

**Agriculture in Trans-Himalayan Sikkim in
Thangu and Adjoining Areas:
Issues and Challenges**

A Dissertation Submitted

To

Sikkim University



In Partial Fulfilment of the Requirement for the
Degree of Master of Philosophy

By

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February 2017

Dedicated to...

Late Azhoo Doko (Grandpa)

DECLARATION

I, Chador Lachungpa, do hereby declare that the subject matter of the dissertation entitled “**Agriculture in Trans-Himalayan Sikkim in Thangu and Adjoining Areas: Issues and Challenges**” is the record of work done by me, that the contents of this dissertation did not form basis of the award of any previous degree to me, and wherever contribution of others are involved, every effort is made to indicate this clearly, with due reference to the literature and acknowledgment, and that the dissertation has not been submitted by me for any research degree in any other University/Institute.

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This is to certify that the dissertation entitled “**Agriculture in Trans-Himalayan Sikkim in Thangu and Adjoining Areas: Issues and Challenges**” submitted to Sikkim University in partial fulfilment of the requirements for the degree of Master of Philosophy in Geography is the result of bonafide research work carried out by **Mr. Chador Lachungpa** under my guidance and supervision. No part of the dissertation has been submitted for any other degree, diploma, associateship and fellowship.

All the assistance and help received during the course of the investigation have been duly acknowledged by him.

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ACRONYMS

ASTER	: The Advanced Spaceborne Thermal Emission and Reflection Radiometer
GDEM	: Global Digital Elevation Model
HKH	: Hindukush Himalaya
GPS	: Global Positioning System
GIS	: Geographical Information System
NASA	: National Aeronautic and Space Administration
USGS	: United States Geological Survey
ITBP	: Indo Tibetan Border Police

Chapter 1

Introduction

1.1. Introduction

Agriculture started at least 10,000 years ago, but no one knows for sure how old it is. The development of farming gave rise to the Neolithic Revolution whereby people gave up nomadic hunting and settled in what became cities¹. The gatherers enjoy a more orderly social existence than the hunters, and when they acquire the skills of cultivation, potentially they enjoy better opportunities for leisure and the acquisition of civilization. Cultivation is also economically more productive than pastoralism, since animals are inefficient converters of vegetable matter into food (Zvelebil, et.al, 2011).

The origin of agriculture is seen as a long-term process of fundamental social and economic significance. The consequences of the origins and early development of agriculture cannot be overestimated. They profoundly changed the operation of human communities within the last 10000 years. These changes included an increase in population density, the greater survivorship of infants in the early stages of farming (Zvelebil, et.al, 2011).

There is more than one bottleneck hampering the productivity of mountain agriculture wherein infrastructure can be a crucial point. Improved roads, for example, will enable many farming families in mountainous regions to switch to more productive farming system. However, mountain agriculture is not only challenged by

¹ The Neolithic revolution was the first agricultural revolution—the transition from nomadic hunting and gathering communities and bands to agriculture and settlement. It occurred in different prehistoric human societies at different times. Most societies changed 9–7 thousand years ago (Wikipedia, accessed on 13th April, 2016).

opportunities, but also by threats. Global warming is considerable threat for the viability of mountain agriculture (Mann, 2013).

In developing and transition countries, mountain people have reduced possibilities. Their lack of good roads increases transaction costs, the steeper slopes on the farmland add to the cost of maintaining agricultural systems. In addition, they are disadvantaged owing to low current investment in, and less innovation adapted to, mountain farming conditions (Hurni H, 2014). The benefits of mountain farming go far beyond the mountain regions and contribute to societies at large. Globally, mountains provide freshwater to half of the world's population. Mountains are also reservoirs of global biodiversity including agro-biodiversity and mountain farmers have been the custodians of this genetic richness for centuries.

The mountain farming is undergoing rapid transformation, due to both internal and external drivers such as population growth, economic globalization and market integration, penetration of urban lifestyles, outmigration of men and youth, and the resulting increased workload for women who remain behind, and increasing claims on land for conservation and large-scale resource extraction, such as mining (Kohler, 2014). These have contributed to higher pressure on local resources, unsustainable practices in land use, disintegration of local customs and traditions, and increased vulnerability to global change.

The majority of mountain households in the Hindu Kush-Himalayas (HKH) operate mixed crop-livestock farming systems. Production of food grain crops, horticultural and cash crops, and livestock are 3 integral components of mountain farming households. Changes have been taking place over the years with respect to cropland use, land resource allocation, production and productivity of cereal food grain crops,

horticultural crops, and livestock structure and composition (Tulachand, 2001). A better understanding of these changes can have important implications for development of sustainable mountain agriculture.

The present study is an attempt on the agricultural scenario of Trans Himalayan region of Sikkim. Before entering into the Trans Himalayan agriculture in particular, one has to understand what is Trans Himalaya? However, the study has given below a segregation of Himalaya wherein one can comprehend the concept of Trans Himalaya in particular.

1.2. Agriculture in Trans-Himalaya

The Himalayan Ranges immediately to the north of the The Great Himalayan Range are called the Trans Himalayas. Most of the part of this Himalayan range lies in the Tibet and hence also called Tibetan Himalaya. With an average elevation of 3,000 mt above mean sea level, the Trans Himalayas stretches for a distance of about 1,000 km in east-west direction and its average width varies from 40 km at the eastern and western extremities and about 225km in the central part. The Zaskar, the Ladakh, the Kailash and the Karakoram are the main ranges of the trans Himalayan system².

The agriculture in Trans Himalayan region is different from other mountainous region or one can classify hill agriculture and Trans Himalayan agriculture within a domain of mountain agricultural system. However, the Trans Himalayan regions are basically of cold desert where limited crops are grown and it is based subsistence on farming.

² <http://inindiaaa.blogspot.in/2013/07/the-trans-himalayas-and-eastern-or.html>, accessed on 28th March 2016

1.3. Theoretical Framework

To understand the structure of Trans Himalayan agriculture in Sikkim the study has immersed in a theoretical framework pertaining to ‘human ecology’. Human ecology is the study of the interactions of humans with their environments, or the study of the distribution and abundance of humans. Ecology is usually defined as the study of interactions of organisms with their environments and each other. More pointedly, it can be defined as the study of the distribution and abundance of organisms.

Although humans are part of the ecosystem, it is useful to think of human - environment interaction as interaction between the human social system and the rest of the ecosystem (Figure 1.1).

The social system is everything about people, their population and the psychology and social organization that shape their behavior. The social system is a central concept in human ecology because human activities that impact on ecosystems are strongly influenced by the society in which people live.

Values and knowledge - which together form our worldview as individuals and as a society - shape the way that we process and interpret information and translate it into action. Technology defines our repertoire of possible actions.

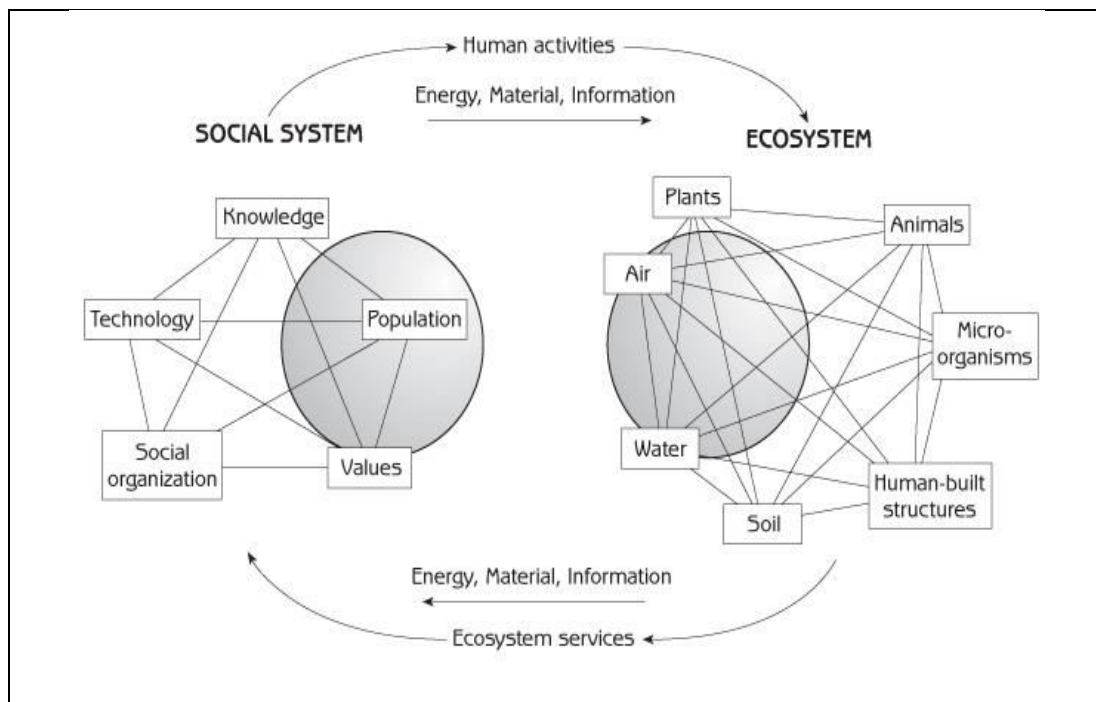
Social organization, and the social institutions that specify socially acceptable behaviour, shape the possibilities into what we actually do. Like ecosystems, social systems can be on any scale - from a family to the entire human population of the planet.

The ecosystem provides services to the social system by moving materials, energy and information to the social system to meet people’s needs. These ecosystem services include water, fuel, food, materials for clothing, construction materials and recreation.

Movements of materials are obvious; energy and information are less so. Every material object contains energy, most conspicuous in foods and fuels, and every object contains information in the way it is structured or organized. Information can move from ecosystems to social systems independent of materials.

A hunter’s discovery of his prey, a farmer’s observation of his field, a city dweller’s assessment of traffic when crossing the street, and a refreshing walk in the woods are all transfers of information from ecosystem to social system.

Figure 1.1: Interaction of the human social system with the ecosystem



Source: M. Sontag Suzanne (1993: Page 25)

1.3.1. Human Ecology Theory

Theories of human interaction should provide a way of making sense of events that have happened in the past, and then allow us to make predictions about what may happen in the future. Human ecology theory is a way of looking at the interactions of humans with their environments and considering this relationship as a system. In this theoretical framework, biological, social, and physical aspects of the organism are considered within the context of their environments.

Human ecological theory is probably one of the earliest theories of the family and yet, it also contains many new and evolving elements that have emerged as we have begun to realize how the natural and human created environments affect our behavior, and how individuals and families in turn, influence these environments. In human ecology, the person and the environment are viewed as being interconnected in an active process of mutual influence and change.

1.3.1.1. The Origins of Human Ecological Theory

The origin of the term ecology comes from the Greek root *oikos* meaning "home." As a result, the field of home economics, now often called human ecology, has produced much of the contemporary research using this theoretical perspective.

Margaret Bubolz and M. Suzanne Sontag (1993) attribute the concept of an ecological approach to the work of Aristotle and Plato, and then to the evolutionary theory of Darwin. They trace the word ecology to Ernst Haeckel, a German zoologist who, in 1869, proposed that the individual was a product of cooperation between the environment and organismal heredity and suggested that a science be developed to study organisms in their environment. Early home economists were major proponents

of this theory as their field developed in the early twentieth century applying various disciplines to the study of the family. The theory has since been used by sociologists, anthropologists, political scientists, and economists. This work continues, with the human ecological framework being a major perspective in research and theory development in the twenty-first century.

As Sontag and Bubolz (1996) discuss, embedded in the natural and human-built environments is the social-cultural environment, which includes other human beings; cultural constructs such as language, law, and values; and social and economic institutions such as our market economy and regulatory systems.

The ecosystem interacts at the boundaries of these systems as they interface, but also can occur within any part of an ecosystem that causes a change in or acts upon any other part of the system. Change in any part of the system affects the system as a whole and its other subparts, creating the need for adaptation of the entire system, rather than minor attention to only one aspect of it (Sontag, et.al, 1996).

Hence, a basic premise of a human ecological theory is that of the interdependence of all peoples of the world with the resources of the earth. The world's ecological health depends on decisions and actions taken not only by nations, but also by individuals and families, a fact that is increasingly being realized.

Although the concept of a family ecosystem is not a precise one, and some of the terms have not been clearly and consistently defined, a human ecological theoretical perspective provides a way to consider complex, multilevel relationships and integrate many kinds of data into an analysis. As new ways of analyzing and combining data from both qualitative and quantitative dimensions of interconnected

variables develop, this theoretical perspective will become more precise and continue to enhance understanding of the realities of family life.

1.4. Literature Review

Agriculture is by far the most important of the world's economic activities; it uses one-third of the total land surface and employs 45 per cent of the working population. Yet the study of agriculture receives relatively little attention from geographers. In Britain and the USA only 2 per cent of the employed population are engaged in agriculture, and it contributes a similarly small proportion to the national income (Grigg, 1984).

In many developing countries, however, over half the population depends upon farming for a living and it is the most important contributor to the national income. But even in developed countries agriculture is more important than these statistics suggest, for between 12 per cent and 30 per cent of disposable income is spent on food, while agriculture is the major user of land.

Agricultural geography seeks to describe and explain spatial variations in agricultural activity over the earth's surface. The heart of this task is to explain the great diversity of agriculture. It has been estimated that there are over 250 million farmers in the world. Between them they grow many different crops—at least 1000 species are in use—and they raise these crops in a variety of ways (Grig, 1984).

1.4.1. Mountain Agriculture in Global Phenomena

From a global perspective, mountain farming is family farming. Mountain areas, with their dispersed patches of useable land at different altitudes with different

climates and with their often highly fragmented landscapes and narrow limits for mechanization, are most efficiently and effectively managed by family farms.

According to the Zimmerer, 1992, “ the fate of agricultural biodiversity varies among the native crops produced in a mountainous region. Four native crops (potatoes, maize, *ulluco*, quinoa) cultivated in the southern Peruvian sierra demonstrate different patterns of cultivar loss and cultivar maintenance. Contingent social, economic and environmental conditions in mountain agriculture shape the distinct fates befalling the cultivars in each crop”.

Zimmerer further states that the three sets of specific conditions contribute to differences in the patterning of cultivar loss and maintenance: (1) proximate conditions in the local peasant economy, particularly access among agricultural households to land, labor, and capital, and changes in the availability and quality of the three endowments; (2) the social and cultural value of the crop in the local diet and cuisine; and (3) the bio geographic patterning of cultivars. Maintenance of cultivars currently marks the *ulluco* and quinoa crop as well as many potato and maize types. Cultivar loss besets the fast maturing potato *S. phureja* and the slow-maturing maize types. To incorporate variable in situ crop-conservation programs in to development planning for montane regions requires thoroughly assessing the contingent conditions for continued production.

Alteiri, 2011 asserts that “despite the increasing industrialization of agriculture, the great majority of the farmers in the Andes are peasants, or small scale producers. They still farm the valleys and slopes with traditional and subsistence methods. After centuries of cultural and biological evolution, traditional farmers have developed and inherited complex farming systems, adapted to the local conditions”.

These have helped them to sustainably manage harsh environments and meet their subsistence needs, without depending on mechanization, chemical fertilizers, pesticides or other technologies of modern agricultural science.

Kohler, 2013 states that the family farming in mountains is as diverse as the myriad mountain landscapes of the world, but at the same time, there are also commonalities. For example, mountain family farms are usually not the centers of national production in terms of quantity, with the exception of tropical mountain regions. Most of their production is for family consumption, playing a key role in ensuring household food security. In addition, family farms in mountains help shape mountain landscapes, providing ecosystem services that are vital for development far beyond mountain areas. These services include provision of freshwater, disaster risk reduction, preservation of biodiversity including agro-biodiversity, and space for recreation and tourism.

According to Kohler, 2013 the terraced landscapes found in all major mountain regions of the world are the most spectacular testimony of such reproductive investment. In addition, family farming in mountains largely operates with low external inputs, most often owing to circumstances rather than choice, meaning that mountain farmers often do not have the means, in terms of physical access or finance, to invest in external inputs such as fertilizer, plant and animal protection chemicals, let alone machinery.

One of the results of marginalization is widespread poverty. Around 40% of mountain populations in developing and transition countries – about 300 million people – are food insecure, with half of them suffering from chronic hunger (Kohler, 2013).

In response, family farming in many mountain areas is increasingly affected by outmigration. Although those who leave can provide remittances, it also means heavier workloads for those remaining – women, children and the elderly. Limited availability of land that often has low productivity, lack of recognized land tenure rights and population pressure are all elements that can contribute to unsustainable use of mountain natural resources.

1.4.2. Mountain Agriculture in Himalaya

Schroeder, 1985 states that the agriculture in the hills and mountains of Nepal includes few of the high-yielding crop varieties, chemical fertilizers pesticides, effective water control, and integration into major commodity markets which characterize agriculture in most the world. Indigenous agriculture maintains a subsistence orientation in which a large proportion of the population is engaged agricultural work and almost all production is for local use.

Schroeder, 1985 further states that the rapid population growth induces intensification of subsistence in which diminishing return on labour is traded for increased production. These processes have also affected cropping land-use strategies, resulting in major environmental and social changes. Although the specific agricultural changes taking place in rural Nepal are unique and conditioned by culture and history, the logic of agricultural intensification and its effect on village communities may be similar in Himalayan Nepal.

Singh, 1989 contributed some academic work on Ladhak whereby he states that the Ladhak has traditional self sustained agricultural system. In addition, important crops grown in the region is included grim (naked barley), wheat and peas.

It may be pointed out that peas are grown not as a vegetable but are used for making *tsampa (sattu)*. As expected, crops here were grown mainly for self consumption. It is only recently that some vegetable crops have produced to meet the demand of the army and the tourists. It may be mentioned that the region is highly suitable for the vegetable cultivation. Market facilities in places like Leh and Kargil have also played an important role in vegetable growing. Till the early 1960s, the farmers had no place to sell vegetables nor could they buy food as there was no market.

Nusser, 1996, states that the Hindukush, Karakorum, and northwest Himalaya the struggle for subsistence by mountain farmer is based on agriculture and animal husbandry in the form of mixed mountain agriculture. Traditionally, this strategy of resource management was sustainable, but increases of population and livestock as well as external innovations are rapidly effecting change throughout the region. He further continues that the results of this development vary according to the potential for off-farm employment and access to modern infrastructure in each valley.

In Hunza, a approximately 100 km north of Rupal, the utilization of alpine pastures decreased following a significant reduction of the male workforce and, after the introduction of cash crops and fodder cultivation, cropping patterns changed. Agriculture in the Rupal Valley during the last 20 years is characterized by an increase in animal husbandry and pastoral movements (Nusser, 1996).

Tulachand, 2001, informs that the area under food grain crops has not increased, their yields have not declined as much as is often perceived. In some cases, crop productivity has increased. This evidently implies that mountain farmers are maintaining productivity of food grain crops for food security reasons.

According to Tulachand, 2001, increasing trends in crop diversification toward horticultural and cash crops. Present trends in rapid expansion of areas under these crops indicate the growing importance of horticultural and cash crops in mountain farming systems and the household economy across the Hindu Kush Himalaya. These trends have positive implications for the future development of mountain agriculture in terms of harnessing mountain niches and comparative advantages. In the livestock sector, there is a general decline in the cattle population across the HKH. Trends indicate the possibility of greater development of small holder dairies with improved buffaloes in the Himalayan subtropics.

Although there is also off-farm employment, it is more likely that animal husbandry will remain an important part of the agro-pastoral economy and there is potential for its commercialization.

As according Thulachan, 2001, the majority of mountain households in the Hindu Kush-Himalayas (HKH) operate mixed crop-livestock farming systems. Production of food grain crops, horticultural and cash crops, and livestock are 3 integral components of mountain farming households''. Changes have been taking place over the years with respect to cropland use, land resource allocation, production and productivity of cereal food grain crops, horticultural crops, and livestock structure and composition.

Jindal, 2003 states the issues on mountain farming have attracted attention in the last couple of years. A body of literature is now available for understanding the problems faced by the mountain agriculture. One of the important conclusions that can be drawn from the literature available on hill farming is that hill agriculture faces

serious threat and is becoming unsustainable in most part of the regions in this country and abroad.

The unsustainability indicator relate to resource base, production flow and changes in resource management practices. There has been a degradation in the natural resource base which has, inter alia, contributed to falling yield levels, increase in drudgery, especially of women, in terms of time required for collecting fuel and fodder, low availability of capital to be invested, and so on (Jindal, 2003).

M.S Kanwar, 2011 says that the production of tomato is limited by harsh climate and a short growing season in the trans-Himalayan Ladakh region of India. The performance of five tomato genotypes was compared under polyhouse and open field conditions. Moreover the study revealed that the performance of all tested tomato genotypes is far superior in the polyhouse, as compared to open field conditions, for all the considered characters. 'Shivalik' performed best with respect to yield characters followed by Tusa Rohini' under polyhouse conditions. However, in the open field, Tusa Rohini' showed the highest values, followed by 'Shivalik'. Cultivation of tomato under the polyhouse produced 136.12% more yield per ha and 188.93% more fruits per plant compared to open field cultivation. Therefore, tomato cultivation under protected conditions is advised for Ladakh growing conditions, employing specific polyhouse responsive varieties.

The list of above mentioned literatures clearly indicates the nature of mountain farming with especial reference to trans Himalayan agriculture. Moreover the mountain farming is based on family farming where most of the family members are directly involved in agricultural practice. It is also been documented that the majority

of agriculture in mountain areas are characterized by the self subsistence agriculture. Mixed form of agriculture is also very common in mountain areas like Himalayas.

However, producing crops and livestock in mountain environments can present many difficult challenges. Compared to surrounding lowlands, highland farmers contend with shorter growing seasons, greater distance to markets, and the ever-present challenge posed by gravity. The soils are usually less favorable, and the weather more prone to extreme events that can lead to sudden disaster. These and other issues are presented and analyzed in this timely volume on the future of mountain agriculture.

1.5. Research Problem

The study has attempted to bring forth the nature and pattern of mountain farming in Sikkim Himalaya with major focus on Trans-Himalayan agriculture. Ever since the available literature on agriculture in Sikkim Himalaya doesn't narrate the explicit account of mountain farming with respect to alpine and trans Himalayan agriculture of Sikkim. However, the study will deal with Thangu and its peripheral villages.

The current agricultural system in the study area doesn't fit in any of the thirteen agricultural typology of the world as presented by D Whitlesey. However, the agriculture in the study area partly reflects the 'mixed farming' within agricultural typology. It is the result of the combination of numerous factors such as physical, economic, political and social. Holdings are of variable size. The farms have individual and family ownership and are operated by family labor.

In this region mixed form of agricultural practice takes place. Moreover the nature of agriculture in this region can be seen as subsistence farming. In terms of livestock, one can see an existence of transhumance practice. Though the entire regions seems to be backward, recent developments and certain socio-cultural factors have brought about significant changes in the traditional land use. The present study has attempted to understand the process of interaction as reflected by land use particularly in terms of agriculture and to make sense of the relationship that man evolved nature by developing certain type of agricultural system.

1.6. Study Area:

Thangu is a village in Chungthang sub-division, North Sikkim district, Sikkim, India. The Ministry of Home Affairs has given it a geographical code of 260865. GPS renders an information that the *Thangu* is located at $27^{\circ} 53' 2''$ North and $88^{\circ} 32' 6''$ East and it is however 30 kms beyond Lachen lies at an altitude of 12781ft. Tree lines disappear at Thangu and start a zone that can be compared only with the unreachable terrain in Tibetan plateau.

The study has witnessed that the area has summer settlement which means a very less number of people remain in the area during winter season. An unstructured interview was conducted to understand the mode of agricultural system in the area. As per the available respondent, the study has documented the mode of agricultural system wherein the agricultural practice in the area is well regulated according to the norms of *Lachen Dzumsa*. The *Peepon* pronounces the time agricultural operation every year. In such cases, farmers are not allowed to cultivate crops in their own field without the go-ahead from *Peepon* of *Lachen Dzumsa*. This signifies the effectiveness of local administration and the head of the *Lachen Dzumsa*.

The agriculture in this region is based on subsistence farming and the well cherished crops are potato, and some green vegetables. The agricultural practice in this region is well regulated according to the norms of *Lachen Dzumsa* wherein the *Peepon* will proclaim the right the season for the cultivation of crops. In such cases, farmers are not allowed to cultivate crops in their own field without any orders from *Peepon* of *Lachen Dzumsa*. This signifies the esteem of local administrative, the *Dzumsa* and its *Peepon*.

1.7. Sample size:

As per 2011 census, there are 65 households comprising 1294 of its population *Thangu* has a large military base as the place is close to the Indo-China border and this is the last civilian settlement in Northern most part of Sikkim. However, the field study revealed different story that Thangu alone does not have 65 households but by putting household of its transit zone and adjoining it somehow reaches the figure of 2011 Census.

The study has taken the entire population in the context of sample size of the study. The study has covered 35 households from Thangu and its transit zone. These were the only available household during field survey. The surveyed villages were *Thangu*, Kalep, Samdong, Thangchung, and Chopta. In addition, Muguthang region as an adjoining area of Thangu has 18 household of Dokpa Community and the study has extracted generalized information through Focus Group Discussion and interview from available respondents at the time of field visit. The interview and FGD were conducted with 6 *Dokpas*.

1.8. Objectives

- To examine the nature of Trans-Himalayan agriculture in Sikkim Himalaya.
- To identify the issues of mountain farming triggered by environment, economic and political factors in the study area.

1.9. Research Questions:

- What have been the level of the agricultural operations in the study area?
- What are the basic inputs of agriculture?
- Has the area experienced changes in agricultural pattern over a decade or so?
If so, what has been the nature of it?

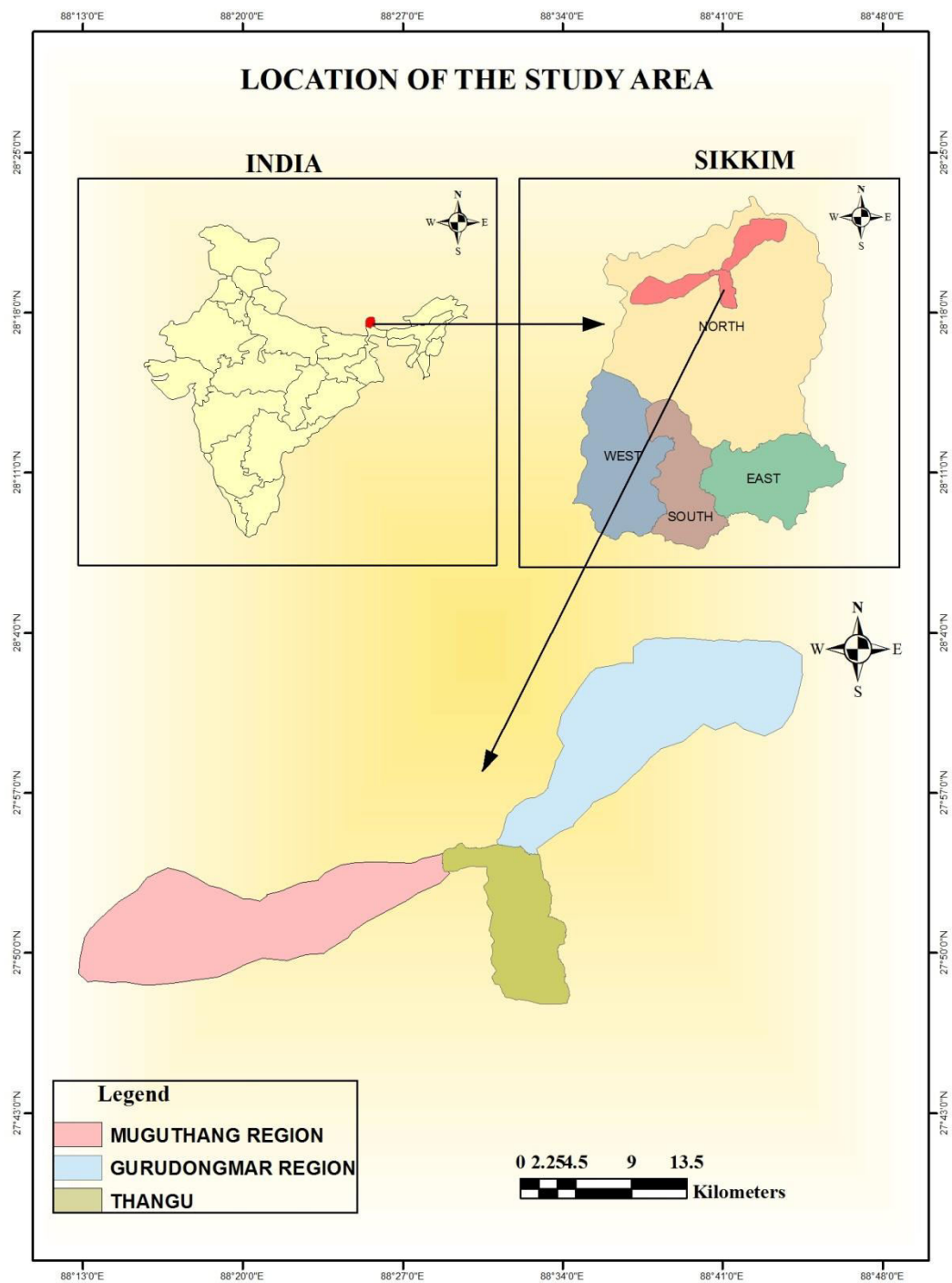
1.10. Data-base and Methodology

The study has applied a mixed method analysis which is an amalgam of both quantitative and qualitative approach which includes primary and secondary data. The study has conducted household survey, interviews and Focus Group Discussion. Following are the secondary data employed in the study:

- Gazetteer of Sikkim, 2013
- Information Public Relation, Government of Sikkim, 2013, 2014, 2015.
- Sikkim Statistical Journal 2002 and 2013, published by Department of Economics Statistical Monitoring Evaluation, Government of Sikkim, 2013

In qualitative method, the research study has conducted an interviews and focus group discussion through open ended as well as semi structured questionnaire. Despite of interviews, the focus group discussion has given more emphasis on research. Focus Group Discussion had a certain morphology comprising group member, moderator, and researcher.

Map.1.1.



Source: Google Earth Pro, Imageries 2015

In addition to FGD, the selection of moderator has been done after identifying the active respondent while conducting pilot survey. The group members has not exceeded more than five individuals excluding moderator and researcher while conducting FGD. Three FGDs were conducted during field visit in Thangu, Yathang, Chopta Valley and Kala Patthar. The nature of agriculture, climate pattern, type of crops and role of local governing system in the study area were mainly discussed while conducting FGD. Seasonal Calendar as perceived by the local people and Crop Calendar of the study area have been done through FGD.

In quantitative approach, scientific mapping and calculation were done as the qualitative approach was not enough for the study. Hence, following are the prominent sources used in the study:

- Google Earth Pro
- United States Geological Survey (USGS)
- Advanced Space-borne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) Version 2

The boundary of the study area has been demarcated as according to the water-shed ridge-line following to imageries from *Google Earth Pro*. Therefore, with the help of above mentioned sources, different available imageries pertaining to the study area were downloaded. Land cover of the study area has been shown through digitized map with their calculated values. In order to prepare maps on land cover and drainage, imageries were downloaded from Google Earth and these imageries were digitized and georeferenced using Arc GIS 10.2 version.

Land use and land cover mapping and total length of the river were calculated from the downloaded imageries using Arc GIS. In addition, ASTER GDEM³ has been used for preparing maps on elevation and slope of the study area.

Drainage mapping has been with a help of downloaded imageries from *Google Earth*. Strahler stream ordering has used in drainage mapping. It is a method for assessing river size and complexity based on the number and hierarchical relationship of tributaries (Pierson, 2008).

While determining the stream order, perennial and intermittent streams have been included. The headwater stream (a stream with no tributaries) is considered a 1st order stream. When two 1st order streams join, a 2nd order stream is formed. When two 2nd order streams join, a 3rd order stream has formed, and so on. The ordering continued downstream within a drainage network. Smaller or lower order streams entering the network has not changed the order of larger or higher order streams. For example, a 3rd order stream entering a 4th order stream has not changed the order of the 4th order stream. Hence, the highest stream ordering of the study area is 3rd order.

1.11. Data Analysis

- Representation of data analysis has been depicted through table, graphs and maps.

³ The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on the National Aeronautic and Space Administration (NASA) spacecraft Terra is capable of collecting in-track stereo using nadir- and aft- looking near infrared cameras. The ASTER GDEM covers land surfaces between 83N and 83S and is comprised of 22,702 1 x 1 tiles. Tiles that contain at least 0.01% land area are included. The ASTER GDEM is distributed as Georeferenced Tagged Image File Format (GeoTIFF) files, and in geographic coordinates (latitude, longitude).

- Land use pattern of the study area has been shown through digitized map.
- Elevation and slope of a region has been shown through digitized map.

1.12. Organization of Materials

- **Chapter 1:** This chapter talks about the mountain agriculture with especial focus on Trans-Himalaya. This chapter is also followed by objectives, research questions and data base and methodology of the study.
- **Chapter 2:** This chapter has discussed natural setting of the study area. This chapter is also supported by drainage mapping, elevation and slope mapping. wherein precipitation soil pattern of the study area.
- **Chapter 3:** This chapter has major focus on the very first objective of the study wherein the nature and mode of Trans-Himalayan agricultural practice in Sikkim has been discussed. This chapter supplemented by primary data collected through semi-structured interviews and Focus Group Discussions.
- **Chapter 4:** This chapter has discussed agriculture and allied activities in a study area. This chapter further augmented with brief discussion on nomadic lifestyle of Muguthang and Gurudongmar region.
- **Chapter 5:** Summary and Conclusion

Chapter 2

Natural Setting

2.1. Introduction

Natural setting of a region seems to be the most important on all the anthropogenic activities, especially on crop production. There is always a close link between climate and success and failure of crops in areas of harsh environment. If one can wonder through the perspective of plant response then, the temperature, water supply and light are three most important factors of climate. The important factors that control and influence the different aspects of climate are location and relief.

Natural environment of different regions provide different set of possibilities to human and it plays a significant role in the efforts of human beings to modify the various elements of environment (Warpa, 2007). It may permit modification even with low level of technological input in one region while it may restrict its appropriate utilization even with higher level of technology in another. It is difficult to quantify technological development but it can be seen in relative terms (Warpa 2007).

A kind of technology may hold importance in one region while the same may not be applicable in another region. The technical inputs those may prove to be a boon for plains may not be applicable in high mountains. Since agriculture is directly related to physical environment, thus variations in the later are bound to affect agricultural land-use. Therefore, agriculture is not only an economic activity, but also a form of applied ecological activity.

Sikkim has its own climatic peculiarities caused by its geographical location, relief and altitude ranging from 300 metre to 8598 metre above sea level and as such temperature condition vary from sub-tropical in the southern lower parts to cold desert in the snowy north (Bandhopadhyay et.al, 1998).

The whole region of the study exhibits cold climatic conditions. Since climatic factors exert mainly a regional influence on plant life, the differences in the behavior of a crop or a group of crops over extensive areas, as in a given state or a group of states, may be considered as due primarily to differences in climatic rather than soil conditions.

The summer months are cool and relatively warmer than winter months. Most of the precipitation occurs in the form of snowfall during winter months. The winter season begins from the middle of November and lasts till March-April followed by the spring that lasts up to the end of May. The next four months from June to September are summer months. October and the first half of November marks the transition phase. It is, therefore necessary to analyze the important climatic variables that govern the entire agricultural calendar of this region. These are mainly temperature and precipitation which in turn will help in assessing crop structure and productivity so that environmental constraints can be comprehended.

Nevertheless, this chapter has focused on following aspects of natural setting of Thangu and aits adjoining areas;

- Climate: to comprehend the pattern of temperature and precipitation of a study area.
- Drainage: to understand the route of drainage in study area.

- Soils: to comprehend the nature of soils in the region
- Elevation: to comprehend the variation of elevation of the region.
- Slope: to understand the varying slope pattern of the region.

2.2. Climate

On the basis of *Koppen's* climatic classification of Thangu and its adjoining areas fall within a category of 'ET' (Table 2.1.) which is relatively polar tundra type of climate. The polar tundra climate is characterized by cold winters, cool summers, and a summer rainfall regime. Annual precipitation averages less than 250 mm for most locations and most of this precipitation falls during the summer. However, *Thangu* and its adjoining areas are characterized by high mountain environment which acts as a restrictive force on technological development within the region. Apart from this, it imposes constraints on its interaction with adjacent territories from where modern development impulses could possibly penetrate the region.

The region adorn its surroundings with numerous ice capped glaciers and the entire region has a very rugged terrain. The precipitation received in the region is mostly through snowfall only. Soil temperature is identified as idsofrigid. Areas above 2700m in altitude and nearer to isofrigid. Temperature varies from 7.8°C to 17°C and rainfall varies from 821mm at *Thangu* to 1652mm at *Lachen* (Upreti, 2013). The subsistence agriculture of Trans-Himalayan Sikkim has been affected by the seasonal shift of snowfall events.

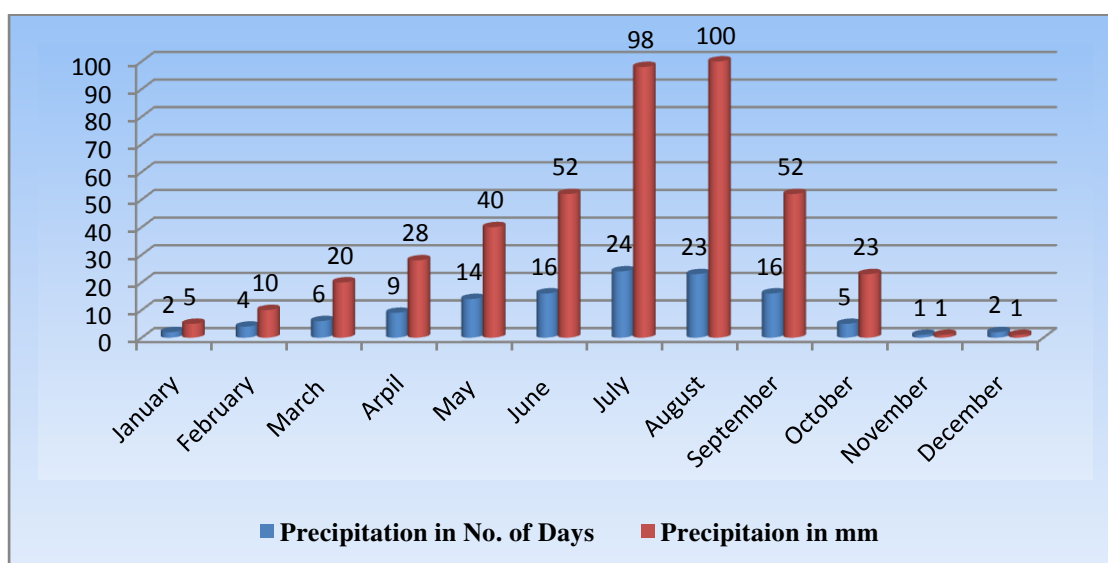
Table 2.1. Climate type of Sikkim

Types of Climate	Koppen- Geiger	Places
Humid Subtropical	<i>Cwa</i>	<i>Mangan, Sankalang, Dikchu, Makha, Legship</i>
Subtropical higland oceanic	<i>Cwb</i>	<i>Gangtok, Namchi, Gezing, Chungthang</i>
Tundra	<i>ET</i>	<i>Yumesamdong, katao, Thangu, Muguthang</i>
Warm Humid Continental	<i>Dfb</i>	<i>Phuni</i>
Oceanic	<i>Cfb</i>	<i>Hema</i>

Source: en.climate-data.org/region/779/ (Accessed on 8th August)

“Elderly farmers remarked that 20-30 years ago at Thangu, snowfall events use to be continuous for a week to 15 days. In the last 10 years, dramatic changes have been observed at Thangu where snowfall events have become untimely and occasional snowfall takes place that lasts for one to two days only. About 15 years ago, in Thangu area, first snowfall was observed normally by the end of October. Now snowfall begins only by the first or second week of November showing a shift by 15-20 days. In the last 5-8 years (2000-2010) the total snowfall in these areas has declined by almost 40%” (Sharma Ghanshyam, et.al, 2012).

Figure 2.1. Rainfall at Thangu, 2015



Source: www.meteoblue.com/en/weather/forecast/archive (Accessed on 24th October, 2016)

2.2.1. Precipitation

The amount of precipitation is largely governed by location, altitude and topography of the region. Here, most of the precipitation falls in the form of snow. Directly, it has little significance for agriculture, as entire agricultural calendar is restricted to short summer months. Indirectly, the good amount of snowfall during winter months help in productivity of agricultural produce by providing soil moisture. The entire area can rightly be called arid and semi-arid zone with intra valley variations, therefore, all cultivated land is irrigated.

Thangu received highest amount of rainfall in the month of July and August with 24 mm and 23 mm in a year of 2015 (Figure 2.1). As opposed to this, the region received lowest amount of rainfall in November and December with 1 mm and the annual rainfall record for 2015 was 430 millimeter. The average annual rainfall was 35.83 millimeter. The given rainfall and temperature data of 2015 for Thangu has been extracted through satellite data called *meteoblue*.

According to the farmers' perception, the region receives high snow fall in December, January, and February followed by low snow fall in March and first week of April (Table 2.2).

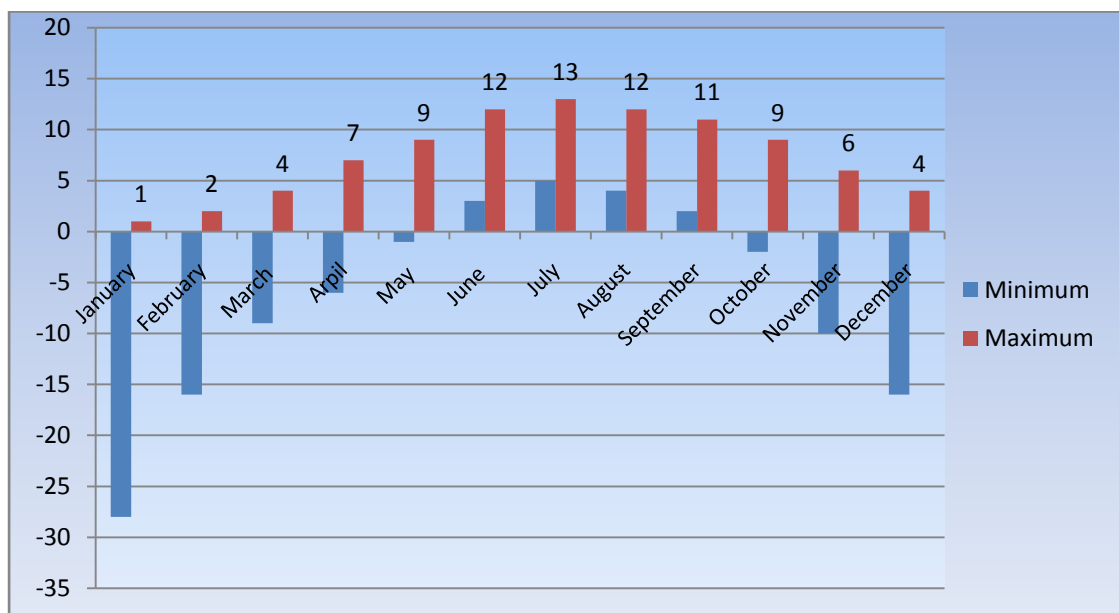
2.2.2. Temperature

In crop productivity, most of the plants have their threshold climatic requirements. Every plant species has its own minimum and maximum for its growth. Agricultural crops have been domesticated and tailored from their original state as opposed to natural vegetation. Consequently, their flexibility in terms of climatic needs is

reasonably important. In fact, temperature is the main factor which has been governing the agricultural system in the study area.

Despite of cold weather all over the year, there is a variation of temperature in a study area. The figure on temperature (Figure 2.2.) shows that January, February, and December lowest temperature category -28°C , -16°C , -16° and -10°C respectively. As opposed to it, the figure also reveals that the highest temperatures are recorded in the months of July, August and June with 13°C , 12°C and 12°C respectively.

Figure 2.2. Temperature in Degree Celsius, Thangu, 2015



Source: www.meteoblue.com/en/weather/forecast/archive (Accessed on 24th October, 2016)

Irrespective of secondary information of climate, the study has also generated minor information on prevailing temperature in the study area through people’s perception. This was done through FGD. As per people’s perception (Table 2.2), December, January and February lies in a category of highly cold months and July and August are relatively warmer months in a year.

Table 2.2.

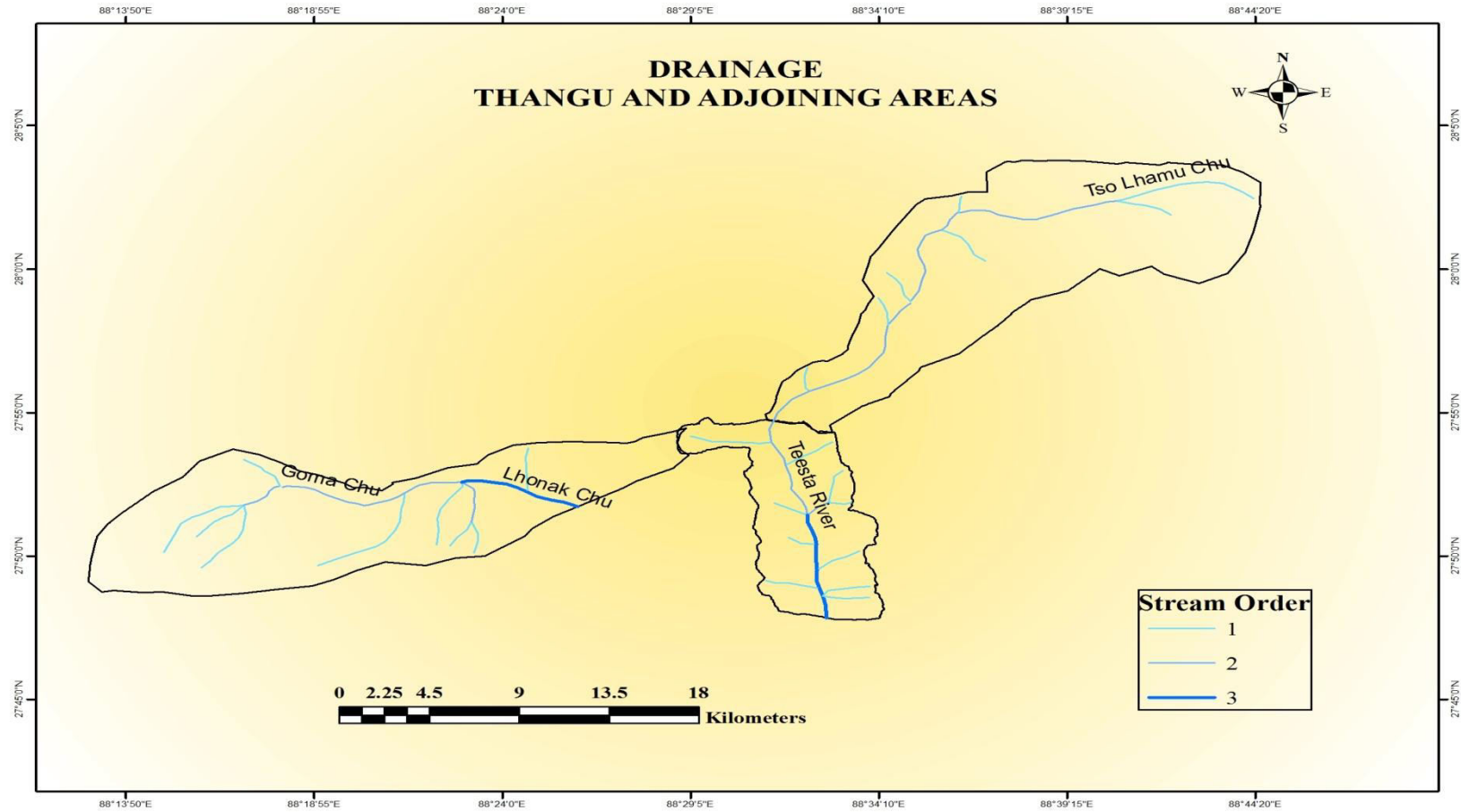
Seasonal Calendar of Thangu extracted from People’s Perceptio

SEASONAL CALENDER													
SI. NO		January	February	March	April	May	June	July	August	September	October	November	December
Rainfall	Past	*	*	*	*	*	**	**	**	*	*		
	Present		*	**	**	**	**	**	**	**	*		
Snow Fall	Past	***	** *	**								*	**
	Present	***	**	*								*	**
Warm temperature	Past					*	*	*	**	*	*		
	Present					*	*	**	**	*			
Cold temperature	Past	***	***	***	**	**	**	**	**	**	**	***	***
	Present	***	***	***	**	**	**	**	**	**	*	***	***
Dry Period	Past											*	*
	Present										*	*	*

Source: FGD conducted during field visit on 16th July, 2016

Index	*** = High
	** = Medium
	* = low

Map 2.1.



Source: Google Earth Pro, imageries 2015, accessed in 201

2.3. Drainage

The vast complex of high mountains, intermontane valleys, and plateaus produces one of the world's largest renewable supplies of fresh water. It is essential for the survival and well-being of almost one billion people, most of whom live on the surrounding plains (Bandyopadhyay and Gyawali, 1994). Teesta can be considered the most important of all the rivers in Sikkim, as it covers the entire stretch of the state. Teesta has its origin in the *Cho lhamu lake*. Near its origin, Teesta looks like a stream. However, only 100 kms down the stream, the river turns into a big river (Uprety, 2015).

As mentioned in methodological part of preceding chapter that the stream ordering has been done on the basis of *Strahler* Stream order. The Main tributaries of River Teesta originates from Gurudongmar via Thangu and Muguthang region with numerous small sources of tributaries. The total length of the river of the study area is 126 Kilometer which has been calculated in Arch GIS 10.2 version.

According to the current mapping of drainage system of the study area (Map 2.1) the prominent river that originates from Gurudongmar region are *Cho Lhamu Chu*, *Gudongmar Chu* with other minor rivers joins and flows as a beginning of Teesta river and later gets mixed up with other minor rivers such as *Chopta Chu*, *Kalep Chu* and other minor rivers at Thangu region and it continues to flow further below lower Teesta Basin. On the other hand, the important rivers that originates from *Muguthang* region are *Goma Chu*, *Zeemu Chu*, *Lhonak Chu* etc.

Goma Chu originates in North and South *Lhonak* glaciers and runs across the Valley to join *Zema Chu*. However, the major river, *Zeemu Chhu*, which originated from Muguthang region finally joins the river that originated from *Gurudonmar* region via Thangu valley and continues to flow further as *Lachen Chu*.

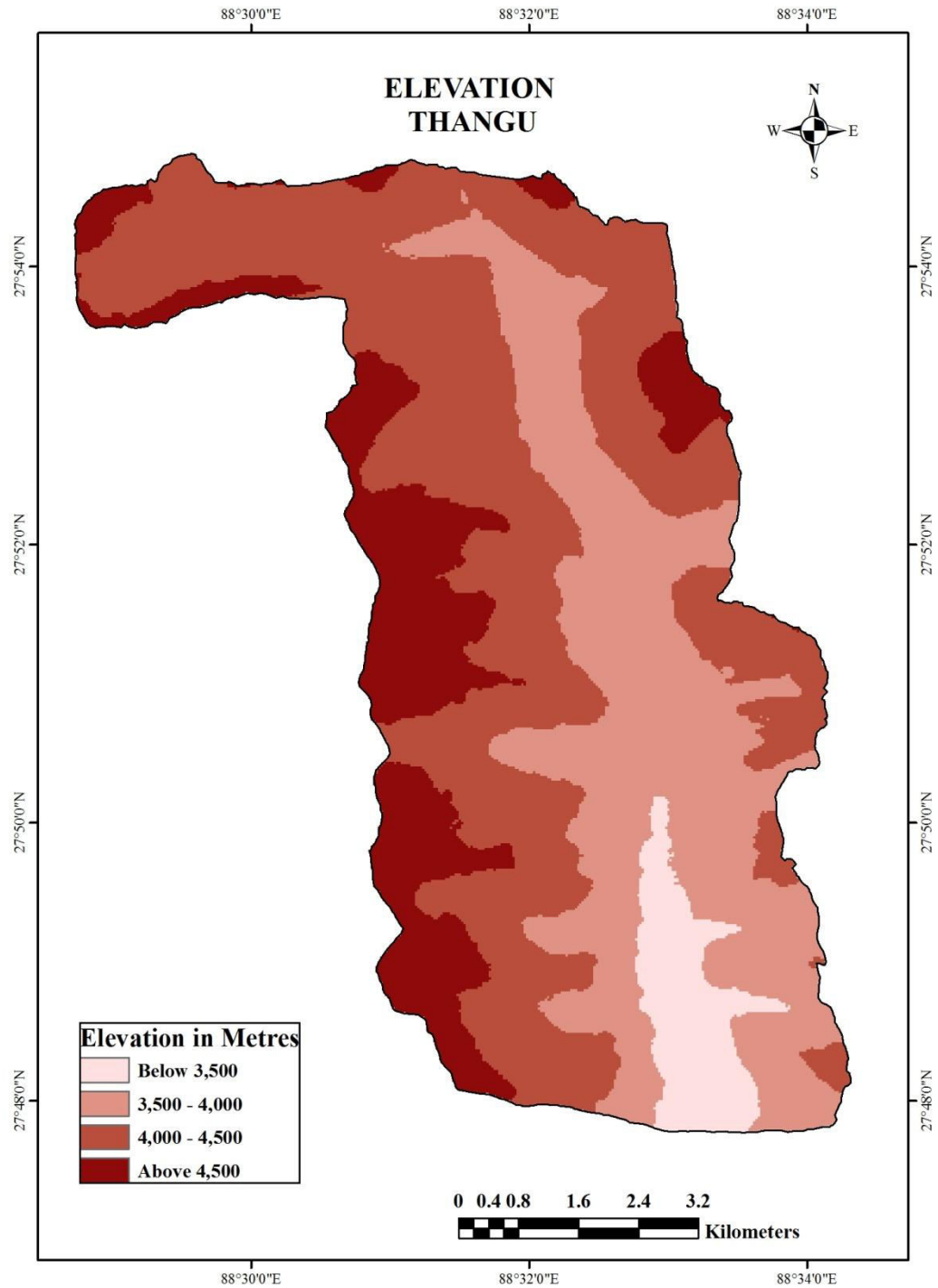
2.4. Soil Type in Study Area

Sikkim Himalaya enjoys a wide range of climate, physiography, geology and vegetation that influence the formation of different kinds of soil. The soils have been mapped described, analysed, characterised and classified under five broad physiographic units. Soils occurring in different landforms are studied in respect of their morphology, physical and chemical characteristics.

In accordance with the physiographic sequence of the terrain features, 78 soil families were identified and they have been mapped into 69 mapping units (Upreti, 2013). It is found that *Inceptisols* are dominant (42.84 %) followed by *Entisolls* and *Molisols* occupying 42.5% and 14.64% respectively. However, the study area is dominated by one soil system as per the demarcated boundary of study area. Soil moisture and soil temperature regime are identified as mesic and perudic respectively. These soils are shallow, somewhat excessively drained, loamy-skeletal with gravel loamy surface, moderate surface stoniness and moderate erosion. They are classified as Lithic Cryorthents and Lithic Cryumbrepts¹.

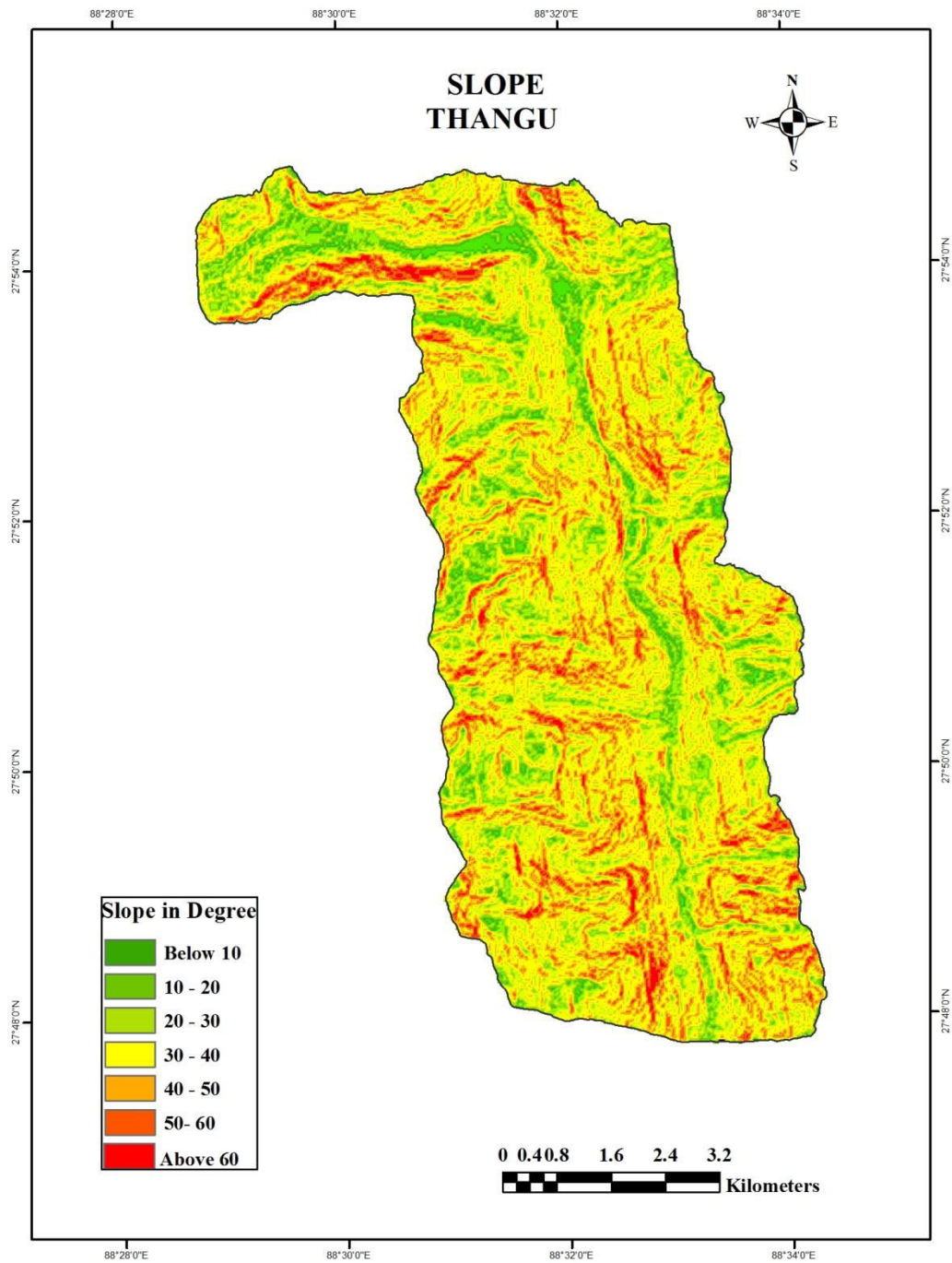
¹ Based on National Bureau of Soil Survey and Land Use (Upreti, 2015)

Map 2.2.



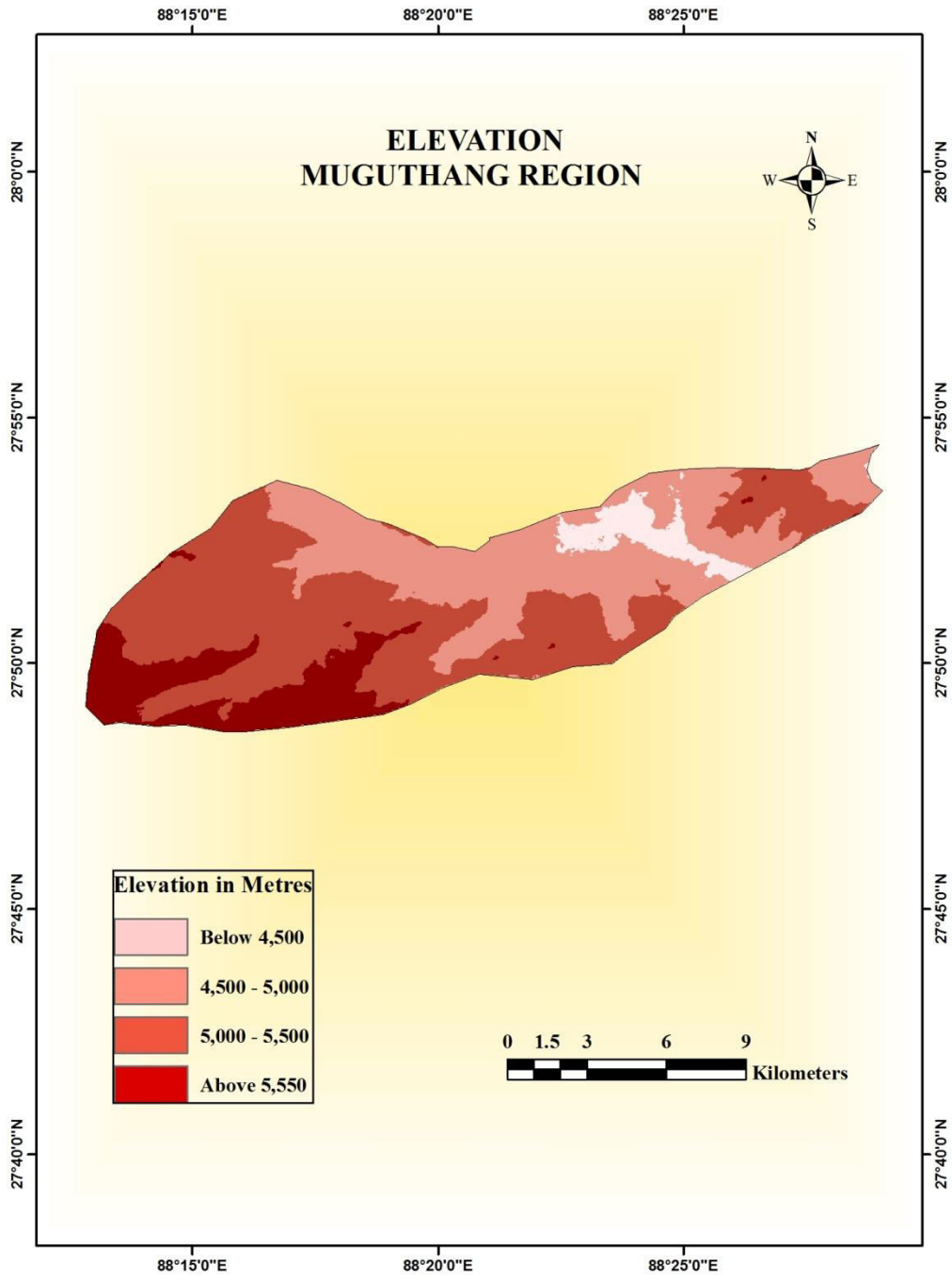
Source: ASTER GDEM Version 2, Projection used: UTM WGS 1984, 45° North

Map 2.3.



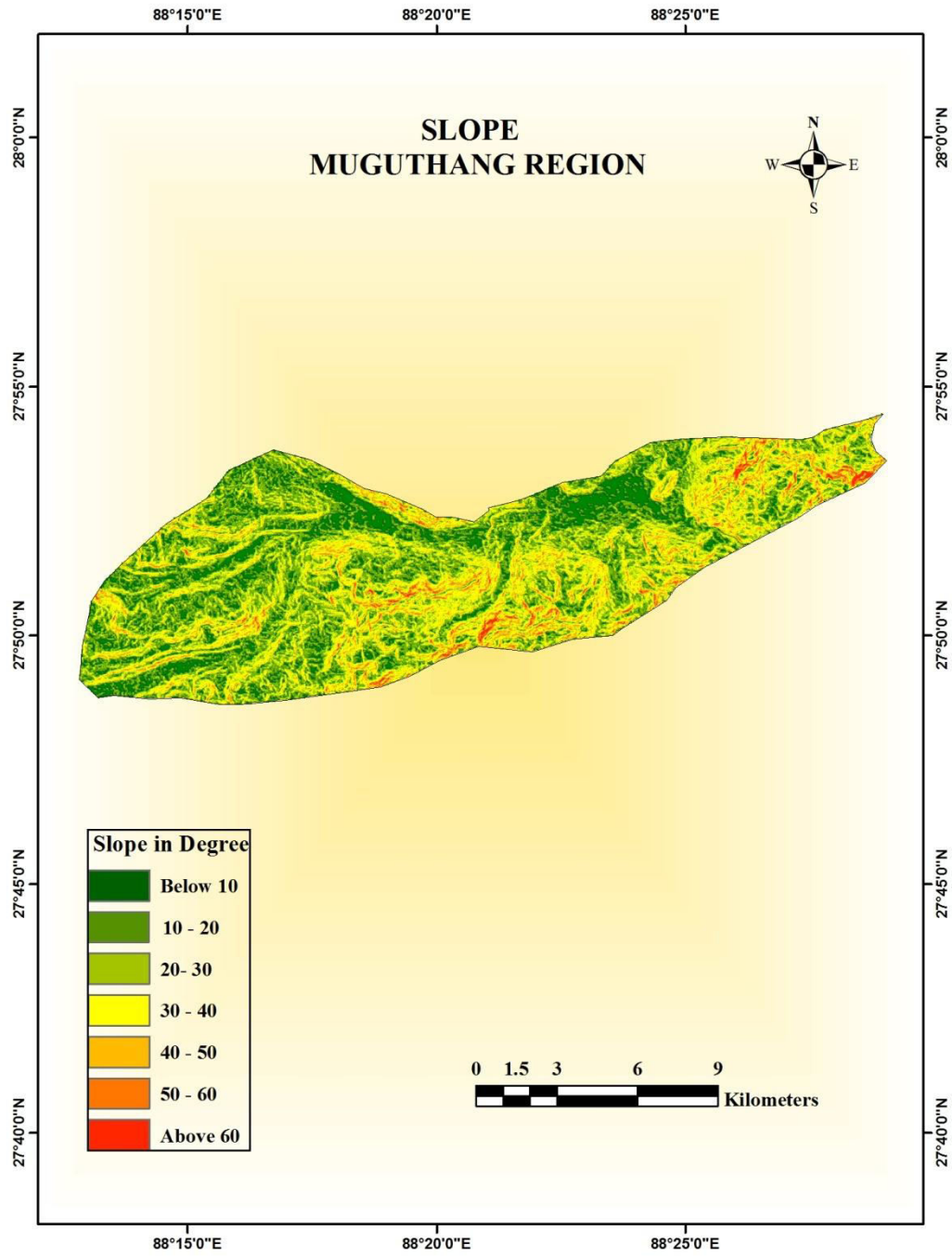
Source: ASTER GDEM Version 2, Projection used: UTM WGS 1984, 45° North

Map 2.4.



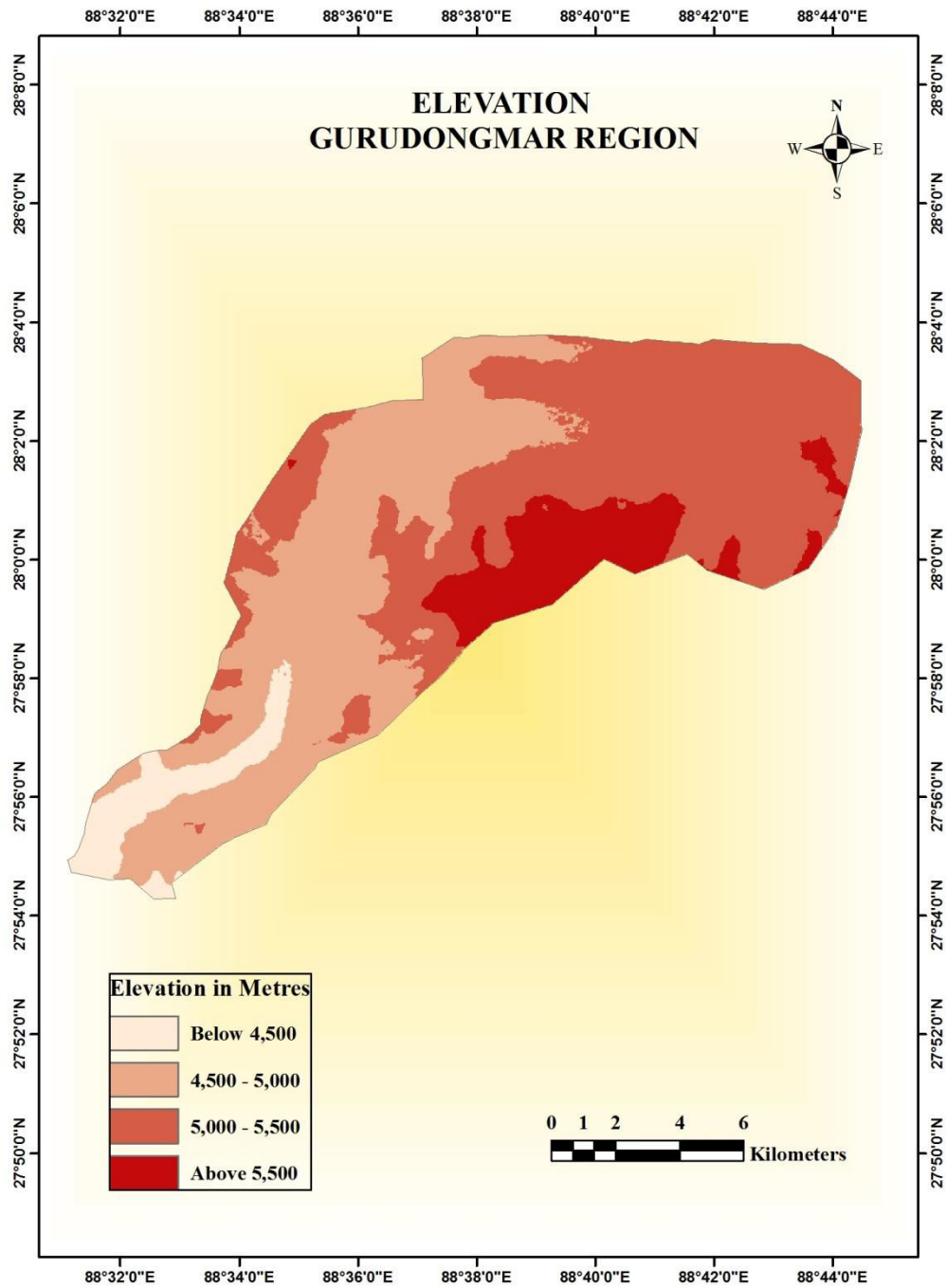
Source: ASTER GDEM Version 2, Projection used: UTM WGS 1984, 45° North

Map.2.5.



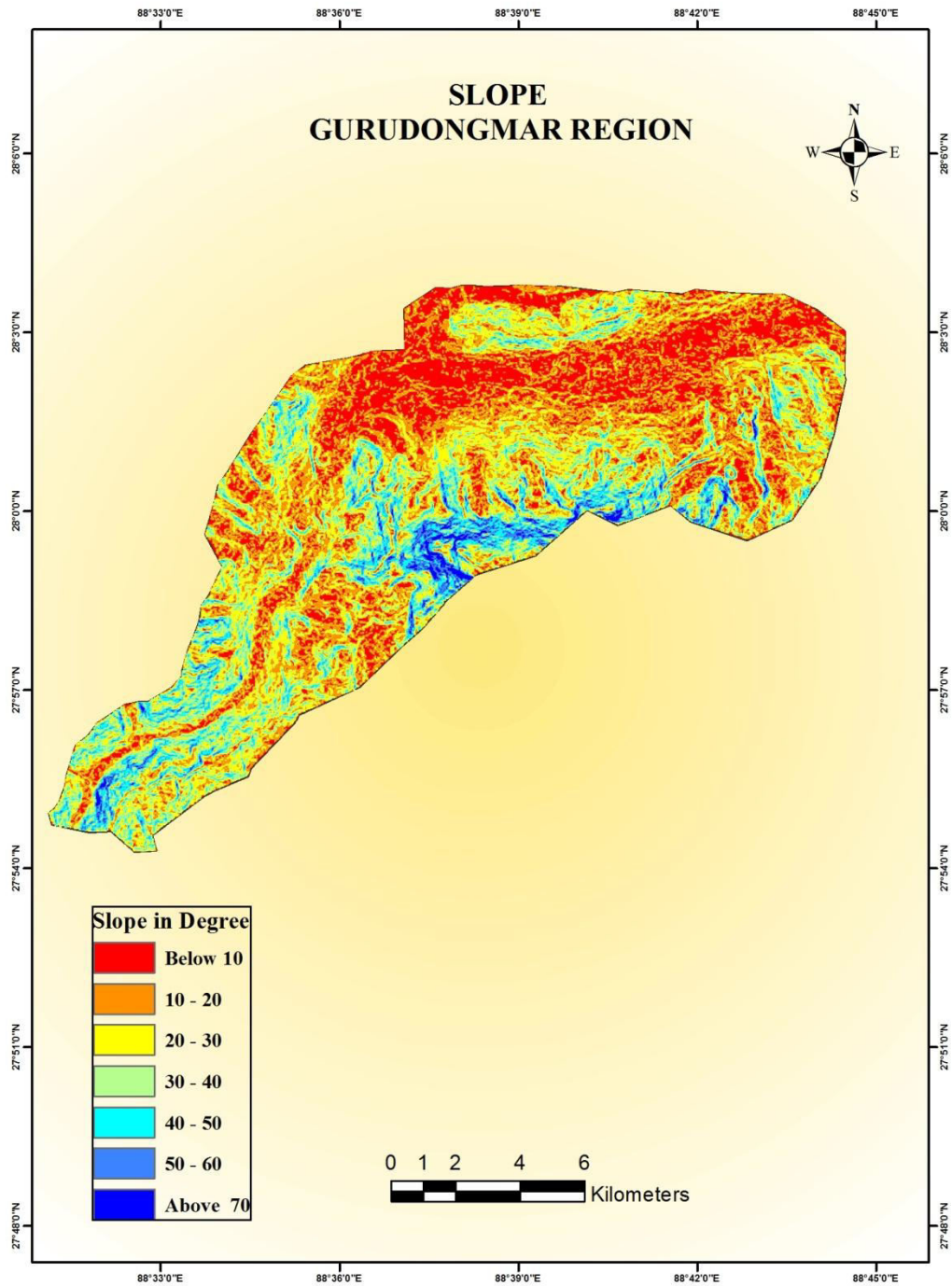
Source: ASTER GDEM Version 2, Projection used: UTM WGS 1984, 45° North

Map.2.6.



Source: ASTER GDEM Version 2, Projection used: UTM WGS 1984, 45° North

Map 2.7.



Source: ASTER GDEM Version 2, Projection used: UTM WGS 1984, 45° North

2.5. Elevation and Slope types in Thangu and its adjoining Area

The study area has varying features of elevation and slope. Although, elevation and slope maps of study area has been done on the basis of ASTER GDEM which was downloaded from *Earth Explorer- U.S. Geological Survey*. The mapping and calculation of slope and elevation have been done systematically by using Arc GIS 10.2 version.

The highest and lowest elevation of Thangu region is 5010 meter and 3150 meter respectively. Elevation of Thangu (Map 2.2) ranges with an altitude of below 3500 metre to above 4500 metre. The human settlement and agricultural operation lies between an altitude of 3500 metre to 4000 metre. The area which lies between an altitude of 4000 meter to 4500 metre are mostly forest land with trees and grasses and the area above 4500 metre are mostly of ridges.

The slope map of Thangu (Map 2.3) varies with less than/equal to 10 degree slope to above 60 degree slope. According to the chosen boundary of Thangu, out of total area of 62.97 sq km, about 3.90 sq km area lies in a category of less than/equal to 10 degree slope. About 9.77 sq km area lies in a category of 10 degree to 20 degree slope. In a similar way, the size of area recorded in a category of 20 degree to 30 slope is 16.64 sq km. The slope of 30 to 40 degree has an area of 19.22 sq km and about 10.32 sq km area falls in a category of 40 to 50 degree slope. Similarly, about 2.77 sq km area falls in a category of 50 to 60 degree slope and around 0.24 sq km area lies beyond 60 degree slope.

Unlike Thangu, Muguthang region is basically a land of Yak grazing. An elevation map of Muguthang has been classified into four class intervals (Map 2.4.) which ranges

from below 4500 meter to 5500 meter. Although, the highest and lowest elevation of Muguthang region is 5988 meter and 3150 meter respectively. The grazing of yak mostly takes place at an altitude of 4500 metre to 5000 metre. Area above 5500 metre are mostly high ridges of mountain and peaks.

On the other hand, the slope of map Muguthang region (Map 2.5) varies also with a slope degree below. An area of 51.67 sq km metre lies in a category of less than/equal to 15 degree slope which is highest in area coverage followed by 15 to 25 degree slope with 46.42 sq km, 25 to 35 degree with 37.42 sq km, 35 to 45 degree slope with 13.2 sq km and only 3.01 sq km. area is covered by above 45 degree slope.

Gurudongmar region is also a grazing land like Muguthang region. This region has high presence Indian Army. The region has better road accessibility than Muguthang. The elevation map (Map 2.6.) is classified into four class intervals which varies below 4500 metre to above 5500 metre. The larger area coverage is found in a category of 4500 metre to 5000 metre followed by 5000 metre to 5500 metre, 5500 metre to 5000 metre and above 5500 metre.

According to the slope of map of Gurudongmar (Map 2.7) larger area is covered between 15 degree to 25 degree slope with an area coverage of 42 sq km out of total area of the region followed by slope of below 15 degree with 47 sq km, 25 degree to 35 degree slope with 35 sq km, 35 degree to 45 degree slope with 10 sq km and above 45 degree slope with 14 sq km.

2.6. Conclusion

The natural setting of a study area is characterised by extreme cold weather in winter and cool weather in summer. The region receives very low rainfall throughout the year and snow fall is prevailing precipitation during winter season i.e., from mid November to mid March.

The main source of river Teesta actually originates from this region. The arable land in the region is cultivated once in a year due to the extreme cold and snow cover in winter season. The prominent river that flows from Muguthang are *Goma Chu*, *Zeemu* etc. In similar way, the river that flows from Gurudongmar region via Thangu are *Gurudongmar Chu*, *Tsho Lhamu Chu*, *Chopta Chu* and *Kalep Chu*. The total length of the rivers within the demarcated boundary of the study area is 126 kilometer which has been calculated by using Arc GIS 10.2 version.

On the basis of systematic calculation in Arc GIS 10.2 version, the highest and lowest elevation of the study area are 6812 meter and 3150 meter respectively. of Soil moisture and soil temperature region are identified as mesic and perudic respectively. The region has somewhat excessively drained, loamy-skeletal with gravel loamy surface, moderate surface stoniness and moderate erosion. They area classifies as Lithic Cryorthents and Lithic Cryumbrefts.

Chapter 3

Agriculture at Thangu Region

3.1. Introduction

Agriculture in Thangu region is characterized by both crop farming animal farming. The agricultural system in the region based on seasonal pattern and it is completely based on subsistence agriculture wherein the output is mostly for local requirements with little or no surplus for trade. Study of land-use and cropping-pattern reveals several important aspects of agricultural economy in the region.

Mountain areas, with their dispersed patches of useable land at different altitudes with different climates and with their often highly fragmented landscapes and narrow limits for mechanization, are most efficiently and effectively managed by family farms (Kohler, et.al, 2014). In addition, the farming system in Thangu and its adjoining areas have mostly been based on family farming.

It is difficult to alter nature in remote and mountainous areas like Thangu and its adjoining areas, where natural milieu restricts the role of human beings to alter nature. People are compelled to survive on limited available resources. The level of their utilization depends upon number of factors including technology, institutions and spatial inter-relationships etc.

Economic structure of a study area has been influenced more by the human power rather than by technology. The role of human labour makes the socio economic survival possible in hostile environment. The natural resources need to be analyzed in terms of land uses under different categories like land available for cultivation, forests

and other economic purposes such as pastures and grazing land and net sown area etc. The level of socio-economic well-being in mountainous regions is assessed by the intensive utilisation of limited natural resources mainly in terms of land-use and cropping-pattern. Mountainous regions lack the process of industrialization.

Amidst the above mentioned statements, it becomes very important to make a comprehensive understanding of the role of natural milieu in high altitude region of Thangu and its adjoining areas. Therefore, this chapter has been classified into following sub themes.

- Land resources, to know the extent of availability of land suitable for agriculture;
- Distribution of land holdings, to see the relationship between farm-size and family-size;
- Cropping-pattern and importance of commercial crops versus traditional crops;
- Irrigation, to comprehend its role in semi-arid and arid conditions of the region;
- Farm inputs, to understand their use and intensity;
- Lastly, organic farming, to comprehend the agricultural operation under the framework of organic mission of Sikkim.

3.2. Land Resources

Land cover data documents how much of a region is covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types. Water

types include wetlands or open water¹. Land use shows how people use the landscape – whether for development, conservation, or mixed uses. The different types of land cover can be managed or used quite differently. Land cover can be determined by analyzing satellite and aerial imagery. Land cover maps provide information to help managers best understand the current landscape. Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. It also has been defined as "the total of arrangements, activities, and inputs that people undertake in a certain land cover type. In addition, land-use in a sense is the spatial expression of human efforts to modify natural environment in a region.

In the light of above, forest, mountain, defence settlement, civil settlement, grazing land are the prominent land cover found in the study area in general. However, this chapter has considered only Thangu region in order to segregate land use and land cover. The region which lies beyond Thangu region are mostly grazing land which has been discussed in Chpter-IV.

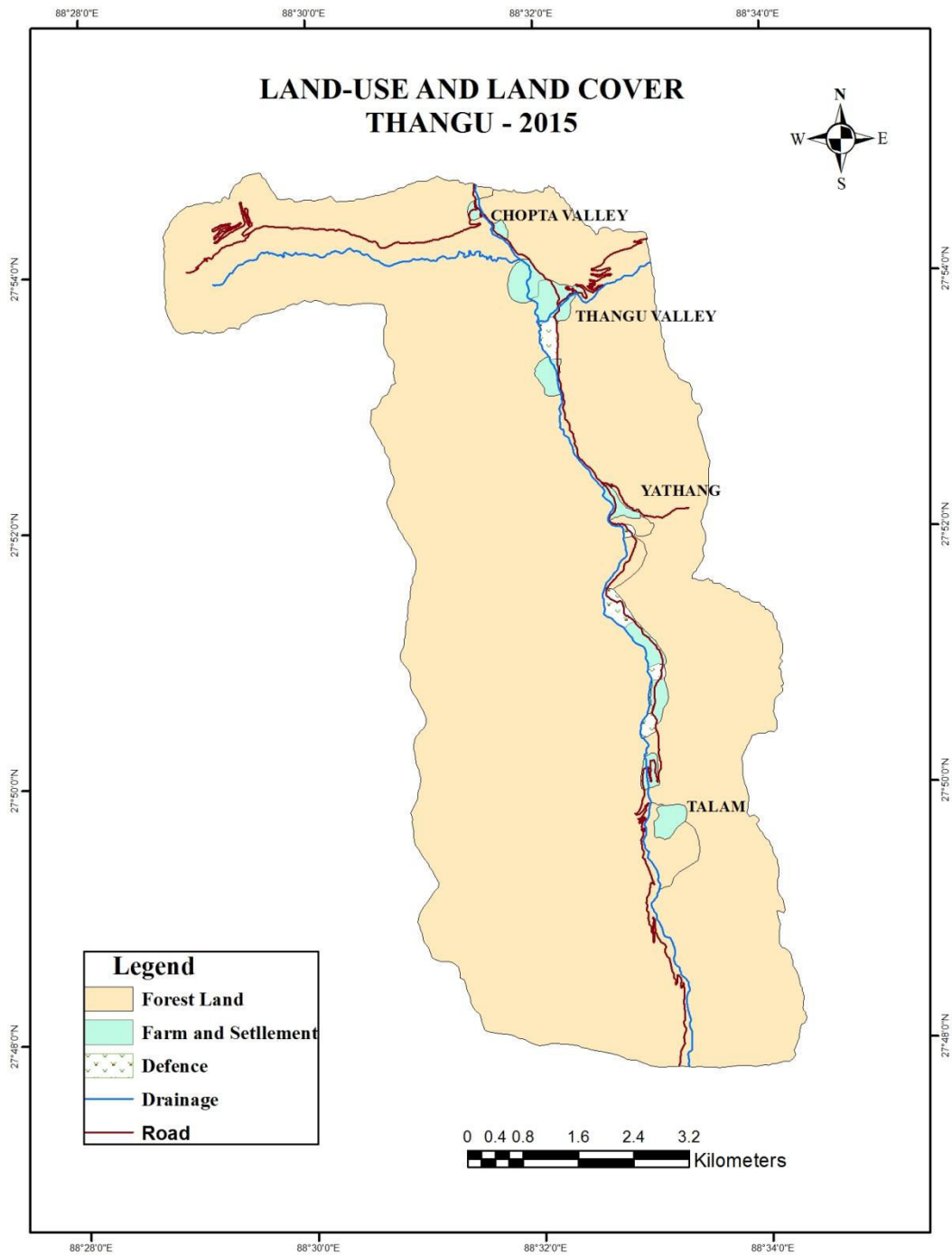
Table.3.1. Land Use and Land Cover of Thangu Region

SI.NO	LAND UNIT	AREA IN HECTARE	TOTAL AREA IN HECTARE	PERCENTAGE
1	Forest Cover	6107	6260.00	97.56
2	Farm and Settlement	111		1.77
3	Defence	42		0.67

Source: Satellite imageries, downloaded from Google Earth Pro and Processed in Arc GIS.10.2

¹ <http://oceanservice.noaa.gov/facts/lclu.html> (Accessed on 13th September 2016)

Map 3.1.



Source: Imageries, Google Earth Pro

Since, the study has taken its own classification of land use and land cover into account as the study area is unable to get immersed into the given nine fold classification of land use and land cover of India. Nevertheless, if the study is considering the entire North District it would have been wise to proceed with mostly celebrated nine fold classification of land use and land cover of India. The above given table on land use and land cover has been generated through *Arc GIS 10.2* by using satellite imageries. Moreover, the Map 3.1 and Table 3.1 are interconnected. Both maps and table are prepared from collected Satellite imageries and processed in *Arc GIS 10.2*. As stated in methodology in earlier chapter, there is no official and legitimate demarcation of geographical boundary for the study area. The study has come across with its own boundary line by taking ridges of the area into account.

Table 3.1. indicates that the forest cover has recorded a highest area coverage with 6107 in hectare followed by farm and settlement and defence with a land coverage of 111 hectare and 42 hectare out of the total area of 6260 hectare. Farm and settlement has been put together in order to address the human settlement and crop farming and it was very difficult to classify both farm and settlement separately due to its proximity to each other in small area.

Indian soldier has its presence in the region due to India's close physical proximity and shared border with China. With especial reference to the elevation map of Thangu given in chapter 2, all agricultural activities, human settlement and defence base has been located within the altitude of 3500 to 4000 metre.

3.3. Carrying Capacity of Agriculture in Thangu Region

One of the most interesting problems in the human geography of developing countries is to estimate the carrying capacity of land under agricultural systems for any given natural vegetation zone occupied by a given ethnic groups (Hunter, 1966).

In the sub section of this chapter, the study has dealt with size of land holding as well as the size of land under agricultural operation, role of domestic livestock (cow)², cropping pattern. Moreover, the study has associated the Thangu region with its minor villages viz., Kalep, Thangu, Samdong, Chopta and Thangchung.

According to the Census Report of India, 2011, Thangu has 65 households with total population of 1294. However, the study has not witnessed the same figure given by the *Census Report of 2011* but has covered 35 households within Thangu region. In addition, at the hour of field survey, the study had witnessed that most of the households located in the study area abandoned due to the seasonal movement of the people. Settlements are mostly of seasonal in nature dominated by *Lachenpas* except few Tibetan immigrants.

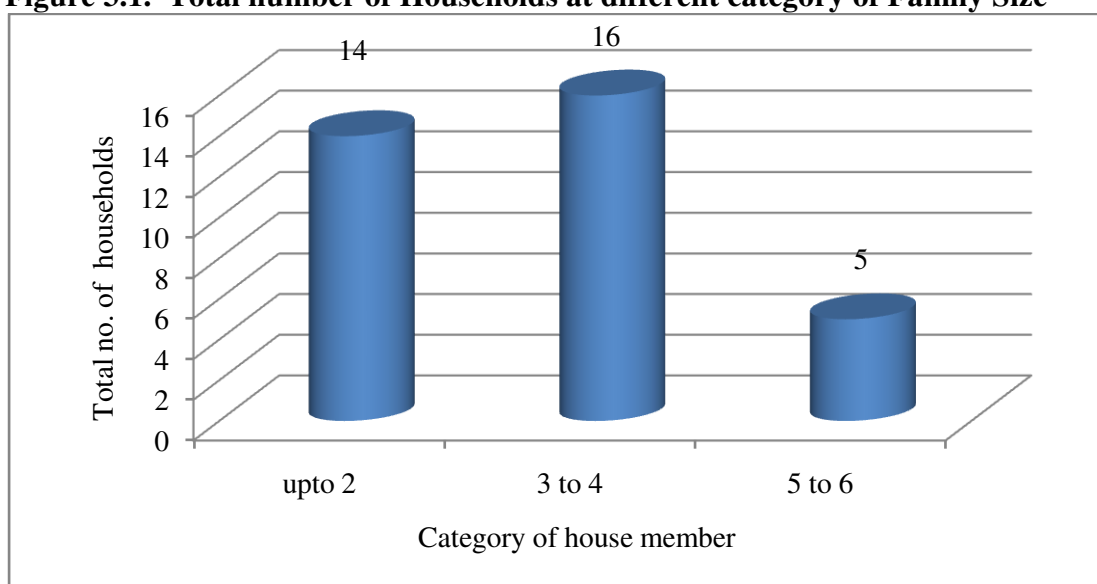
3.3.1. Distribution of Land

Availability of land for cultivation is an important aspect in high altitude regions in its agricultural economy. It acquires an additional importance in isolated mountainous regions like *Thangu* where land available for agriculture is extremely limited. Increasing crop-yield is not easy. Therefore, size of holdings is closely related to productivity.

² The study is not addressing the livestock of grazing land situated beyond *Thangu* region. Here the study is referring only to those cows which has been raised by farmer at *Thangu* region.

The land from all surveyed households are neither given or taken on rent nor operated on the basis of crop sharing. The figure (Figure 3.1) indicates the family size of different household under categorised class interval. Firstly, the maximum number of households has been recorded under the class interval of ‘3 to 4 family size’ with 16 households which further indicates that there is a threshold of 3 family members in this category. Secondly, the second highest number of households lies under the class interval of ‘0 to 2 family size’ with 14 households. Lastly, the class interval of ‘5 to 6 family size’ has recorded lowest number among all categorised class interval with 5 households.

Figure 3.1. Total number of Households at different category of Family Size



Source: Household Survey Conducted on 17thth July 2016

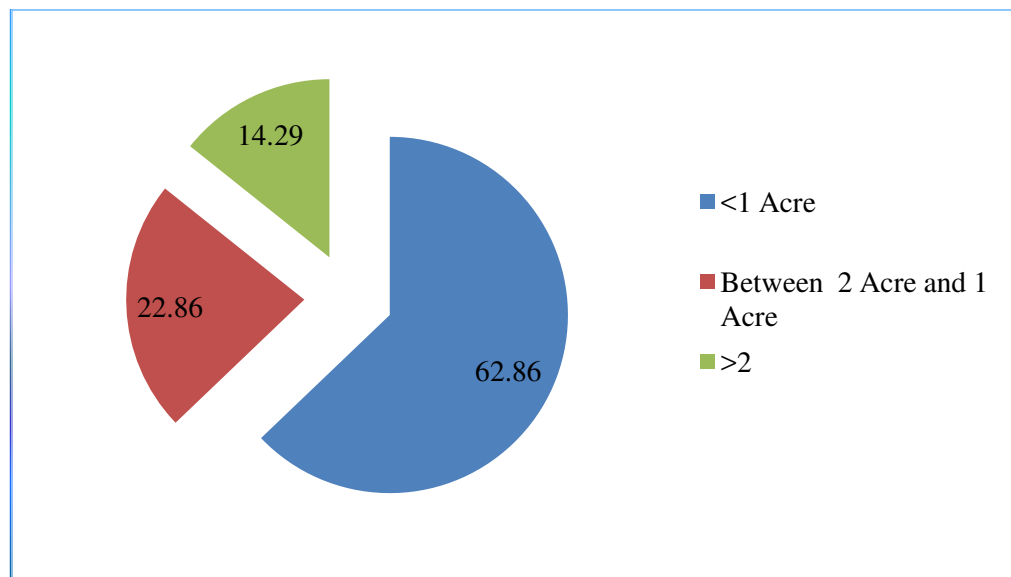
In existing Land Record databases, attribute “Farmer Category (Size of Holding)” is used to capture information about the Category of the Farmer³. It is based on the total land holding in hectares. The given figure below is based on mostly celebrated land size holding category in various agricultural study i.e.,

³ <http://dolr.nic.in/dolr/mpr/mastercodes/sizeofholdingcodes.pdf> (Accessed on 8th June 2016)

- Large Farmer: land size holding of greater than 5 hectares,
- Medium Farmer: land size holding of greater than 2 hectares and less than/equal to 5 hectares,
- Small Farmer/Marginal Farmer: land size holding of less than/equal to 2 hectares.

In the light of the above mentioned division of land size holding of farmers, the current study doesn't adjust into such category due to the small mountainous area and the maximum size of land holding accounts around 2 Acre as per the conducted field survey. As in corollary, the study area relatively falls into the category small/marginal farmer. However, the study has come forth with its own classification of land size holding.

Figure 3.2. Total Land Ownership in Percentage

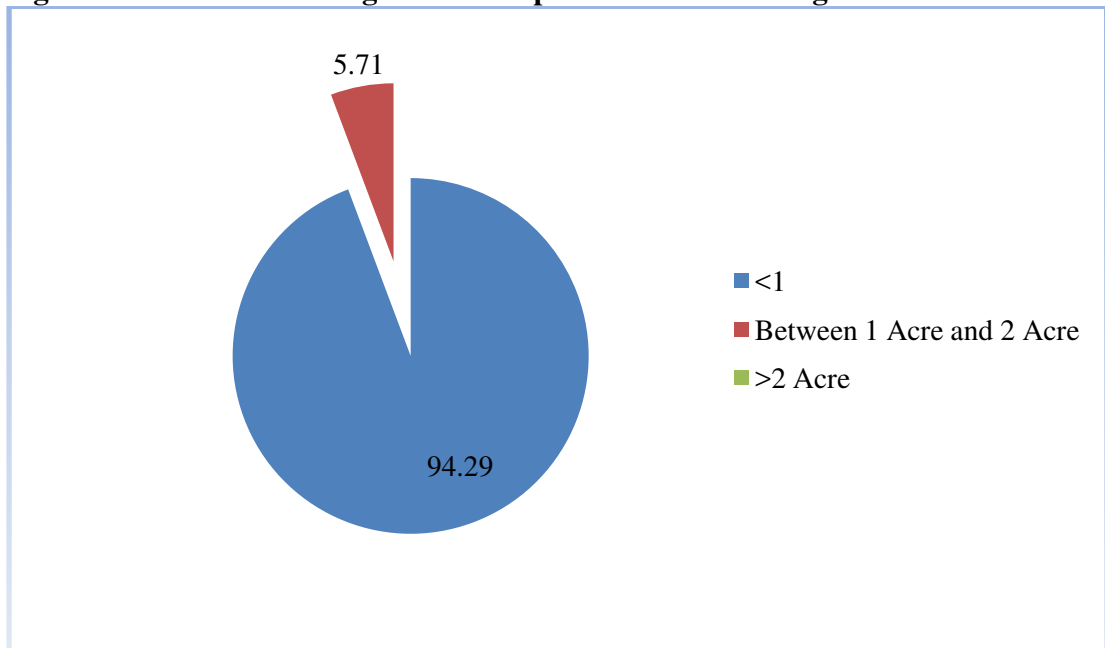


Source: Field Survey

The given figure (Figure.3.2) has been classified into three sections on the basis of land ownership viz., less than/equal to 1 acre, more than 1 acre to less than/equal to 2 acre, and more than 2 acre. The given figure reveals that from the

surveyed households maximum percentage of land size holding is found with 62.86 percent in the category of less than/equal to 1 acre which means 22 household falls in this category. In a similar fashion, 22.86 percent is found in the category of more than 1 acre to less than/equal to 2 acre accounted by 8 households. Lastly, 14.29 percent is found in more than 2 acre category with a household population of 5.

Figure 3.3. Land under Agricultural operation in Percentage



Source: Survey Conducted On 17th July 2016

The land under agricultural operation (Figure.3.3.) has been dragged out of total land size holding. It is entirely based on surveyed households of the study. According to this figure, 94.29 percent of households are operating in the category of lesser than/equal to 1 acre land size. Similarly, 5.71 percent of arable land is found in the category of more than 1 acre to lesser than/equal to 2 acre. The figure also reveals, there is no land operated above 2 Acre.

3.3.2. Cropping Pattern

The cropping patterns of a region are closely influenced by the geo-climatic, socio-cultural, economic, historical and political factors. The physical environment imposes limits on the growth and distribution of plants and animals. Similarly, the cropping pattern of Thangu region is also determined by its own agro-ecological setting.

Cropping systems of a region are decided by and large, by a number of soil and climatic parameters which determine overall agro-ecological setting for nourishment and appropriateness of a crop or set of crops for cultivation (Das. P, 2002). Multiplicity of cropping systems has been one of main features of Indian agriculture and it is attributed to rainfed agriculture and prevailing socio-economic situations of farming community. It has been estimated that more than 250 double cropping systems are followed throughout the country and based on rationale of spread of crops in each district in the country, 30 important cropping systems have been identified (Das. P, 2002).

Nevertheless, at farmers' level, potential productivity and monetary benefits act as guiding principles while opting for a particular crop/cropping system. These decisions with respect to choice of crops and cropping systems are further narrowed down under influence of several other forces related to infrastructure facilities, socio-economic factors and technological developments, all operating interactively at micro-level. These are:

Infrastructure facilities: Irrigation, transport, storage, trade and marketing, post-harvest handling and processing etc.

Socio-economic factors: Financial resource base, land ownership, size and type of land holding, household needs of food, fodder, fuel, fibre and finance, labour availability etc.

Technological factors: Improved varieties, cultural requirements, mechanization, plant protection, access to information, etc.

3.3.2.1. Celebrated Crops and Cropping Season at Thangu

The study area is characterised by subsistence farming with very limited crop varieties. The prevailing crops in the region are potato, reddish, mustard leaf and beans. However, among the said varieties of crop, the reddish and potato are highly celebrated in the region. The table on crop varieties and cropping season (table.III.2.) clearly indicates the nature of cultivation in concerned area of Trans-Himalayan Sikkim. in terms of cultivation of crops, the table further reveals that the sowing and harvesting of crops cannot be repeated as it occurs once in a year. According to the crop calendar (Table 3.2.), potato, Beans, and reddish are sown from the last week of April till the end of May and same are harvested in the month of September and October. Likewise, mustard leaf is sown in May and harvested in July and August.

Table 3.2.

Crop Calendar of Thangu

CROP CALENDER													
Sl. No.	Crops	Months											
		January	February	March	April	May	June	July	August	September	October	November	December
1	Potato	-	-	-	Sown (from 4th Week)	Sown	-	-	-	Harvest	-	-	-
2	Reddish	-	-	-	Sown	Sown	-	-	-	Harvest	-	-	-
3	Beans	-	-	-	Sown	Sown	-	-	-	Harvest	-	-	-
4	Mustard Leaf	-	-	-	-	sown	-	Harvest	Harvest	-	-	-	-

Source: Focus Group Discussion conducted on 12th July 2016, at *Thangu* during field visit

3.3.2.2. Agricultural Inputs

The prevailing agricultural inputs are characterised by consumable inputs and capital inputs wherein consumable inputs deals with variety of seeds and fertilisers. In addition, seeds are classified into local/traditional seed and hybrid seed. Fertilizer is also an important consumable input which can be further divided into chemical fertiliser and natural fertiliser/manure. Capital inputs are tractor, agricultural machineries (thrasher, harvester), agricultural implements and tools (cultivators, levellers, irrigation, pump sets, motors, sheds, bullock carts, jeeps etc.).

Study has witnessed that the seeds used during agricultural operation are of traditional/local in character. However, other hybrid seeds were seldom given to the farmer by Agriculture/Horticulture Department, Government of Sikkim but farmer of the study area also states that the government has just refrained from distributing those hybrid seeds for the last couple of years. Moreover, the local seeds are in greater use in study area. The traditional seeds are being dumped beneath the land surface in order to store during winter for next sowing season. At the hour of household survey, questions were raised to the respondents regarding the use of seeds and answers received from them were all similar. The statement given below has emanated from one of those respondents.

Doda Lama, 75 years old farmer of Thangu states that “We are accustomed to our local/traditional seeds. During off cropping season we store our seeds by dumping them for next sowing season. Its not that we never use other hybrid seeds. We did use. Prior to the couple of years, we were sometimes provided with hybrid seeds by Agriculture/Horticulture department, Government of Sikkim. Presently, we haven’t received any hybrid seed from government”.

The another consumable input is fertiliser which is very prominent in its own way of being used. The agriculture in study area has been encompassed by the use of natural fertilizer/manure rather than chemical fertilisers. In precision to this, like other parts of Sikkim, Thangu also has refrained from using chemical fertiliser since the declaration of Organic Farming in Sikkim. However, manure is mostly celebrated in agricultural operation in the region. The wastes of domestic animal (cow dung) is being used in order to trigger the productivity.

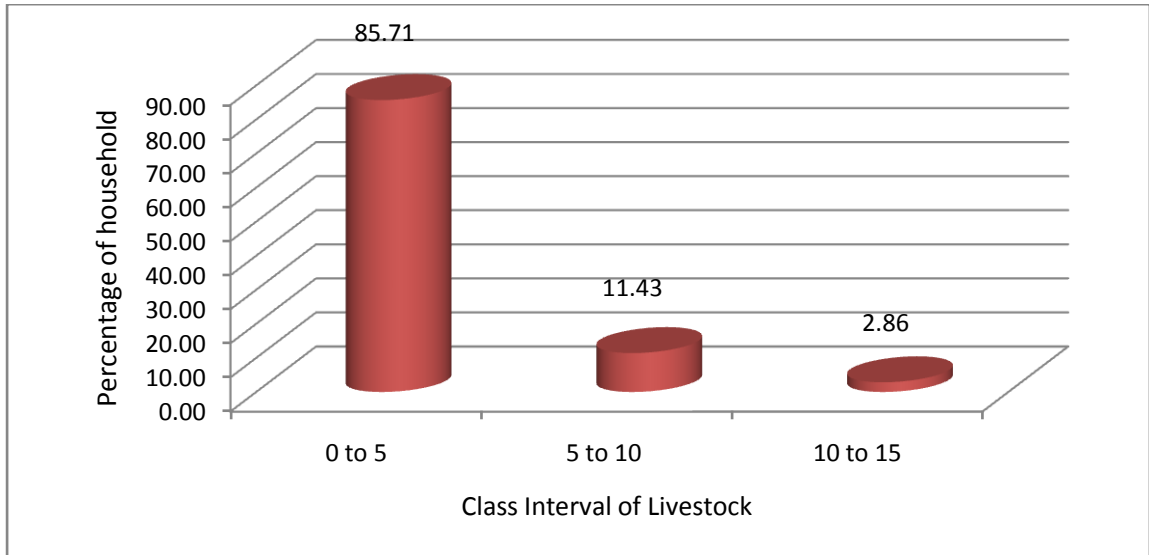
In the light of above, most households have kept small section of livestock (cow) in order to support their livelihood but the population of these livestock is not larger than the population of livestock found in grazing land of Muguthang and Gurudongmar region whereby they use cow dung as manure. The various animals being reared in the mountains sustain agricultural activities such like ploughing of the field; providing organic manure and transportation coupled with plenty of other benefits.

It is being realised by the scientific and academic communities, concerning agro-pastoral economy that highland alpine pastures are suffering from overgrazing which triggers other geomorphic hazards as well (Warpa, 2007).

Livestock form an integral part of agriculture, which can be visualized from the fact that tribal families do necessarily rear one type of animal or other. These provide opportunity to utilize the varied resources of mountain environment in a more effective way. The livestock population per households at Thangu region is mentioned below (Figure.3.4). The figure reveals that 85.71 percent out of total surveyed household owns up to 5 livestock. Similarly, 11.43 percent of households are holding 5 to 10 livestock followed by 2.86 percent of household with 10 to 15

livestock. Hence, the maximum households are having livestock population size below 5 and only one household is having livestock up to 15.

Figure 3.4. Size of Livestock (cow) in Percentage at Thangu Region



Source: Household Survey Conducted on 9th and 10th July 2016

Capital input is hardly seen as the agriculture in the study area is characterised by manual labour as there is no such machinery tools as seen in mainstream agriculture system like use of tractor, motor, bullock carts etc. In addition, manual labor is at greater pace from the season of sowing till the harvesting season. The use of bullock cart and tractor are totally absent in the region. In fact, farmers are totally relying on precipitation in order to irrigate their agricultural land. However, such practice is very common in almost all hill regions.

3.3.3. Agricultural Yield

The reddish and potato cultivation in a year is around 8 *mun* per household in general which is merely consumed by farmer.

Table 3.3. Selected task by gender, Thangu 2016.

TASK	ALMOST DONE BY MEN ONLY	DONE BY EITHER SEX	ALMOST DONE BY WOMEN ONLY
Ploughing		XX	
Harrowing		XX	
Smashing Clods	XX		
Sowing grain			XX
Planting Seeds			XX
weeding			XX
Hauling manure		XX	
Spreading manure	XX		
Harvesting		XX	

Source: FGD

As stated earlier also that the mountain farming is based on subsistence farming and the current study area is truly situated in such kind of farming system. It is due to small arable land holding which is only capable of feeding the farmer and their livestock but cannot make an adequate business trading out of agricultural products like other large scale agriculture operating regions of a country.

However, the agricultural yields are consumed by farmers and their livestock but sometimes farmer does exchange their yields with army personnel with other desirable goods which farmer cannot afford to get in such region such as kerosene, sugar, milk powder, chocolates etc. Nevertheless, exchanging yields from agriculture with other goods of army is operated in covert form. In some cases, farmer gifts their agricultural products to their family, relative residing in other parts of the state like Lachen, Chungthang and Gangtok.

According to surveyed households, agriculture is not only a source of livelihood of the farmers. There are other seasonal allied activities they perform. Many households run small restaurant cum shop as the region receives numerous

tourists hailing to *Gurudongmar*. The region also has relatively large number of labour working under ITBP border road construction from Thangu to Muguthang.

3.4. Locating the Study Area in the midst of Organic Farming

Organic agriculture could be a vital supplementary option for the small and marginal farmers of mountainous Himalayan States of India (Subba, 2014). FAO, Food and Agriculture Organization defines “Organic agriculture is a unique production management system which promotes the and enhances agro ecosystem health, including biodiversity, biological cycle and soil biological activity, and this is accomplished by using on farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs”.

The decision of government of Sikkim to go organic was based on the premise that farming in this hilly state was traditionally organic before its merger to the Indian Union in 1975; and it will be to the benefit to the farmers who own an average of 1.9 hectares of farmland with minimal chemical fertilizers use i.e., 12 kilogram per hectare compared to 90 kilogram per hectare of national average and inorganic pesticides even at its post-merger period; but also to maintain quality of environment of the state.

Plate 3.1.

Thangu in December and July



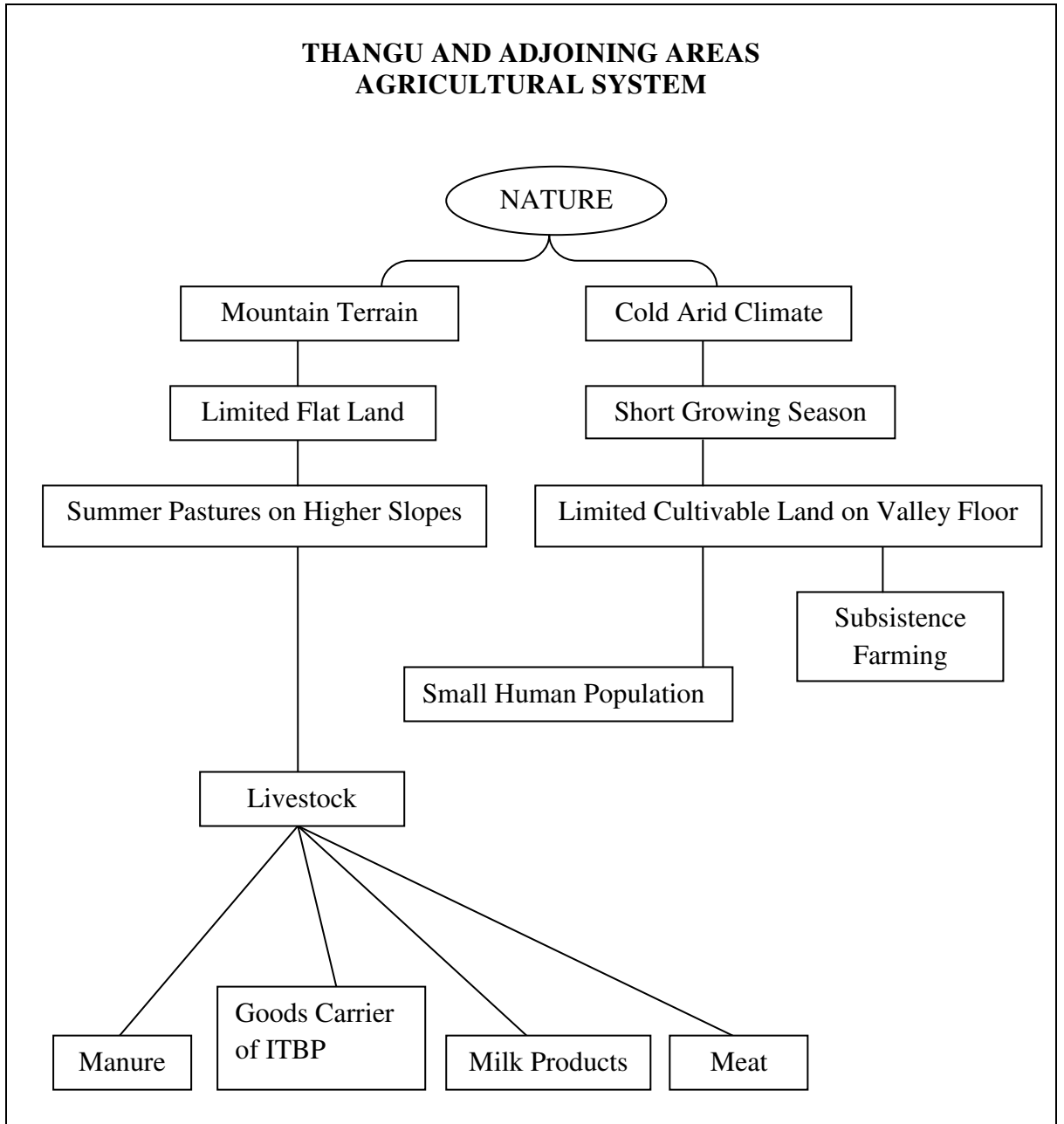
Thangu in December



Thangu in July

Source: Photo taken on field visit on 9th December 2015 and 16th July 2016

Figure 3.5. Agricultural System of the Study Area



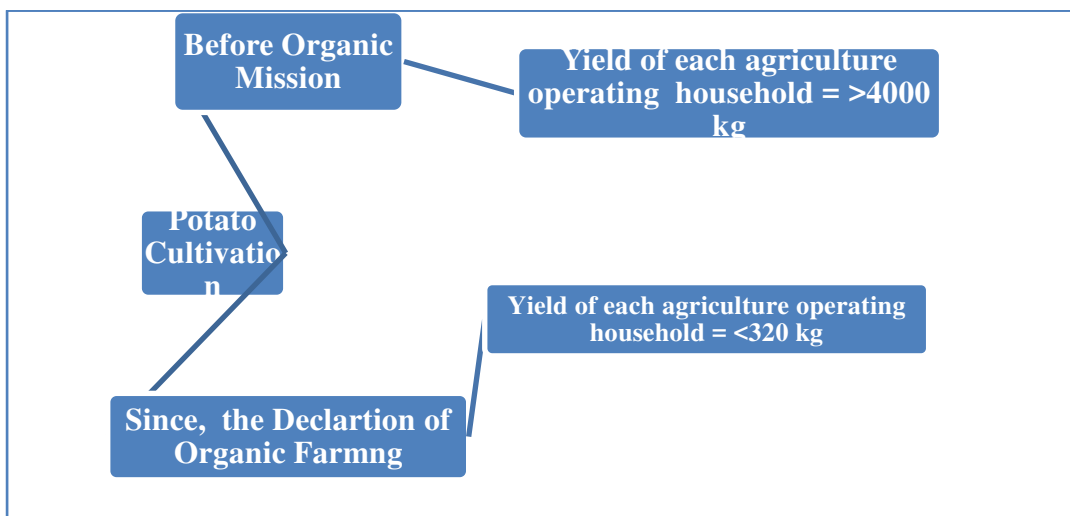
The process of bringing all cultivatable land under organic farming commenced at ground levels from 2010. Today, farmers do not apply fertilizers and pesticides on many crops such as large cardamom or a wild commercial spice crop, turmeric, off season vegetables, potato, yams, most of the fruit orchards, and some flowers (Subba, 2014) .

The effectiveness of organic mission is also seen in Thangu as well. Farmers had different opinion on organic farming during field survey. Majority of respondents with 70 percent out of total respondents criticised the so called organic farming of Sikkim by referring to the low productivity of agriculture and many supported the idea of organic farming. One of the respondent's statement over organic farming has been cited below;

“ I support organic farming because I want to consume healthy food. Today, with the implementation of organic farming we are unable to produce enough crops as we used to produced prior to the emergence of organic farming. After the implementation of organic mission one is not allowed to use fertilisers, pesticides that we once applied while operating in our farm. Today, we are instructed to use only bio waste/manure in order to sustain our crop farming. Sikkim was already on organic mode of cultivation prior to its merger with India. Later we adapted our farming culture with a use of chemical fertilisers, pesticides and so on. Today, its quite difficult to fall back again into the regime of organic farming as our crop productivity is not satisfactory as before. Moreover, I believe it may take time to adapt under organic mode of farming but our agriculture system will flourish in near future.” -Stated by Billy Lachenpa, 65 years old, male respondent at Thangu, North Sikkim.

The above mentioned statement made by farmer clearly indicates the direct effects of organic farming on yields of agriculture. According to him, despite of comparatively low productivity, organic farming has scope in near future but it is taking time to adapt in order to proceed with greater agricultural output. In fact, according to all farmers, the degree of crop productivity has severely fell down under organic mode of farming as compare to earlier years. In addition, prior to the emergence organic farming, the performance of potato cultivation at Thangu was comparatively better than today (Figure.3.6). In general, the output of potato per household was more than 4000 kilograms before organic farming but currently it is not exceeding beyond 320 kilograms per household. However, generalization of potato cultivation is based on FGD conducted at Thangu.

Figure 3.6. Potato Cultivation before and after the Implantation of Organic Mission

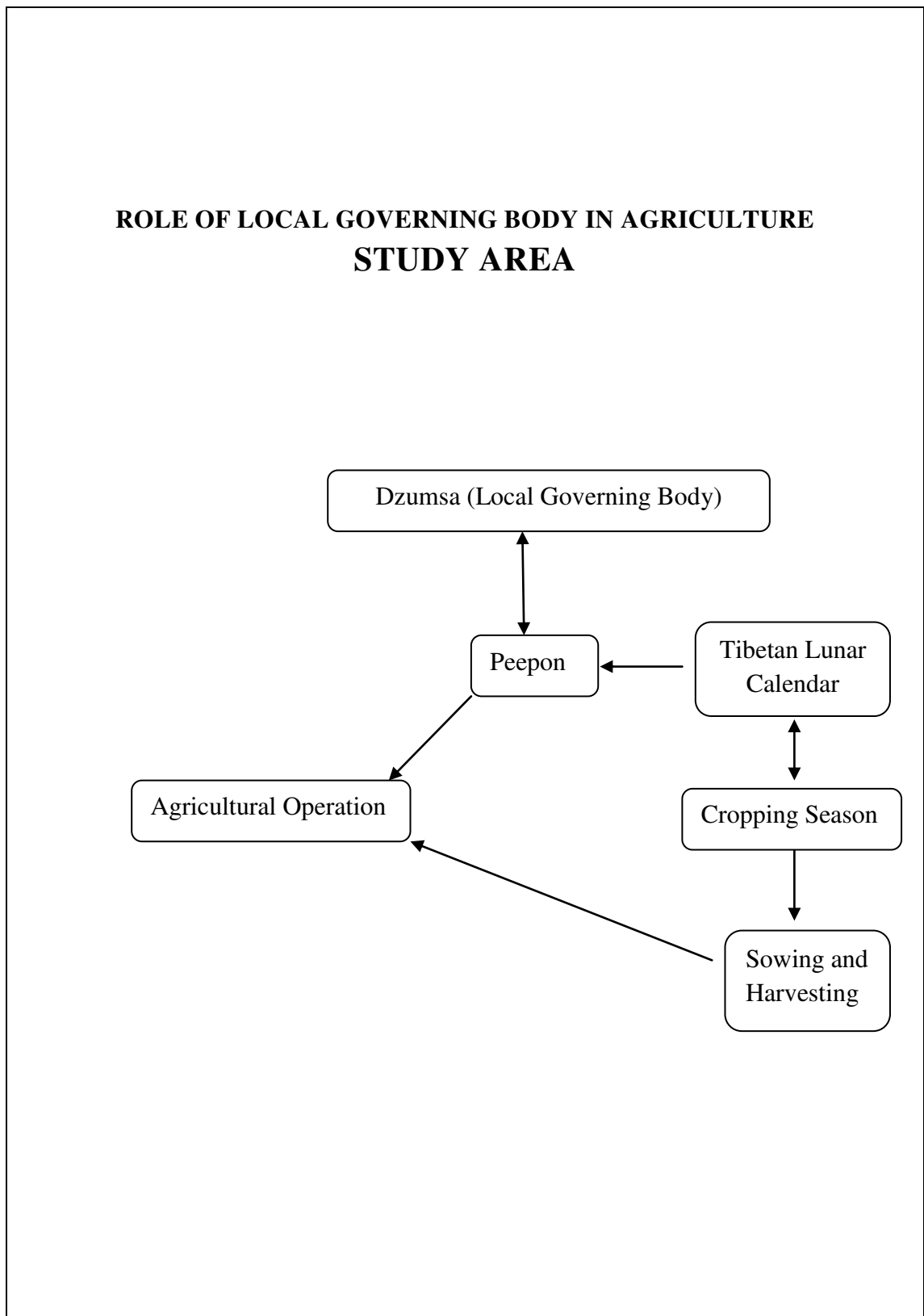


Source: FGD

3.5. Role of Local Administration

Generally, a local administrative unit is a low level administrative division of a country, ranked below a province, region, or state. The local administrative system

Figure 3.7.



means the systems and practices of establishing administrative regional divisions and setting up local administrative organs in order to facilitate the implementation of local administration as such.

In contemporary scenario, the northern part of Sikkim is known for its local administrative unit called *Dzumsa*. Such local administration or governing body is active in Lachen and Lachung, North Sikkim. Therefore, *Lachen Dzumsa* and *Lachung Dzumsa* are two most prevailing symbol of local governing body which has been left by Sikkim's Monarchical System after merging Sikkim with the Union of India. Functioning of *Dzumsa* itself is unique in various sphere as compared to other local governing body like Panchyat System.

In the context of above mentioned statement on *Dzumsa*, the people of Thangu and its adjoining area obeys the rules and norms of *Lachen Dzumsa*. In fact, *Lachen Dzumsa* is headed by the *Peepon*.

However, the local governing body decides all form of agricultural activities like sowing and harvesting of crops and the farmers abide the instructions of the local governing body (Figure 3.7). However, the majority of people in the region are Buddhist by religion and the *Lachen Dzumsa* decides all activities of agriculture according to their Buddhist Calendar.

3.6. Conclusion

Thangu as a mountain region of Sikkim Himalaya, at an altitude of 4000 meter supports very limited varieties of crop. The region is also characterized by very less number of people composed of *Lachenpa* community and Tibetan community. Maximum settlement is based on seasonal movement wherein people tend to move to warmer areas below Thangu during winter season and they settle back in Thangu for next summer season. Such seasonal movement is highly practiced by the *Lachenpas* but Tibetans are the permanent dwellers of Thangu as they do not move according to the varying climate.

The agriculture in the region is imposed by cold and high altitude climate wherein the major climatic element influencing growth of plant is the temperature and precipitation. The agriculture in the region has been based on subsistence farming. The farmers of the region falls into the category of small/marginal farmers as they are holding very limited size of land ranging up to 2 acre. However, the region has very limited people and arable land and keeping the extreme climate into consideration, one cannot cultivate during winter season. The prevailing crops are grown in same season from mid April to September in one field. The pattern of seeds used in the region are of traditional in nature and animal wastes are used as manure but chemical fertilisers cum pesticides/insecticides are totally prohibited after the declaration of organic farming in the State. In addition, the performance of crop cultivation is comparatively poorer after the implementation of organic mode of farming.

The local self governing system, *Lachen Dzumsa* has its own way of functioning in agricultural operation whereby farmers are tend to cultivate in a season which is suggested by the *Dzumsa* through its head representative called *Peepon*.

Chapter 4

Agriculture and Allied Activities

4.1. Introduction

This chapter has largely focused on agriculture oriented activities in Muguthang and Gurudongmar region wherein brief discussion on livestock grazing by nomadic pastoralist has been made. The chapter has further made a brief discussion on some prominent allied activities such as deployment of Yak as ration carrier of ITBP, collection of minor forest product such as medicinal plants (Yartsa Gunbu). These discussion are made within the context of animal grazing by Drokpa.

4.2. Dokpa

The study has referred a term drokpa in order to refer Yak herder in the region. Nevertheless, a nomad is a member of a community who live in different locations, moving from one place to another. Among the various ways nomads relate to their environment, one can distinguish the hunter-gatherer, the pastoral nomad owning livestock, or the "modern" peripatetic nomad. Nomadic hunting and gathering, following seasonally available wild plants and game, is by far the oldest human subsistence method. Pastoralists raise herds, driving them, and/or moving with them, in patterns that normally avoid depleting pastures beyond their ability to recover.

Trans-Himalayan yak herder are also a member of nomadic community of Himalaya who graze their livestock on different pastures according to the changing season of a year. The existence of yak herder are seen at various high altitudinal regions of Himalaya. However, when we talk of nomadic people or community within the context of Himalaya we basically recognize them with a region characterized by cold dessert and certain livestock. They are also known as *Dokpa* in the Himalaya.

In the life of pastoral nomads the climatic component of the habitat is almost as important as the physical layout of the territory they occupy and their chief problem of adaptation pertain to the system of the resource base (Magray, 1988). Climatic influences operate mainly through fluctuations in the biotic environment. Nomadic pastoral cultures have specially to orient to adverse period in the cyclic fluctuations of the resource base. An understanding of the climate of the study area is therefore, important because it primarily determines the seasonally available resource base upon which the community depends for its survival. Also, since most of the time the nomads either have had an outdoor life or live at the most in flimsy structures the altitudinal and horizontal variations indifferent dimensions of climate, specially temperature and rainfall, are of crucial importance in their socio-economic life.

4.3. Muguthang and Gurudongmar Region

The state of Sikkim has been blessed with varied climates which vary from Alpine in the north to subtropical in Rangpo. This is largely the result of the Himalayan location of the state. The physiographically complex Himalayas play a significant role in shaping the climate of the region, particularly temperature and rainfall which in this

region are related to sudden changes in altitude. The higher parts of the Gurudongmar and Muguthang regions receives considerable snowfall during winters. The snow starts melting in April. Most of the rainfall is received from July to September above and is ideally suited for the growth of luxuriant forests and meadows.

The regions of Gurudongmar and Muguthang together, has a Tibetan or Alpine type of climate. The seasonal rythem of the sun clearly defines the short summer from June to September with all the human activities, which are at peak and the long intense cold winters when all the activities come to a standstill.

The *Lachenpas*¹ and Tibetan are the pastoral nomads at the regions of Gurudongmar and Muguthang. Yaks are the cattle owns by the nomad in these two regions. One can also refer the term ‘animal farming’ to the practice of yak grazing. Once sheep were also raised by the nomads which hardly exists in contemporary situation in the region.

“During 1995-96 there was a serious outbreak of disease and heavy snowfall that killed a large number of sheep. After this event, sheep rearing is now completely abandoned in in these regions. The gradual and sometimes sudden shift of seasonal events has caused serious problems to the rotational grazing of livestock in Trans-Himalaya” (Sharma Ghanshyam, et.al, 2012: page no. 200-201)

The grazing land actually lies in between the altitude of below 4500 metre to 5000 meters. In addition to this, grazing of animals also occurs at some areas at the height of

¹ *Lachenpas* are the people residing in *Lachen*, North Sikkim.

5000 meter to 5500 meters. The shaded areas above 5500 meters in a map are basically of snowy mountain peaks and higher ridges.

Muguthang and Gurudongmar renders a very different story of yak grazing pertaining to the size of yak holding, mode of earning livelihood, different aspects of problem, etc. However, both region falls under the jurisdiction of *Lachen Dzumsa* wherein all activities of nomads has to be undergone through the propaganda of the local administration. To be more precise on this, the local governing body (Lachen Dzumsa) actually controls the selling and slaughtering of yaks. In such case, even the real owner of animal has no legitimacy to sell his or her animal to anyone beyond the price value determined by the local governing body. However, for the last two years the local administration has fixed the price value of Rs. 30,000 per Yak if any shepherd is found or caught while selling his or her cattle beyond the legitimate rate of local administration then he or she may have a high probability of paying unbearable penalty to the system. Nevertheless, the determined price value varies according to the size, weight and health of the animal but one cannot go beyond Rs. 30,000 even if the cattle is of greater health and size. Despite of strict rule regulated by the system, the selling of yaks even at greater price value in covert form are seldom occurs. The selling and slaughtering of yaks highly occurs during or prior to the celebration of numerous kind of festivals such as New Year, *Losar*².

² Losar refers to the Tibetan New year of Lunar Calendar.

4.3.1. Dokpa of Muguthang Region

The region is basically a Trans-Himalayan grassland in the exposed river valley of *Goma Chu* in northwest Sikkim, with boggy marshes, glacial lakes, barren scree slopes and glaciers. It is accessible from *Thangu* via the high 5,900 m pass, the *Lungnak La*. Snowfall makes the Valley inaccessible in winter. *Goma Chu* originates in North and South *Lhonak* glaciers and runs across the Valley to join *Zema Chu*. *Zemu* glacier is at the southern end of the Valley, as is the Green Lake. This Valley is the only known breeding area in the Eastern Himalayas of the Black-necked Crane *Grus nigricollis*. Lakes and marshes here are used as stopover sites for migratory water birds and support populations of the Sikkim Snow Toad *Scutigera* sp. Vegetation is typical cold desert, with *xerophytic* species such as *Ephedra gerardiana*, herbs, grasses and sedges, aquatic weeds and many medicinal and commercially valuable plants such as *Picrorhiza kurrooa* and *Meconopsis horridula*.

Forestry operation, Military deployment, GREF work, Nature conservation and research, and Tourism/recreation/mountaineering expeditions are the land used in the region. The prominent threats and conservation issues in the region are accumulation of non-biodegradable garbage, Stray dogs around army camps, Spread of disease to wildlife, Collection of wild medicinal plant, Poaching/snaring of wildlife. Overuse of *Tchopta-Lungnak La-* Muguthang trail and habitat by pack animals (horses, yaks) of Border Police has been reported during the Sikkim Biodiversity Strategy and Action Plan exercise of the State Forest Department. Besides large numbers of horses on the trail to

ferry rations across the *La*³, the attendant hazards of harvesting/collection of commercially valuable medicinal plants such *Picrorhiza kurrooa*, *Nardostachys grandiflora* and poaching of Blue Sheep and Himalayan Marmot by the travellers have been reported. The military has a permanent station here with many outposts, as there have been incidents of Tibetan refugees coming in over the passes. As a result of past airdrops, till date, one can see broken jerry cans and sacks of coir padding littering the landscape.

The valley is home to Tibetan Drokpas who graze yak in a rotational system governed by traditional laws. Perhaps due to the outside sheep brought into the Valley for food for the military, a disease has killed off the entire local sheep population, and according to the local Animal Husbandry authorities, the disease may still persist in wild snails found in the marshes and wetlands of the region. On finishing their duration, usually over a year or two, in this difficult region, the military personnel leave their pet dogs behind. These 'pet' dogs survive by scavenging kitchen and mess wastes. They have multiplied over the years and have now taken to roaming in packs on the plateau in *Tso Lhamo, Lhonak and Lashar*, hanging around army camps during mealtimes, preying upon wildlife and have even been seen swimming in the glacial lakes after *Brahminy Shelduck* chicks. Of late, they have taken to preying upon domestic livestock of the Dokpas. In order to protect the wildlife of this site, these free-roaming 'pet' dogs need to be eliminated without further delay.

³ *La* refers to pass in Bhutia language

The region is considered to be a great grazing land by the people of Lachen for yaks from time immemorial.

The nomadic community has been characterized by eighteen families among which three families are of Sikkimese origin and rests are the Tibetan Diaspora⁴. Here, beside grazing of animal, the *Drokpas* also cultivate crops in small patches of land for their sustenance and the grown crops aren't meant for sale but for self consumption. Due to very less amount of rainfall in the midst of growing their crops they do not rely on rain water in order to irrigate the land. Hence, they pull water through pipes from nearby river to the patches of cropped land and carries out irrigation for crops.

4.3.1.1. Size of Yak Holding and Livelihood in Muguthang Region

In terms of size of yak holding, the Muguthang region has a larger number of yaks as compare to Gurudongmar Region and this is due to the availability of adequate amount of grasses to Yaks. Within the domain of Nomadic understanding of their animals, Yaks are being segregated on the basis of their biological characteristics (sex) such as '*Yak or Yaahk*' refers to the male Yak and '*Gnoh*' refers to the female one. Generally, common people summons Yak to both male and female yaks. This division of animal (Yaks) is important for nomads especially when they have a deal of selling their animal because male Yak worth higher prices than the female. The study has unveils that the number of livestock (Yaks) of nomadic community in Muguthang region accounts not lesser than sixty in each family.

⁴ Interview with Head Representative of Community reveals the pattern of Nomadic Life in Muguthang region (Interview conducted on 15th July 2016).

“ I am appointed as community head and I look after all matters pertaining to the issues and problems of my people. Currently I am grazing one hundred and thirty yaks. Like me other families are also accounting not lesser than sixty in case of numbers of Yaks. Yaks are the source of our livelihood. We sell their prominent products like raw butter, fresh cheese, hard cheese, manes etc. We don't go to far places like Gangtok to sell our products but we tend to sell our products in Chungthang which has been within our reach. Though we do not generate lavish profit from this traditional way of earning but its enough to sustain our livelihood. Besides depending on the selling of milk oriented and other products of Yaks, we use some of our cattle in order to ferry the ration of Indo Tibetan Border Police (ITBP). We are more concern about the availability of grasses to Yaks in winter and increasing number of stray dogs” (Tsogyal Bhutia, Community Head of Muguthang)

The above mentioned statement of Community Head gives an understanding of broader scenario of the Nomadic life in the region. The mode of earning is by selling milk products like *churpi* (cheese), butter, selling of yaks etc⁵. Nomads sell *churpi* (hard cheese) at Chungthang, North Sikkim wherein each loop of *Churpi* is sold at Rs. 600 per Kg. Around 60 to 70 kg of *churpi* are sold annually. In addition, *churpi* is well liked by the people of Sikkim and there is always a good demand of hard cheese made out of yaks' milk.

⁵ *Churpi* is basically refers to cheese but it would be of either fresh cheese or hard cheese. Fresh cheese can be cooked which is mainly consumed with food but the hard cheese can be carried in pocket in order to chew it as a traditional chocolate.

The region has many outpost of ITBP at ridges and there is no vehicle access to this region. Amidst the traditional way of leading nomadic life, the ITBP is generating some source of income to the Nomads of Muguthang, North Sikkim.

Yaks are being deployed by the nomads in order to carry goods of ITBP. These goods are brought in Truck of ITBP at Kala Patthar, last point of vehicle accessibility which is 8 km away from Thangu. At Kala Patthar, goods are being transshipped from truck to giant yaks. These yaks will further travel around 18 km at the height of 4000 to 6000 metres. However, it is very difficult to reach rations of ITBP to their outposts located at higher ridges of the region during peak winter months of December, January and February due to the thickness of snow cover all over the months.

Hence, rations and other necessary goods are carried to this region during dry months of April, May, June and July. Rations are being dumped in order to store which will be used later during extreme climate season. Nevertheless, the carrying charge of goods per yak is Rs. 800⁶. Most of the nomadic family purposively engage some of their Yaks as goods carrier of ITBP.

Amidst the yields from Yak, the drokpas are seldom boosted economically by engaging themselves in collection of medicinal herb which is popularly known in Himalayan range as *Yartsa Gunbu*. To be more precise, *Yartsa Gunbu* is a Tibetan term given to *Ophiocordyceps sinensis* whereby 'yar' means summer and 'tsa' means grass and 'guen' means winter and 'bu' means insect.

⁶ The head of nomadic community reveals the carrying charge of Yaks (Interview conducted on 7th July 2016)

According to the interviewed respondents, they sell their collected medicinal plants (*Yartsa Gunbu*) to broker who actually hails from Lachen, North Sikkim. They sell their plants at Rs. 30 to Rs.40 per piece which is comparatively very reasonable price than the broker's actual selling price in mainstream.

Some section of people from mainstream *Lachen* are also engaged in the collection of *Yartsa Gunbu* during peak season of collection i.e., from mid April till mid July.

Plate.4.1. Yartsa Gunbu



Source: <https://www.google.co.in/search?q=yartsa+gunbu+lachen&biw>

4.3.1.2. Dokpa Family in Muguthang Region

The region has a traditional nomadic herding system and Drokpa actually does not have their permanent house in grazing land as they keep moving into different altitudes according to the season determined by the weather.

The grazing land Muguthang region has all together eighteen family with a population of 90 people approximately⁷ but the said population doesn't exist in Muguthang as many of the family members are working and studying somewhere in mainstream areas. In addition, only active member of the family who actually takes care of their cattle are available in the region and the active member is non other than mother and father and in some cases the eldest one in the siblings are seen available in this region.

Nonetheless, these Dokpas leave their animals back in grazing land during peak winter season. The drokpa themselves spend time with their family during those season in places like Lachen, Chungthang, Gangtok etc. The Lachenpa drokpa mostly have their family in *Lachen* and the Tibetan *drokpas* have their family in Gangtok, the capital city of Sikkim. The study also indicates that many children of the drokpa are doing very fine as many of them are studying in colleges of medical sciences and engineering and universities.

4.3.1.3. Problems and Prospects of Drokpas of Muguthang

As stated in earlier phrases of this chapter that the stray dogs and grasses in peak winter are prominent matter for the *drokpas* of the region. Grasses are the crucial subject for the sustenance of the cattle and during winter season. Sometimes fodders are being dropped from helicopter but this one is seldom possible with consistent request made to

⁷ The head of nomdic community gave a size of population in generalised form (Interview conducted on 7th July 2016)

state government by *Lachen Dzumsa*⁸. The most annoying subject of drokpas are the increasing number of stray dogs which has been creating a lot many problems since its emergence. These dogs relentlessly feeds on minor yaks when the care taker is not around. In addition to this, it is always a great loss to the owner whenever their yaks are get killed or consumed by these uncatchable stray dogs.

In the context of animal farming anywhere in the world, there may have a different kind of diseases harming the livestock but the story of Muguthang is different as the Drokpas of Muguthang assures that there is no severe diseases faced by the yaks which indicates that the health of Yaks in this region is quite appreciable. This is quite amazing fact, Yaks have almost vanished in other parts of Sikkim due to end number of emerging diseases. The region might be having a abundance of good quality of grasses and medicinal herbs which is consumed by the yaks a great and the same may not be case with other grazing regions of Sikkim.

4.3.2. Dokpa of Gurudongmar Region

The story of grazing land in Gurudongmar region is quite different than the story of Muguthang region. Although, both regions bifurcates at Thangu and like Muguthang, Gurudongamr region is also characterized by cold dessert. Unlike Muguthang, this region has accessibility of vehicle till Indo-China border and this region is dominated by eight animal grazing community.

⁸ Focus Group Discussion with Drokpa reveals the problems of drokpas of Muguthang (FGD conducted on 8thJuly 2016)

Plate 4.2. Dokpa Community Head of Muguthang Region



Source: Filed Visit

Plate 4.3. Yaks are deployed as goods carrier of ITBP



Source: Field Visit on 16th July 2016

Plate 4.4. Transshipment of goods from ITBP Truck onto Yak's Back



Source: Field Visit on 16th July 2016.

Plate 4.5. Yaks Carrying Pipes to Lhonak Lake



Source: Talk Sikkim, Magazine, post from 17th November 2016

Among the eight nomadic families three of them are Lachenpa and the remaining families are of Tibetans as in Muguthang region. The nomadic herder of this region moves to higher altitude of *Tso Lhamu* during peak winter months of December, January and February and falls back to relatively lower altitude.

The basic problem of grazing yaks in this region is the nomad has to look after their livestock 24 hours as region has greater presence of army and many areas planned under bombs and mines. Animal may have a chance of penetrating into those dangerous portions of the areas. Many times animals get killed by moving into such areas.

4.4. Family Ecology of Dokpa

The family ecology explores how a family influences and is influenced by surrounding environment. Similarly, Dokpa family of Muguthang and Gurudongmar regions are also influenced by the surrounding environment⁹. The whole region is characterized by cold desert which restricts many facilities to reach the Dokpa family.

The Dokpa family uses dry animal dung fuel or dry manure fuel which is animal **feces** that has been dried in order to be used as a fuel source as the physical setting of the region restricts other forms of fuel sources like wood and Liquefied Petroleum Gas (LPG). Using dry **manure** as a fuel source is an example of reuse of excreta. The dry manures used by the Dokpa family are of yaks. Dokpa family consume large amounts of local biomass, especially yak dung, for cooking and heating. They still inherit the traditional lifestyle, including living in tents and burning yak dung for fuel.

⁹ Here environment refers to the natural setting of the region

4.5. Conclusion

In the midst of cold and dynamic climate and weather condition in a cold desert; the *dokpas* have other friend to talk besides their livestock and unfriendly nature. This unfriendly nature in the form of adversely changing climate and many other form create an undeniable relationship between the *dokpas*, livestock and the nature. In the end, *dokpa's* sustainable way of living to frequent encounter with nature builds them with special understanding of the place. This culture of *dokpas* eventually orients them in case of adversity in cyclic fluctuation in the resource base.

Unlike Muguthang, the grazing land of Gurudongmar region has a severe problems with an emergence of diseases to their livestock. The *dokpas* of the regions accuse that these diseases are brought along with other animals of Army which has been brought from mainstream India¹⁰.

Muguthang and Gurudongmar region have similar kind of yak grazing and yak oriented activities but dissimilarities in some subjects also occurs. To be more precise, the size of yaks' population are high in Muguthang region and comparatively lower in Gurudongmar region. Secondly, *dokpas* of Muguthang assure that there is no diseases harming their livestock but the *dokpas* operating in Gurudongmar region has different story to share as they complains that their livestock are suffering many unknown diseases which has been brought in by army along with other animals from other parts of the country. Those diseases are severely transmitting into yaks grazing regime.

¹⁰ Interview of *Dokpa* of Gurudongmar Region (Interview conducted on 9th July 2016)

Due to the absence of vehicle accessibility to Muguthang, the drokpas are getting an opportunity to engage some sections of their livestock as goods carrier of ITBP whereby they get to regenerate some profits beside selling milk made products of yaks. Such opportunity is completely missing in Gurudongmar region. Gurudongar region has a presence of Indian army and road connectivity is also available to this route.

Chapter 5

Summary and Conclusion

It is very obvious that the different geographical areas have varied form of agricultural system. The nature of Trans- Himalayan agriculture of Sikkim itself distinguishes it from other agricultural region of Sikkim. Agriculture in Trans Himalayan Sikkim has been associated with subsistence farming. Crop farming in Thangu region and animal farming (pastoralism) in its adjoining areas have been characterized by family farming. The Trans-Himalayan pastures in the entire adjoining areas of Thangu continue to be traditionally utilized for resource use through grazing and associated activities.

Nature of environmental problems in a mountain farming system in the context of their role in mediating the same by human efforts assumes prime importance. Major problem is short growing season owing to low temperature because of high altitudinal character of the region. Environment has influenced various aspects of agricultural economy of study area.

In the midst of a given environmental situation, a complex system of management has been existed in a region. This involves cropping season, rotational grazing, sharing of grazing lands, seasonal movements of animals, forage production for lean season etc. This also ensures that during the fallow period, the grazing land will have enough natural regeneration and biomass production. This is an indigenous conservation and management approach followed by the people in a region for sustainable management of agriculture.

However, the prevailing threats are seasonal variability, rapid reduction of grazing pastures, herd animals being predated upon by Tibetan wolf, snow leopard and feral dogs, landmines and winter forage shortage. The Dzumsa has ensured strong adaptive strategy in high altitude agro-pastoralism such as timing of farming, rotational grazing, movement of animals and fodder production for the lean season.

The Dzumsa announces the dates of movement of herds from one location to another as per the lunar calendar which is applicable to all herders. Irregular herding or shifting of livestock from one pasture to another, other than the specified dates is unlawful, resulting in fines levied by the Dzumsa.

Hence, the nature of agriculture in Trans-Himalayan Sikkim and issues and challenges of Thangu and its adjoining areas at different scales have been summarized as follows:

2.1. The climatic features of Sikkim is caused by its geographical location, relief and altitude ranging from 300 metre to 8598 metre above sea level and as such temperature condition vary from sub-tropical in the southern lower parts to cold desert in the snowy north. Study has been done on cold desert in the snowy North Sikkim. The natural setting of the study area actually shapes the anthropogenic activities, especially on crop production. It is therefore, the area is always characterized by harsh environment.

2.2. The study area falls in polar tundra type of climate which is characterized by cold winters and cool summers. Therefore, Thangu and its adjoining areas located in a regime of high mountain environment which acts as a restrictive

force on technological development within the region. The precipitation received in the region is mostly through snowfall only.

2.2.1. The amount of precipitation in a region is governed by location, altitude and physiography in extreme North Sikkim. Here, entire agricultural calendar is restricted to short summer months. Indirectly, the good amount of snowfall during winter months help in productivity of agricultural produce by providing soil moisture. The entire area ranges from semi-arid and arid zone with intra valley variations. Thangu receives a highest amount of rainfall in the month of July and August and the lowest amount of rainfall in November and December.

2.2.2. Despite cold climate all over the year, there is a variation of temperature in a study area. The minimum temperature ranges from -28°C , -16°C , -16°C and -10°C in respective months of January, February, and December and the maximum temperature ranges from 13°C , 12°C and 12°C in July, August and June.

2.3. The prevailing river system of study area contributes as main tributaries of River Teesta which originates from Gurudongmar- Cho Lhamu area via Thangu and Muguthang region with numerous small sources of tributaries. *Cho Lhamu Chu*, *Gurudongmar Chu* are the prominent rivers that originates from Gurudongmar region and flows as a beginning of Teesta river and later gets mixed up with other minor rivers such as *Chopta Chu*, *Kalep Chu* and other minor rivers at Thangu region and it continues to flow further below lower Teesta Basin. Likewise, *Goma Chu*, *Zeemu Chu*, *Lhonak Chu* are the important rivers that originates from Muguthang region.

2.4. The study area falls into the domain of one soil system wherein soil moisture and soil temperature are identified as *mesic* and *perudic* respectively. These soils are shallow, somewhat excessively drained, loamy-skeletal with gravel loamy surface, moderate surface stoniness and moderate erosion. They are classified as Lithic Cryorthents and Lithic Cryumbrepts.

2.5. As per the elevation map of Thangu, human settlement and agricultural operation lies between an altitude of 3500 metre to 4000 metre. The area which lies between an altitude of 4000 meter to 4500 metre are mostly forest land with trees and grasses and the area above 4500 metre are mostly of ridges.

2.1. Mountainous regions lack the process of industrialization. Human power influences the economic structure of a mountain region rather than technology. The level of socio-economic well-being in mountainous regions is assessed by the intensive utilisation of limited natural resources mainly in terms of land-use and cropping-pattern.

3.3.1. Land available for agriculture is extremely limited in isolated mountainous regions like *Thangu*. Increasing crop-yield is not easy. Maximum number of surveyed households are having '3 to 4' family member in the context of family size about 16 household falls in such category. This is followed by 14 households are in the category '0 to 2' family members. The lowest number of household are recorded in the category of '5 to 6' family member.

In the light of surveyed households; the maximum percentage of land size holding is found in the category of less than/equal to 1 acre by 62.86 percent of households followed by 22.86 percent of households is in the category of more than 1 acre to less than/equal to 2 acre and about 14.29 percent of households are found in more than 2 acre category. About 94.29 percent of households are operating agriculture in the category of lesser than/equal to 1 acre land size and 5.71 percent of arable land is found in the category of more than 1 acre to lesser than/equal to 2 acre. However, non of the land is operated above 2 Acre.

3.3.2. There are limits imposed on the growth and distribution of plants and animals by physical environment. Cropping systems of a region are decided by and large, by a number of soil and climatic parameters. The cropping pattern of study area is also determined by its own agro-ecological setting.

The study area is characterized by subsistence farming with very limited crop varieties. The prominent crops grown in the region are potato, reddish, mustard leaf and beans. The reddish and potato are highly celebrated in the region. According to the crop calendar; potato, Beans, and reddish are sown from the last week of April till the end of May and same are harvested in the month of September and October and mustard leaf is sown in May and harvested in July and August.

Traditional/local seeds are used in during agricultural operation in the region. Character and other hybrid seeds were seldom given to the farmer by Agriculture/Horticulture Department, Government of Sikkim but the farmer hasn't received hybrid seeds for the last couple of years. Moreover, the

local seeds are in greater use in study area. The traditional seeds are being dumped beneath the land surface in order to store during winter for next sowing season. The agriculture in study area has been encompassed by the use of natural fertilizer/manure rather than chemical fertilisers. The area has refrained from using chemical fertiliser since the declaration of Organic Farming in Sikkim.

Currently, the use of manure is mostly active in agricultural operation in the region. The wastes of domestic animal (cow dung) are being used in order to trigger the productivity. The majority of households in Thangu have kept small section of livestock (cow) in order to support their livelihood. The livestock produces manure for agricultural operation.

3.3.3. The cultivation of reddish and potato in a year is around 8 *mun* per household in general which is merely consumed by farmer. As stated in previous chapters; mountain farming is based on subsistence farming and the current study area is truly situated in such kind of farming system. The area has limited arable land holding which is only capable of feeding the farmer and their livestock but sometimes, farmer does exchange their yields with army personnel with other desirable goods which farmer cannot afford to get in such region such as kerosene, sugar, milk powder, chocolates etc.

3.4. Majority of farmers in the region are not satisfied with their agricultural operation under organic farming. Many farmers believe that the organic farming has scope in near future but it is taking time to adapt in order to proceed with greater agricultural output. However, the degree of crop

productivity has severely fell down under organic mode of farming as compare to earlier years.

3.5. The local governing body, *Lachen Dzumsa* is headed by the *Peepon* decides all form of agricultural activities in the region. In addition, sowing and harvesting of crops are decided by the local governing body and the farmers abide the instructions accordingly.

4.1. Trans-Himalayan yak herder are also a member of nomadic community of Himalaya who graze their livestock on different pastures according to the changing season of a year. The existences of yak herder are seen at various high altitudinal regions of Himalaya. However, when we talk of nomadic people or community within the context of Himalaya we basically recognize them with a region characterized by cold dessert and certain livestock. They are also known as *Drokpa* in the Himalaya.

4.3. The higher parts of the Gurudobngmar and Muguthang regions receive considerable snowfall during winters. The snow starts melting in April. Most of the rainfall is received from July to September above and is ideally suited for the growth of luxuriant forests and meadows. Gurudongmar and Muguthang has Alpine type of climate. The region is characterised by yaks and Drokpas and army outposts.

4.3.1. Muguthang region has a larger yak' population as compare to Gurudongmar Region and this is due to the availability of larger amount of grasses for Yaks. The mode of earning is by selling milk products like *churpi* (cheese), butter, selling of yaks etc. Nomads sell *churpi* at Chungthang, North

Sikkim. In some cases, yaks are being deployed by the nomads in order to carry goods of ITBP. Commonly, Drokpas are seldom engaged in collection of medicinal herb as well as insect herb which is popularly known as *Yartsa Gunbu* to supplement their incoming.

4.3.1. The grazing land Muguthang region has all together eighteen family. These *Dokpas* leave their animals back in grazing land during peak winter season and they spend time with their family during those season in places like Lachen, Chungthang, Gangtok etc. The stray dogs and grasses in peak winter are prominent matter for the dokpas of the region. The most annoying subject of drokpas are the increasing number of stray dogs which has been creating a lot many problems since its emergence¹.

4.3.2. The grazing land in Gurudongmar region is quite different than the story of Muguthang region. Unlike Muguthang, this region has accessibility of vehicle till Indo-China border and this region is dominated by eight animal grazing communities.

The nomadic herder of this region moves to higher altitude of *Tso Lhamu* during peak winter months of December, January and February and falls back to relatively lower altitude. The drokpa has to look after their livestock 24 hours as region has greater presence of army and many areas planned under bombs and mines.

¹ Interview with Head Representative of Droka Community og Muguthang Region.

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APPENDIX - I

GLOSSARY

Dzumsa: Local governing system existed in Lachung and Lachen, North Sikkim.

Peepon: Head representative of local governing system.

Meteoblue: Meteoblue is a meteorological service created at the University of Basel, Switzerland, in cooperation with the U.S. National Oceanic and Atmospheric Administration and the National Centers for Environmental Prediction. Meteoblue was the world's first weather service to offer weather prediction in a graphical synopsis for any arbitrarily chosen location on earth

Churpi: It refers to local cheese.

Inceptisols: Inceptisols form quickly through alteration of parent material. They are more developed than entisols. They have no accumulation of clays, iron oxide, aluminium oxide or organic matter.

Entisols: An entisol has no diagnostic horizons, and most are basically unaltered from their parent material, which can be unconsolidated sediment or rock. Entisols are the second most abundant soil order (after inceptisols),

Mollisols: Mollisols form in semi-arid to semi-humid areas, typically under a grassland cover. They are most commonly found in the mid-latitudes. Their parent material is typically base-rich and calcareous and include limestone, loess, or wind-blown sand

Drokpa: Traditional Nomads of Trans-Himalayan Sikkim

Yartsa Gunbu: Its scientific name is *Ophiocordyceps sinensis*. It used for medicinal purpose. Yartsa gunbu is a term used in Tibetan language whereby 'yartsa' means summer grass and 'gunbu' means winter insect.

La: La means Pass in Tibetan Language.

APPENDIX - II

FOCUS GROUP DISCUSSION CONDUCTED IN THANGU AND ITS ADJOINING AREAS

SI. No.	Name of Place	No. of FGDs	Group Type	Participants	Date
1.	Thangu Valley	1	Mixed	7	16.07.2016
2.	Chopta Valley	2	Women	5	17.07.2016
			Mixed	7	18.07.2016
3.	Kala Paththar	1	Male	5	17.07.2016
4.	Yathang	1	Mixed	4	19.07.2016

APPENDIX - III

THANGU VALLEY



APPENDIX - IV

THE OLDEST REpondent AMONG THE CONDUCTED INTERVIEWS



Name: Chamden Lama

Gender: Male

Age: 85

APPENDIX - V

DOKPAS OF MUGUTHANG REGION LOADING RATIONS OF ITBP ON YAKS' BACK

