate related natural disasters remain non-poor for both survey periods, but only twenty five percent households who suffered climate related natural disasters remain non-poor for both survey periods. Flood, landslides, and hailstorms are the natural disasters that are frequent in the study areas. Hailstorm and landslide are quite intense in Melauli compared to Patan. In Melauli, 66.1 and 46.4 percent households suffered from hailstorm and landslide respectively. This has adversely affected standing crops among 86.8 percent households, and cropland degradation among 54.7 percent households. In Patan, the figure is relatively small; only 13.3 and 18.3 percent households suffered hailstorm and landslide respectively. The intensity of flood, however, is higher in Patan with 23.3 percent households affected by flood. These natural disasters have affected standing crops among forty five percent households and land degradation among thirty percent of households. Thus, the occurrence of natural disasters has adversely affected livelihoods of household in the study areas.

8.4.3 Factors affecting the dynamics of poverty: Results of multinomial logistic regression

As the initial step to run the model, the entire sixteen variables listed in Table 8.4 including the square of age and family size were included in the initial model. However, after successive dropping and incorporation of the insignificant explanatory variables, the final model was obtained and as presented in Table 8.5.

Table 8.5 Factors affecting dynamics of poverty: An outcome of multinomial logistic regression model

Variables	Transitory poor/non-poor			Chronic poor/non-poor		
	Coef.	RRR	P-value	Coef.	RRR	P-value
VDC (dummy for Patan)	-0.3	0.74	0.74	-1.6	0.19	0.10[*]
Caste (dummy for OC)	22.4	5.2E+09	0.00[***]	24.0	2.6E+10	0.00[***]
Gender of HHH (dummy for female)	0.7	2.01	0.56	1.8	6.39	0.1[*]
Occupation of HHH (dummy for agriculture)	3.0	20.70	0.00[***]	22.9	8.7E+09	0.00[***]
Occupation of HHH (dummy for laborer)	1.6	5.06	0.24	21.4	1.9E+09	0.00[***]
Landholding (ha.)	-1.2	0.31	0.03[**]	-0.15	0.86	0.09[*]
Irrigation coverage (%)	-0.01	0.99	0.70	-0.03	0.97	0.1[*]
Dependency ratio (economically active members)	2.6	13.68	0.00[***]	2.7	14.76	0.00[***]
Occurrence of natural disaster (dummy for occurrence)	1.9	6.86	0.02[**]	0.98	2.66	0.38
Constant	-2.9		0.03	-22.9		0.04
Number of observations	106					
Likelihood ratio Chi^2(18)	92.67[***]					
Log likelihood	-65.62					
McFadden's pseudo R^2	0.41					

Source: Field survey 2001 and 2007

Note: [***], [**] and [*] significant at 0.01, 0.05 and 0.1 level of significance level respectively

Likelihood ratio test shows that the model is significantly not different from the full model, where each of the variables presented in descriptive table (Table 8.4) are included. Thus, the outcome of the model presented in Table 8.5 can represents the best fitted model. The result shows that the relative risk of households in Patan to be chronic poor relative to non-poor is significantly low. However, such risk for households to be transitory poor is non-significant. Caste variable shows a very high risk, which is also highly significant, for OC households to be transitory poor as well as chronically poor in relation to remain non-poor. Similarly, high and significant risk is associated with occupation of household heads, especially in case of chronic poor relative to non-poor. Household with its heads engaged in agriculture and laborer have significantly high risk of being chronically poor. Gender of household heads do not have significant association with transitory poverty relative to remain non-poor, but has mild significance with chronic poor over non-poor. This suggests that female-headed

households have higher risk of being chronic poor relative to remain non-poor compared to their male counterpart.

Landholding significantly reduces the relative risk of being chronic or transitory poor over non-poor. This means, with increase in the landholding, a chance of a household to be transitory poor over non-poor will reduce significantly. The significance is relatively weaker for chronic poor over non poor. This is the reason why though there is slight increase in landholding in 2007 among chronic poor households, they were not able to move out of poverty. Irrigation is another important factor for the rural households, which determine their welfare. Irrigation has negative association with the risk of household being chronic or transitory poor. But the association is significant only in the case of chronic poor, i.e., increase in irrigation coverage will reduce the risk of households being chronic poor relative to remain non-poor.

Dependency ratio based on economically active members shows the increased (higher) risk of transitory and chronic poor in relation to the risk of being non-poor. As discussed in earlier section, dependency ratio based on economically active members is higher than the dependency ratio based on age groups. Therefore, any effort to reduce the dependency ratio based on economically active members through employment generation will also reduce the risk of household being chronic poor and transitory poor relative to the risk of being non-poor, thus, will be helpful in reducing chronic as well as transitory poverty.

The occurrence of climate related natural disasters increases the risk of household being transitory poor over household being non-poor. Occurrence of natural disasters such as hailstorms, landslide, and flood push the households into transitory poverty through damage caused on the standing crops, as well as land assets itself. Therefore, this demands a special

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program such as insurance packages or humanitarian assistance to deal with transitory poverty during the occurrence of the natural disasters.

Within transitory poverty there are two categories of poor; those who moved into poverty and those who moved out of poverty. Thus, consideration of transitory poverty alone cannot capture the direction of poverty movement. Therefore, it is necessary to disaggregate the categories of poverty within. Table 8.6 gives the outcome of multinomial logistic regression obtained through dropping and incorporation of variables from the full model. The likelihood ratio test result shows that the final model (Table 8.6) is nested in full model, i.e., the final model and the full model is not significantly different. Table 8.6 shows the relationship of non-poor and move-out-of-poverty with several socio-economic and environmental factors taking move-into-poverty as reference.

Table 8.6 Multinomial logistic regression for disaggregated transient poverty

Variables	Non-poor/move-into-poverty			Move-out-of-poverty/move-into-poverty		
	Coef.	RRR	P-value	Coef.	RRR	P-value
Caste (dummy for OC)	-40.59	0.00	1.00	-3.86	0.02	0.04[**]
Education of HHH (years of schooling)	0.22	1.25	0.09[*]	0.06	1.06	0.67
Occupation of HHH (dummy for agriculture)	-2.91	0.05	0.01[***]	-0.75	0.47	0.49
Operational landholding (ha.)	-2.00	0.13	0.05[**]	-1.28	0.28	0.21
Total landholding (ha.)	4.16	64.03	0.02[**]	1.57	4.79	0.03[**]
Irrigation coverage (%)	0.04	1.04	0.07[*]	0.03	1.03	0.20
Dependency ratio (economically active members)	1.45	4.26	0.17	3.00	20.18	0.00[***]
Number of CBOs	-2.45	0.09	0.02[**]	-2.19	0.11	0.04[**]
Occurrence of natural disaster (dummy for occurrence)	-4.25	0.01	0.02[**]	-3.75	0.02	0.03[**]
Constant	4.00		0.119	3.63		0.142
Number of observation	83.00					
Likelihood ratio Chi^2(18)	75.95[***]					
Log likelihood	-46.57					
McFadden's pseudo R^2	0.45					

Note: [***], [**] and [*] significant at 0.01, 0.05 and 0.1 level of significance level respectively

A chance of OC household to fall under non-poor category is zero that is the reason why value of RRR for dummy for OC household is also zero. This is because none of the households from OC are non-poor. Occupational Castes has negative and significant

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association in terms of relating probability of moving out of poverty in relation to move-into-poverty, which means OC households have significantly lower probability to move out of poverty in relation to their probability to move out of poverty compared to other caste groups. Education of household heads, which is measured in terms of years of schooling, shows positive significant association with non-poor over move-into-poverty. Therefore, with the increase in education of household heads, probability of households remaining non-poor will increase significantly compared to the probability of households to move into poverty. However, the relation of education with move-out-of-poverty in relation to move-into-poverty is non-significant.

Both the occupation and operational landing holding show negative significant association with non-poor over move-into-poverty. This suggests that probability of being non-poor for the household whose head is engaged in agriculture is significantly low. Consequently, households with their heads engaged have significantly higher chance to fall into chronic poverty. The same holds true for the case of operational landholding as well. It is mostly rich person who rented out their land for cultivation to the poor mostly on share cropping basis. Under such land tenure arrangement, all costs of the variable inputs except labor are covered by the products and remaining products are shared equally among the land owner and cultivator. Therefore, increase in operational land size can be translated into increase in probability of households to move into poverty and decrease in probability to remain non-poor. Landholding shows positive significant association with non-poor as well move-out-of-poverty over move-into-poverty, i.e., with increase in landholding there will increase in probability of households to remain non-poor and also to move-out-of-poverty. Irrigation coverage shows positive significant relation only with non-poor over

move-into-poverty but not with move-out-of-poverty over non-poor. Therefore, limited access of households to irrigation (i.e., decrease in irrigation) will increase the probability of households to move into poverty; thereby reducing the probability of remaining non-poor.

Dependency ratio based on economically active member shows a significant positive association with move-out-of-poverty over move-into-poverty. Here, decrease in dependency ratio is associated with distressed involvement in any sort of income generating opportunity regardless of types of work and age of the household members. This suggests that most of the poor households have low dependency ratio. However, the income earned is very nominal, which is not enough even to meet their basic needs. This is the reason why increase in dependency ratio results in increased probability of households to move-out-of-poverty over move-into-poverty.

Most of the CBOs established in the study areas are established with the objective to deal with the problem of poverty reduction, therefore target poor households under such programs. Therefore, negative significant association of number of CBOs, the household is engaged in, with non-poor and move-out-of-poverty over move-into-poverty is revealed. This suggests that increase in number of CBOs involved reflect increased probability of household to move-into-poverty over remain non-poor or move-out-of-poverty. However, access of chronic poor households to such CBOs is less (Table 8.4). Dummy for occurrence of natural disasters also shows negative significant association with non-poor and move-out-of-poverty over move-into-poverty. Therefore, occurrence of natural disasters will increase the probability of the households to fall into poverty in the study areas.

8.5 Conclusion

Poverty incidence between the study periods declined sharply. With the better access to

infrastructure including motorable road, electricity, communication and relatively developed market, decline in poverty is significantly higher in Patan. Since the higher proportion of households moved out of poverty in Patan, Melauli, a relatively remote VDC, suffers higher intensity of chronic poverty. Excessively higher proportions of OC households are chronically poor. Risk of falling them into chronic poverty is also significantly higher compared to remain non-poor. Gender of households, though is not significantly related with transitory poverty, the risk of female-headed households to be chronic poor is significantly high. Households with their head engaged in agriculture and laboring have higher chance of falling into chronic poverty. Landholding and irrigation coverage, however, reduce the risk of households to fall into chronic poverty. Higher dependency ratio in the study areas is also another important factor that pushes households into chronic poverty. Besides, occurrence of natural disasters will increase the risk of households to be transitorily poor.

Further, disaggregation of transitory poverty into move into and move-out-of-poverty suggests that OC households have higher risk to move into poverty due to their limited socio-economic assets. Increase in years of schooling of households' heads and landholding will help the household to move out of poverty. Only increase in operational landholding through sharecropping will not help households to move out of poverty in the study areas. Secured tenancy right that guarantees full claim over the product they produce from the land they cultivate is necessary for them to move out of poverty. Similarly, increase in dependency ratio through the involvement of school age children in education and economically active age members to well defined economic activities in terms of minimum wage and regulated working hours will help households to move out of poverty. In case of involvement in number of CBOs, it is difficult to establish the relation. It is mainly because

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households were involved in higher number of CBOs, which itself was non-functional during the first wave to survey and could not have any impact on poverty. However, considering the success of such CBOs in reducing poverty, access of poor to such CBOs will be helpful in dealing with the problem of chronic poverty in the study areas. Besides, it is occurrence of natural disasters that forces households to move into poverty.

Thus, any poverty reduction program to deal with transitory as well as chronic poverty should focus relatively on remote VDCs like Melauli. Similarly, OC households, whose major occupation is either agriculture or laboring, should be targeted by such programs, which would be effective in moving households out of poverty. Generation of employment opportunities that reduce dependency ratio based on economically active members to the level of dependency ratio based on economically active age group will significantly reduce risk of being transitory (move into poverty) as well as chronic poor relative to non-poor. Thus, generation of employment opportunities will be very crucial to tackle both transient and chronic poverty. The expansion of irrigation will be helpful in reducing chronic poverty. Such programs targeting chronic poor should focus on the households in Melauli, including female-headed households and households with their heads engaged in laboring. Occurrence of natural disasters is increasing the risk of the households being transitory poor, basically through increased risk of households to move into poverty. Therefore, introduction of some temporary relief program during occurrence of such natural disasters will be very effective in dealing with transient poverty. Besides, the introduction of insurance scheme against the loss of crop or livestock due to natural disasters would be helpful in dealing with the adverse impact caused by natural disasters.

Chapter 9. Summary, conclusion and recommendations

9.1 Summary

Nepal is well-known for its richness in natural resources as well as rich cultural including human resources. Unfortunately, the country falls under the category of least developed countries. Poverty, measured both in terms of monetary as well as non-monetary dimensions, is quite persistent in the country. This is so despite the country receiving huge inflow of foreign aid in terms of grant and soft loan to meet the goal of poverty reduction. It is only recently that there has been decline in poverty, but this was achieved at the cost of ever increasing inequality. Nepal has the highest level of inequality (with gini coefficient of 0.41) in Asian-Pacific region. Besides ever increasing inequality, CC is emerging as a growing threat to recent achievements in poverty reduction. The country, being poor and dependent on natural resources to a greater extent, is highly vulnerable to CC. Thus it is among the most vulnerable countries to CC. Due to the severity of poverty in the country, there is a plethora of literatures on poverty. However, virtually all of these literatures are based on cross-sectional analyses that make static analyses of poverty and fail to capture its dynamic aspects. Therefore, this study aimed to analyze the dynamic aspects of poverty in relation to socio-economic as well as environmental factors.

To meet its objective, the dissertation starts with research design discussing the way it is constructed as well as sources of data and data analysis. This is followed by understanding the incidence of poverty from macroeconomic perspective. It is found that besides the regular socioeconomic factors, CC is emerging as a growing threat to the recent achievements in poverty reduction, and puts the country among the most vulnerable countries to CC. Therefore, chapter four deals with issues of CC in Nepal, and its association

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with poverty. Since the agriculture sector is important to the poor and is going to be adversely affected by CC, chapter five shows how the trend of climate variables have affected yield of basic food-crops of Nepal as well as how it has affected national food self-sufficiency. By doing this, it is established that poverty is still an important issue to be analyzed in detail, and that CC could have potential impact on it. Therefore, chapter six, seven and eight study poverty, initially taking twelve nationally representative districts based on static analysis, and then one poverty-stricken district from Far-Western Rural Hills based on static as well as dynamic analysis, taking several important socioeconomic as well as environmental factors into consideration.

The study is based on sustainable livelihood framework. Poverty is affected by several macroeconomic indicators such as growth rate, inflation rate and population growth rate. Similarly, geographic regions such as development regions, ecological zones and rural-urban divide affect poverty. Besides this macro level consideration, micro level variables such as socio-demographic factors also affect poverty. In addition, economic factors such as resource possession affect poverty directly or through livelihoods outcome, which could be either natural resource based like agriculture and forestry or non-natural resource based like salaried job, remittance, and business. Here, economic factors, and livelihood strategies will be affected by environmental factors such as temperature and rainfall trend, and climate extremes like hailstorm, landslide and flood. The impact of environmental factors depends on the geographic location.

With this analytical framework together with the severity of the problem, twelve districts representing each of five development regions as well as three ecological zones were selected for the study of poverty. Forty samples from each district were selected from the

VDC in the vicinity of the headquarters through random sampling techniques. For the in depth study of poverty to capture both static as well dynamic aspects of poverty, sixty samples each from two VDCs of poverty stricken Far-Western Rural Hill district of Baitadi were surveyed in 2001 and 2007. However, due to consistency in data quality, 116 households from the first wave were considered for the analysis. For the analysis of poverty dynamics, the total size of sample constitutes 106 households. The samples were selected through stratified random sampling techniques in order to represent all strata of the households in the VDCs in terms of caste group as well as resource possession. Data was analyzed using several statistical tools such as frequencies, mean, cross-tabulation, as well as empirical tools such as regression analysis.

The dissertation starts by developing proper understanding on poverty from macroeconomic perspectives based on the literature on historical analysis of poverty in the country. The results show that macroeconomic indicators of the economy are not in favorable condition to tackle poverty. Throughout the period from 1965 to 2007, inflation rate was higher than the real GDP growth rate. Therefore, the country remains the poorest country outside Africa since 1990. Similarly, agricultural growth rate, the sector on which more than sixty six percent of population depends on, is quite erratic and is below population growth rate in some periods. On average, agriculture growth rate is slightly greater than population growth rate, which is mainly due to the expansion in areas under cultivation rather than improvement in agricultural productivity. This has shifted the country from being net food-crop exporter to net importer since 1979/80.

Poverty at the household level has also been increasing continuously since 1976/77 when the first household poverty study was done. Since then, three nationally representative

poverty studies and one rural credit survey were made. Though many of those studies do not share common methodology, the comparison made through proper adjustment among those studies suggests that poverty incidence is ever increasing till 1995/96. Despite that there was decline in urban poverty; such increase in poverty incidence is mainly due to the increase in rural poverty. Even when there was a decline in poverty between 1995/96 and 2003/04, the decline in urban poverty was significantly higher compared to the decline in rural poverty. Thus, there is significant increase in gini coefficient signifying increasing inequality. The results of the study also establish that poverty in the country exists in a wide variation depending on the rural-urban divide, geography, gender and caste/ethnicity. Poverty is more persistent among the households in rural areas in Far and Mid-Western Rural Hills and Mountains, households headed by female and OC households. Also, households headed by agricultural wage laborers and self-employed in agriculture are suffering from higher incidence of poverty. This makes poverty in Nepal complex and diverse. Similar is the case for several indicators of food insecurity. Therefore, huge concentration of poor in rural areas makes rural poverty the core issue focusing more on Far-Western and Mid-Western Hills. There are several programs and policies implemented by the government. However, they failed to reduce the incidence of poverty especially in the rural areas. Target food and feeding programs are relatively successful, but the coverage is very limited as it reaches less than ten percent of the target population. Beside these factors, CC is appearing as a growing threat that increase the vulnerability especially among resource poor households; thereby posing threats to little achievements made so far in reducing poverty. Therefore, Chapter four discusses different aspects of CC in Nepal and assesses its relation with poverty.

Chapter four shows that Nepal has negligible share of global GHG emissions. However, the

greatest concern is that it is increasing at an alarmingly higher rate, excessively higher rate compared to its fastest growing neighboring countries like China, India and Bangladesh. Agriculture alone emits around sixty nine percent of national GHGs, followed by the forestry sector. Both of these sectors have huge significance on livelihoods of more than eighty percent of the country's populations, most of which are poor. Since Nepal has already shown some indications of CC like increase in temperature, erratic rainfall and increased incidence of climate extremities, such trends and events have shown adverse influences on water resources, which consequently affect agriculture and forestry sectors. Therefore, any efforts to mitigate GHGs emission through agriculture and forestry sectors will have positive effects on poverty reduction as mitigation efforts in agriculture and forestry also cross cut adaptation to CC. Moreover, being signatories of major CC regimes, Nepal has high prospects to generate revenue through mitigation efforts especially from alternative energy promotion, forestry and agriculture. Chapter four found that any proactive role of Nepal in international forum to incorporate forestry sector through REDD, existing alternative energy technology, and agriculture practices through CDM can help to meet the adaptation cost of US$ 300 million estimated by NAPA.

After discussing several aspects of CC in relation to poverty, it is found that the agriculture sector is being adversely affected by climate trends. Agriculture, being important sector of national economy, which employs more than sixty six percent of its population and generates one third of national GDP, Chapter five assessed the quantitative relation of major food-crops' yield with current climate trend. The study is based on the relationship established by regression analysis that employs historical data on minimum temperature, maximum temperature, rainfall, and yield of six major food-crops from 1978 till 2008. Data

on climate variables were aggregated on the season basis in order to meet the growing seasons, namely; summer and winter season. The results show that yield of all the food-crops are increasing. However, the yield growth rate, except for potato and wheat, is always lower than the population growth rate. Climate variables also show the increasing trend except winter rain and winter minimum temperature. Empirical analysis shows that summer crops are adversely affected by the current climate trend, especially due to increase in rainfall and maximum temperature. In contrast, increase in temperature has positively contributed to the yield growth of both winter crops. It is mostly the summer crops that contributes to national food self-sufficiency, therefore the current trend of the climate variables suppressing yield of summer crops reduce the probability of the country to become food self-sufficient. Therefore, any effort to deal with minimizing adverse impact of CC on food-crop production should consider crops like maize and potato. Moreover, these two food-crops are important staple food crops in Mountains and Hills, which are exposed to higher degree of vulnerability.

The earlier chapters established relation of poverty with several socioeconomic factors as well as environmental factors that can be attributed to CC at macro level. Therefore, the successive chapters, chapters six, seven, and eight, dealt with poverty at micro level in relation to several socioeconomic and environmental factors (climate extremities). The micro analysis of poverty starts in Chapter six. The chapter analyzes the incidence of food insecurity at household level and establishes its quantitative relation with several socioeconomic variables employing a binary logistic regression. The result shows that merely ten percent of households are suffering from severe food insecurity, i.e., neither they are able to produce sufficient food-crops in their farm, nor are they able to earn threshold income needed to meet deficit food. The risk of being food insecure is significantly higher

for female-headed households, households headed by illiterate heads, big family size, higher dependency ratio, households with its head dependent on agriculture with small landholding, households with limited access to irrigation and fertilizer, households head engaged in wage laboring and households with its members not involved in community organizations.

Chapter seven then concentrates on static poverty analysis on poverty-stricken Far-Western Rural Hill district of Baitadi. Both income and consumption measure of poverty show higher existence of poverty in the study area. More or less similar factors, identified in Chapter six, affect poverty in the study areas as well. With the significantly lower landholding, irrigation coverage and schooling year of the households' heads, the poverty measured in terms of incidence, depth and severity suggests that the problem is more severe in relatively remote VDC, Melauli. Similarly, significant difference in resource distribution among the caste groups resulted in higher incidence, gap and severity of poverty among OC households. Besides, larger family sized households, female-headed households, and households headed by illiterate heads are suffering significantly higher incidence and depth of poverty. The comparison between income and consumption poverty shows significant correlation with each other. However, due to mismatch between income and consumption poverty, weak correlation between income and consumption measure of poverty is found. Here, higher proportions of income non-poor households are suffering from food insecurity, which suggests that the poverty line established for the regions is not even sufficient to meet food need of the households. This is mainly due to the excessively high costs involved in transportation of goods, thus making the food items more expensive in Melauli compared to Patan. Consumption measure of poverty captures several aspects of poverty such as borrowing and bartering, which are also common phenomena in rural Nepal. Thus, the

consumption poverty can capture the state of poverty better in case of rural Nepal. Therefore, consumption poverty is more relevant in making poverty comparison between the two locations. However, such conclusion should be established through poverty analysis based on longitudinal data in order to capture wider aspects of both measures as well as the poverty itself. Therefore, Chapter eight estimates the dynamics of poverty in the same VDCs of Baitadi districts.

The results of Chapter eight shows that the involvement of households' heads in agriculture helped households to move out of poverty to a greater extent, which holds true mostly in the case of *Bahun* and *Chhetri* caste groups especially in Patan. Occupational Castes households, households engaged in agriculture, lower landholding and higher dependency ratio is associated with higher chance of chronic and transitory poverty. Households in Melauli, households headed by female, households engaged in laboring and households with low irrigation coverage are related with higher chance of suffering chronic poverty. Besides, occurrence of natural disasters will increase the risk of households to be transitorily poor. Further, disaggregation of transitory poverty into move-into and move-out-of-poverty shows that OC households have very low chance of moving out of poverty under the existing situation. Improvement in education of households' heads will increase the probability of households remain non-poor. However, only slight increase in education will not help households to move out of poverty in relation to move into poverty, or vice versa. Engagement of households in agriculture is related only with non-poor in negative direction. This suggests that for the households engaged in agriculture, the probability to become non-poor is significantly less compared to other occupations, especially salaried job and business. Similarly, operational landholding also has significant

negative relation with non-poor over move-into-poverty. This is mainly because it is the poor who are cultivating land of non-poor households on share-crop basis from which they receive only half of the products after deducing the product to be paid for the other variable inputs expect labor. Thus, the increase in operational landholding alone would not help households to remain non-poor under the existing production system. However, landholding has positive significant association with both non-poor as well as move-out-of-poverty over move-into-poverty. Therefore, secure land tenancy from which the poor cultivator can receive whole of the product could help them to move out of poverty and also helps household to remain non-poor. Such probability will be further increased with the expansion of irrigation. Results obtained in case of dependency ratio should be interpreted with caution. It is found that dependency ratio is higher among the non-poor households, mainly due to the involvement of the higher proportion of family members specially youth and children in education. Thus, dependency ratio shows positive significant association with non-poor. However, comparison of dependency ratio based on age groups with economically active members show that dependency ratio based on economically active members is higher. This reflects the less opportunity available to involve economically active age group in economic activity. Thus, the provision of income generating opportunities is crucial especially to those who are poor and involved in distress laboring with minimal wage and without working hour regulations. Community Based Organizations are found to target chronically poor households; however, effectiveness of such organization on poverty reduction could not be established through the study, since it was virtually non-functional during the first wave of the survey due to the Maoist insurgency. Besides, the occurrence of natural disasters is associated with move-into-poverty. Thus, any adaptation action carried out to adapt with CC

will help to reduce probability of households to move into poverty, but could not help households to remain non-poor.

9.2 Conclusion and recommendation

Poverty is quite persistent in Nepal. Such persistence, especially in rural areas makes poverty a core issue to be researched in rural Nepal. None of the macroeconomic indicators in Nepal considered under this study are favorable for poverty reduction. Even most of the poverty reduction programs and policies implemented by the government failed to substantially reduce poverty. Besides, new environmental threats that can be attributed to CC are emerging, which adversely affect poverty in Nepal. However, it comes with the potential to generate significant amount of revenue from international CC regimes through mitigation effort, which also has synergy to adapt the adverse effects of CC. Recent trend in climate variables is causing adverse impact on the yield of major summer food crops such as maize, potato and millet. The suppression of these food crops' yield significantly reduces the probability of country to achieve food self-sufficiency.

Poverty analysis based on household level data shows that the problem of food insecurity is more severe in Hills and Mountains. Also, households with higher family size and higher dependency ratio, households headed by female and households having lower resources possession are suffering from higher incidence of food insecurity. Incidence of poverty is significantly high in the Far-Western Rural Hills. This is mainly due to higher concentration of female-headed household, higher dependency ratio, seasonal labor migration, low level of resource possession and geographical disadvantages that hinder access to basic social services like transportation, communication, education, and health. These are also the factors responsible for chronic and transitory poverty. Occurrence of natural disasters increases the

risk of transitory poverty, i.e., households move into poverty. Therefore, the provision of income generating opportunities could be helpful to cope with poverty. This helps to reduce dependency ratio based on economically active members to the extent of economically active age groups by ensuring income generating opportunities with regulated working hours as well as regulated wage rates. This is very critical for the poor households whose members are forced to work regardless of the nature of work as well as age of the members in order to meet their minimum needs.

Expansion of irrigation could be crucial in generation of employment through commercial agriculture. This also serves as an adaptation program to CC, which will be very effective in dealing with transitory poverty. Therefore, any livelihood intervention to deal with chronic poverty should focus on Melauli, OC households, female-headed households, households' heads engaged in agriculture and laboring, marginal famers with small/marginal land holding with limited irrigation access, and higher dependency ratio. Whereas, targeting OC households, households' heads with low years of schooling, small landholding, households suffering from climate related natural disasters (which is more common in Melauli) will be crucial in dealing with transitory poverty (or restricting households move-into-poverty).

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Appendices

Appendix 1 Crop calendar for major food-crops in Nepal

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Season
Mountain (Rainfed)												
		Mai-P	Mai-P				Mai-H	Mai-H	Mai-H			Summer
			Mil-P	Mil-P						Mil-H		Summer
	Pot-P	Pot-P				Pot-H	Pot-H	Pot-H	Pot-H			Summer
				Whe-H	Whe-H					Whe-P	Whe-P	Winter
			Bar-H	Bar-H						Bar-P	Bar-P	Winter
Hills (Partial irrigation/Rainfed)												
				Pad-TP	Pad-TP			Pad-H	Pad-H			Summer
		Mai-P	Mai-P				Mai-H	Mai-H				Summer
				Mil-P	Mil-P				Mil-H	Mil-H		Summer
		Pot-P	Pot-P				Pot-H	Pot-H				Summer
		Whe-H	Whe-H	Whe-H					Whe-P	Whe-P	Whe-P	Winter
		Bar-H	Bar-H						Bar-P	Bar-P	Bar-P	Winter
Hill (Irrigated)												
		Pad-TP	Pad-TP			Pad-H	Pad-H					Spring
	Mai-P	Mai-P			Mai-H	Mai-H						Spring
		Whe-H	Whe-H	Whe-H					Whe-P	Whe-P	Whe-P	Winter
Tarai (Rainfed)												
					Pad-TP	Pad-Tp		Pad-H	Pad-H	Pad-H		Summer
		Mai-P	Mai-P				Mai-H	Mai-H				Summer
		Whe-H	Whe-H						Whe-P	Whe-P		Winter
Tarai (Irrigated)												
						Pad-Tp	Pad-Tp			Pad-H	Pad-H	Late-summer
	Mai-P	Mai-P			Mai-H	Mai-H						Spring
		Pad-Tp	Pad-Tp			Pad-H	Pad-H	Pad-H				Spring
	Mai-H	Mai-H							Mai-P	Mai-P		Winter

Mai-Maize, Mil-Millet, Whe-Wheat, Bar-Barley, Pad-Paddy, P-Plantation, Tp-Transplantation, H-Harvesting

🟧 Plantation/transplantation   🟩 Crop growing phases   🟥 Harvesting

Source: Food and Agriculture Organization & World Food Programme, 2007; http://www.lanra.uga.edu/potato/asia/nepal.htm

Appendix 2 Poverty line derivation for the study considering poverty line of Rural Western Hills

Year	Poverty line (based on growth rate)	Consumer price index (CPI) (Hills)	Poverty line (based on CPI)	Poverty line (average)
1995/96	**5403.0**	100	**5403.0**	**5403.0**
1996/97	5750.9	108.6	5867.7	5809.3
1997/98	6121.3	117.3	6337.7	6229.5
1998/99	6515.5	130.8	7067.1	6791.3
1999/2000	6935.0	135.6	7326.5	7130.7
2000/01	7380.6	142.6	7704.7	7542.6
2001/02	*7857.0*	146.2	*7899.2*	*7878.1*
2002/03	8362.9	151.8	8201.8	8282.3
2003/04	8901.5	156.6	8461.1	8681.3
2004/05	9474.7	163.5	8833.9	9154.3
2005/06	10084.9	177.5	9590.3	9837.6
2006/07	10734.3	188.2	10168.4	10451.4
2007/08	*11425.6*	202.2	*10924.9*	*11175.2*

Source: Central Bureau of Statistics, 2005b; Ministry of Finance, 2010.

Appendix 3 Conversion factor to compute adult equivalents

Age group	Adult equivalence		Age group	Adult equivalence	
	Male	Female		Male	Female
Under 1 Year	0.33	0.33			
1-1.99	0.46	0.46	12-13.99	0.96	0.84
2-2.99	0.54	0.54	14-15.99	1.06	0.86
3-4.99	0.62	0.62	16-17.99	1.14	0.86
4-6.99	0.74	0.70	18-29.99	1.04	0.80
7-9.99	0.84	0.82	30-59.99	1.00	0.82
10-11.99	0.88	0.78	60 and over	0.84	0.74

Source: Gamba, 2005.

Appendix 4 Academic and professional profile of the author

Academic and professional profile of the author

Personal Data

Name:	Niraj Prakash JOSHI
Nationality:	Nepalese
Sex:	Male
Date of Birth:	March 9, 1978
Home Address:	60, Pragatipath, Bharatupur Municipality-3, Chitwan, Nepal.
Email:	nirajpjoshi@hotmail.com; niraj_2008@yahoo.com

Academic/professional qualification

Academic qualifications

Masters of Art majoring in Agricultural Economics/Rural Economics, September 2008, Graduate School for International Development and Cooperation, Hiroshima University, Japan.

Masters of Agricultural Science majoring in Agricultural Economics, July 2004, Institute of Agriculture and Animal Science, Tribhuvan University, Nepal.

Bachelor of Agricultural Science majoring in Agricultural Economics, July 2002, Institute of Agriculture and Animal Science, Tribhuvan University, Nepal.

Professional qualifications

Postgraduate Courses on Building Resilience to Climate Change, Spring 2011, The University Network for Climate and Ecosystems Change Adaptation Research (UN-CECAR), Institute for Sustainability and Peace, United Nations University Center, Tokyo, Japan

Summer Course 2010 entitled Development within Low Carbon World: Participatory Approaches in Planning and Implementing Climate Change Policies Jointly organized by Global Environment Leader Education Program for Designing Low Carbon Society, Graduate School for International Development and Cooperation, Hiroshima University and SEAMEO BIOTROP Campus, Bogor Agricultural University, Indonesia from August 5 to 13, 2010.

Global Environment Leader Education Program for Designing Low Carbon Society, Graduate School for International Development and Cooperation, Hiroshima University.

Training on MDGs-Needs Assessment: Resource Costing and Information Requirement Jointly Organized by South Asian Network for Development and Environmental Economics and Nepal Forum of Environmental Journalists form 10-11 November 2004 at Kathmandu, Nepal.

Short course on Environmental and Resource Economics jointly organized by South Asian Network for Development and Environmental Economics and World Bank Institute from 30th Oct to 17th Nov 2003 at Bangkok.

Training on <u>Social Mobilization and Community Development</u> held at Institute of Agriculture and Animal Science (IAAS) jointly organized by IAAS and UNDP from 17th August to 8th Dec 2003 at IAAS, Rampur Chitwan, Nepal.

<u>Work experience</u>

April 2009 – September 2011 Research Assistant, Graduate School for International Development and Cooperation, Hiroshima University, Japan.

April 2006 – March 2009 Teaching Assistant, Graduate School for International Development and Cooperation, Hiroshima University, Japan.

June 2004 – September 2005 Lecturer, Institute of Agriculture Science, Tribhuvan University, Nepal

<u>Awards and Scholarships</u>

<u>Hiroshima University Excellent Student Scholarship 2010</u>, Hiroshima University, Japan.

<u>Hiroshima University Excellent Student Scholarship 2007</u>, Hiroshima University, Japan.

<u>Gold Medal (Nepal Biddya Bhushan)</u> for securing the highest score in Masters of Agricultural Science (Agricultural Economics) Institute of Agriculture and Animal Science, Tribhuvan University, Nepal.

<u>Japanese Government Scholarship</u> to pursue PhD Degree (2008-2011) at Graduate School for International Development and Cooperation, Hiroshima University, Japan.

<u>Japanese Government Scholarship</u> to pursue Master's Degree (2006-2008) at Graduate School for International Development and Cooperation, Hiroshima University, Japan**.**

<u>Japanese Government Scholarship</u> to pursue Research on <u>Food Self-sufficiency situation of Nepal</u> (2005-2006) at Graduate School for International Development and Cooperation, Hiroshima University, Japan.

<u>Merit scholarship</u> award during Bachelor of Agricultural Science, Institute of Agriculture and Animal Science (IAAS), Tribhuvan University, Nepal.

<u>Publications</u>

Refereed journals

<u>Joshi, N. P.</u>, Maharjan, K. L., and Piya, L. 2011. Effect of climate variables on yield of major food crops in Nepal: A time-series analysis. *Journal of Contemporary India Studies: Space and Society*. Vol. 1: 19-26. [Available   at http://ir.lib.hiroshima-u.ac.jp/metadb/up/kiyo/hindas/J-ContempIndiaStud-SpaceSoc-HiroshimaUniv_1_19.pdf]

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Maharjan, K. L., and <u>Joshi, N. P.</u> 2011. Determinants of household food insecurity in Nepal: A binary logistic regression analysis. *Journal of Mountain Studies*. Vol. 8(3): 403-413 [Abstract available at http://www.springerlink.com/content/mp61830731139ww3/]

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Piya, L., Maharjan, K. L., <u>Joshi, N. P.</u>, and Dangol, D. R. 2011. Collection and marketing of non-timber forest products by the Chepang community in Chitwan district of Nepal. *Journal of Agriculture and Environment*, Vol. 12: 10-21. [Available at http://www.moac.gov.np/geed/art2.pdf]

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Iamtrakul, P., <u>Joshi, N. P.</u>, Solikin, A., Rugayah, N., Situmorang, J. and Djatna, T. 2011. "Promoting waste-to-energy program for BRT Project based on participatory research approach: A case of used cooking oil in Bogor City, Indonesia" *Journal of International Development and Cooperation (Special Issue)*, Vol. 17 (3): Forthcoming.

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Thesis

Joshi, N. P. 2008. Poverty and food insecurity analysis in Far Western Hills of Nepal: A case of Baitadi district. Unpublished M. A. Rural Economics Thesis, Graduate School for International Development and Cooperation, Hiroshima University, Japan.

Joshi, N. P. 2004. Production and marketing of rice in different Development Regions of Nepal. Unpublished, M. Sc. Ag. Thesis. Tribhuvan University, Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal.

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Maharjan K. L., and <u>Joshi. N. P.</u> "Determinants of household food security in Nepal: A binary logistic regression analysis". *58th Annual Meeting of the Association of Regional Agriculture and Forestry Economics (ARFE)*, 24th to 26th October, 2008, Kobe University, Kobe, Japan.

Maharjan, K. L., and <u>Joshi, N. P.</u> "Assessment on food self-sufficiency situation and food security situation in Nepal". *The 56th Annual Meeting of the Association of Regional Agriculture and Forestry Economics (ARFE)*, October 27th to 29th, 2006, St. Andrew's University, Osaka, Japan.

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