Agricultural innovation in Arun valley of the Himalayan region

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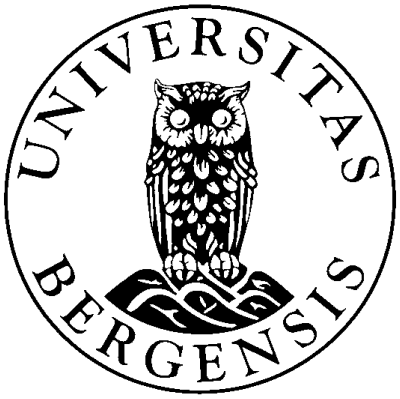

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DEDICATION

TO MY PARENTS

Abstract

Majority of subsistence farmers in the Himalayan region have been suffering from several problems, which emerged due to social and environmental changes. Scientific studies have already predicted more serious and unpredictable production situation in coming days. In recent times, many academic and non-academic researchers have advocated agricultural innovation as a vital strategy to cope with those problems as well as to face the unpredictable production condition. Therefore, it is important to explore the circumstances that influence the occurrence of agricultural innovations. This thesis assumes that the frequencies of actual innovations are an index of farmers' innovative capacity. With this assumption, it attempts to make an investigation into the farming practices in Arun valley area of the Himalayan region particularly focusing on mapping innovative practices and analyzing the influencing factors as well as actors of farmers' innovative capacity. On the conceptual level, it attempts to conceptualize innovative capacity as adaptive ability.

The empirical evidences for this thesis have been produced from eight weeks fieldwork in 2016 employing household survey (n=50), group discussions (n=4), key informant interviews (n=10) in two different villages: Majuwa (subsistence-oriented) and Aahale (market-oriented). Innovation system approach has been applied as a theoretical framework and data analysis has been based on the integrated innovation system model, which has been designed by integrating the concept of 'innovation system' and 'innovative place'. The result from comparative case analysis between two villages shows that more innovative practices have been emerged in Aahale than Majuwa during last ten years' duration. Higher frequency of innovativeness has been identified mainly in off-season vegetable and livestock sectors in Aahale. In the both sectors, interconnected nature in innovation adoption has been observed in which the first adoption itself has become an inducement to the next. Therefore, based on the assumption, it has been revealed that Aahale village has higher degree of innovative capacity than the Majuwa village. Concerning the influencing factors and actors, it has been found that wide and various institutional associations, efficient governmental supports, good market access, sufficient water availability, limited labour migration and less impact of socio-cultural barriers are the major enablers of farmers' innovative capacity and innovative practices in Aahale village. The lack of these supporting factors and actors and high impact of social-cultural barriers have enacted as impediments of innovative capacity and innovative practices in Majuwa.

It has been concluded that farmers' innovative capacity can be raised through promoting multiple factors and actors not through a single or specific factor and actor. While taking into consideration the adaptive ability in multiple challenges and uncertain future, it can be said that innovative practices such as adoption of hybrid crops, higher breed animal varieties and use of modern technology tend to increase productivity and profitability of agriculture. It could raise the farmer' well-being and reduce the poverty but not all the innovative practices and modification necessarily increase the adaptive capacity to climatic and other uncertainties. It essentially depends on the specific context and circumstances of the farmers' household, community or country.

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CHAPTER 1: INTRODUCTION

Agriculture sector is increasingly being affected by global environmental and social changes in the world (Tilman et al., 2002). The challenge of food production and risk of food insecurity is growing because the population size has been predicted to reach nine billion by 2050 in the world (FAO, 2014b, Fischer et al., 2014). In addition to this, the uncertain climatic situation is expected to cause production decline in several developing countries (IPCC, 2014). It has been estimated that about ten percent of agricultural productive capacity in developing countries will be declined by 2080 due to global warming (Cline, 2007). The smallholder farmers particularly from Asia and Africa are likely to face the challenges of food production (Godfray et al., 2010). Majority of rural farmers in these region have been already trapped by poverty and food insecurity due to the low production and lack of adequate food access (FAO, 2015). A way to cope with those challenges of agriculture and to face future uncertainties is to enhance farmers' innovative capacity and empowering them for the betterment of agricultural production. Recently an argument about strengthening innovative capacity has gained substantial attention among the diverse group of academics, researchers, multilateral and bi-lateral development stakeholders (World Bank, 2006, Klerkx et al., 2009, Aase et al., 2013). At this point, this research specially focuses on assessing innovative practices of agriculture in the Himalayan region. By identifying various actors and factors of agriculture, this thesis analyses how those various actors and factors influence the farmers' innovative capacity and actual innovation in agricultural practices. It also analyses whether farmers' innovative capacity makes them more adaptive or not to cope multiple challenges and face uncertain production condition.

1.1 The multiple challenges and the issues of agriculture in the Himalayan Region

The Himalayan region is said to be naturally fragile and instable due to steep and rugged topography. Large number of farmers in this region have been contended with several challenges, for instance, rainfall variability (Bookhagen and Burbank, 2006), low agricultural productivity (MOAC, 2013) and increasing labour mobility (Massey et al., 2010) etc. The farming practices are still subsistence oriented and conventional. Overall progress of agriculture sector has been constrained by numbers of hindrances (Lancker and Nijkamp, 2000). Such as, high degree of fragility, marginality and limited accessibility are the major constraining factors (Jodha, 2000), which have created a complex problem to the farmers and their farming activities. The loss of top soil from the cultivated land due to soil erosion is

very high which causes negative impact on soil productivity and crop production (Ghosh et al., 2012). Most of the farmers have small land holdings and the rate of land fragmentation is high due to rapidly added number of families (MoAC, 2014). Besides some pocket areas, the cultivation practices are more labor intensive and the use of modern technologies is very insignificant throughout the region. Farmers have to depend on rainfall due to limited access of irrigation facilities (FAO, 2010, Shrestha, 2000). Additionally, the access to market for agricultural input and output supply is limited because of inadequate road access. Farmers often suffer from inefficient flow of market information and an unorganized market structure (NARC, 2010). Farmers who have less marketing information and knowledge is affected to the low returns to them. The costs and access of farm inputs such as fertilizers, pesticides and supply of other resources are increasingly linked with the global markets. Farmers always have to face market uncertainty due to higher external dependency for agricultural inputs. Furthermore, frequently occurring extreme climatic events often limits the agricultural production and productivity in this region (FAO, 2014a).

People's livelihood activities have always been affected by multiple global stresses and challenges (O'Brien et al., 2009). According to a recent report of World Economic Forum (2017) the most important global challenges are social instability, climate change impact, large scale regional migration etc. The impact of such kind of global challenges in agriculture of the Himalayan region is higher than other part of the world (Xu and Grumbine, 2014). It has been considered that farmers and their farming practices in this region are being highly affected biophysically by rising temperatures, changing precipitation regimes, changes in soil fertility and increasing atmospheric carbon dioxide levels (Manandhar et al., 2013, Immerzeel et al., 2010b). They are also being affected by changes in global socio-economic changes, for instance, fluctuation of global commodity prices, regional changes in agriculture productivity, population dynamics, political instability and international relations etc. (Parry et al., 2004). It has been widely agreed that to address such challenges and tackle with such problems it is fundamental to raise the farmers' innovative capacity and bring innovations in farming practices for environmentally sustainable and economically viable food production that eventually led to cope and adapt with increasing climatic and non-climatic uncertainties (see Aase et al., 2013, Joshi et al., 2012, Chhetri et al., 2012, Rodima-Taylor et al., 2012, Klerkx et al., 2009). However, the issue is remained uncleaned when it comes to the questions, how innovative capacity can be raised? What kind of actors and factors influences

the innovative capacity? Do all innovative actions in agricultural practices enhance the adaptive ability?

1.2 Innovation as a key to strengthen the farming system

In this thesis, innovation is chosen as a fundamental analytical concept in the process of understanding local-level agricultural dynamics in the context of multiple challenges and uncertain future. It considers that multiple challenges and uncertainties are caused by social and environmental modification which span local to global level affecting farmers and their farming practices. Thus, innovation can be a fundamental approach to strengthen farming system.

The term innovation refers to 'the action or process of introducing something new'[1]. It can have multiple meanings, however, the innovation concept given by Mytelka (2000) is used in this thesis. Her concept of innovation is essentially unlike than the concept of invention. She defines, innovation is *"a process by which firms master and implement the design and production of goods and services that are new for them, irrespective of whether or not they are new to their competitions" (* Ibid:18*)*. Using this concept of innovation Mytelka has given an account of innovation system. The innovation system considers that innovation emerges through the multiple socio-economic actors', their interaction and learning.

As an analytical framework, I have combined two concepts; the 'innovation system' and the 'innovative place' for this study. The concept of innovative place is associated with the recent paper of Aase et al. (2013) where the concept of innovation has been conceptualized as "capacity to adapt to change". The study suggests that innovations in agriculture can be can be understood as "innovative place". The more detail of theoretical framework will be illustrated in the theory section of the thesis.

1.3 Agricultural innovation: review of the global level studies

Existing studies that analyze the issue of agricultural innovation show that the questions of how innovations in agriculture of developing countries can be promoted and how innovative capacity can be raised are complex and sometime are contended. Studies which advocate the liner process of innovation argue that if scientific or public researches were performed well, technological innovations such as modern technologies could be transferred in a linear way

[1] https://en.oxforddictionaries.com/definition/innovation

towards the farmers. On the other side, studies which advocate the innovation system and principally stand as the opponents of liner process of technology transfer, argue that innovations in agriculture emerge through the interactive process of individuals and organizations within social, political, policy, economic and institutional context (see.World Bank, 2006 p.12)

Innovation studies which specially focus the agriculture of developing countries of Asia and Africa have frequently employed the thought of innovation system. Those studies have arguably suggested the significance of institutional cooperation and setting among the actors of innovation system. Scholars such as (Hall et al., 2003, Horton and Mackay, 2003, Spielman et al., 2009) have acknowledged that the institutional network and learning within a system can be the core incentives of agricultural innovation process. In similar vein, a study about Dutch agricultural innovation gives more emphasis on the involvement of 'innovation brokers' in which intermediary organizations play important role in bridging the innovation actors for the successful innovation (Klerkx et al., 2009).

Many empirical studies have mentioned that the innovation system instead of liner process provides the vital way of agricultural development. For instance, according to Clark et al., (2003) the combination of both research and intervention are crucial to gain agricultural innovation. Presenting empirical evidences of small-scale farmers of the northern India, the study revealed that, INGOs, NGOs, local organizations and their project's intervention have played important role to promote farmers for tomato cultivation and improving post-harvesting mechanism (Ibid:1852). An another example of native potato farmers from Andean highlands of South America shows that farmers in this area have been benefited from the collaborative interventions implemented within two institutional approaches (Devaux et al., 2007). First, the participatory market chain approach (PMCA) and the next is Stakeholder platform. These approaches were designed within the innovation system framework and implemented in collaboration of actors from multiple fields, such as NGOs, universities, civil society including farmer which promoted farmers in post-harvesting as well as marketing capacity.

It is also argued that participatory activities facilitate to strengthen the farmers network, knowledge sharing practices and interpersonal trusts. The public policy, governmental interventions along with institutional arrangements and their networks have got successful result in Cassava production in Colombia (see World Bank, 2006 p.45). The Cassava

production has been shifted from the traditional subsistence crop into a market oriented product. Government's effort for creating value chain and extending networking among the stakeholders is one of the favorable enabling environments. A study of Prasad (2005) shows that there was significant role of a civil society organization i.e. *Murugappa Chettiar Research Center* (MCRC) and other non-governmental organization to enable both production as well post-harvest innovation of Spirulina (a high quality food supplement that contains multiple vitamins) in India. The evidence of Ghana shows that small scale cocoa farmers of Ghana obtained several innovative changes such as adoption of hybrid cocoa seed via social networks (Boahene et al., 1999).

The literatures on agricultural innovation conducted based on innovation system reviewed so far have mainly advocated the role of social actors i.e. institutions, farmers group, civil organization, research organization etc. to bring agricultural innovations. However, the limited scholars have studied the role of natural resources which is important factors of in agricultural innovation. Aase et al. (2013), for instance, suggest the important role of land, water, climate in farming system innovations besides social actors.

Moreover, it has been documented that, the role of farmer's socio-economic status and inter-personal characteristics on agricultural development can be significant (Boahene et al., 1999). Farmers and their family's socio-economic status, attitude, knowledge and education could have direct and indirect influence on agricultural changes (FAO, 2014b). For instance, in rural part of Ethiopia, educated farmers improved their farming practices than the ones without education (Knight et al., 2003). The indirect effect of education is also found positive in this area (Ibid). Within farmer's family the gendered influence on agriculture innovation in terms of flexibility, role and responsibility within socio-cultural context of household has been worth noted (Ilie et al., 2005). An empirical evidence from Malawi shows that the spouse's education and women's involvement in decision making in farming activity is vital and positive. In this case the traditional informal network and Muslim culture had negatively influenced on progress of agriculture (Mutenje et al., 2016). However, none of these studies were conducted based on innovation system framework focusing the agricultural innovation.

It has traditionally been understood that agricultural innovation is a good way of raising agricultural production (OECD, 2013) and in recent years, it has been recognized as an important approach to tackle with farmers multiple challenges (Smit and Skinner, 2002). Therefore, studying the process of agricultural innovation has got considerable attention in

the literatures. However, to date, except few, most of the studies only focused to the social actors and institutional influence on agricultural innovation process. Thus, it is crucial to analyze multiple factors and actors of agricultural innovations for instance, social institutions, natural resources, farmers' socio-economic conditions, accessibility etc. This is because farming practices are directly and indirectly associated with the multidisciplinary context (Turner and Brush, 1987) and could be influenced by various circumstances.

1.4 Agricultural change and innovation: review of the local level studies

As I explained in previous section (1.2), farming system and farmers have several issues in the Himalayan region and there is a pressing need of improving farming system. It has been considered that farming system can be improved through the process of innovation, therefore the issue of how actual innovation process comes in farming system is important. Several studies have been carried out about the Himalayan farming practices, related to the effect on ecological degradation and recently the concern has been directed towards the agricultural innovation in relation to climate change. In this section, I review some previous studies related to the Himalayan farming practices, its change and innovation.

Since 1970s, a great academic attention has begun in Nepal Himalaya concerning the issues of Himalayan people and environment. Over the decade of 70s and 80s scholars such as Eckholm (1976), Blaikie et al. (1980), Ives (1987) and (Bishop, 1990) have mainly raised the problems of rapid population growth, rural poverty and ecological degradation from the neo-Malthusian casual explanation. Particularly in the account of Eckholm (1976) and Ives (1987), the rapid population growth and traditional farming practices for example, slash-and-burn agriculture, shifting cultivation conducted in slope and marginal land of Himalayan region were recognized as the main causes of deforestation, soil erosion and downstream flooding (Guthman, 1997). Although their understanding and explanations about farming practices and ecological crisis have been largely questioned and got several alternative explanations, it has become a hegemonic narrative among the academic and non-academic researchers as well as policy makers (Ibid:p.46).

Regarding dynamic and changing nature of agriculture of Nepal, studies on agricultural change have explored different driving factors of change. For example, studies of Dahal et al. (2009) and Raut et al. (2011) in mid-hill of Nepal have found that farmers have shifted their need-based cereal farming system (i.e. subsistence oriented) to the marketed-oriented

vegetable production. In these case, the proximity to market, availability of water for irrigation, and road network up to cultivated filed have been observed as major agricultural drivers. Similarly, Brown and Kennedy (2005) assess the impact of cash generating vegetable crops on farmers well-being in mid-hill of Nepal Himalaya. They found that adoption of vegetable crops has raised the farmers' well-being, however, farmers' willingness of cultivating such crops as primary product has been found less because of the higher market uncertainties. Study of Chapagain (2003a) found several new changes in agricultural practice in Ilam district of Eastern Nepal and observe significant improvement in overall farming system. However, variations in adopted of cash generating value crops such as tea, large cardamom have been found in different villages. The analysis stated that, this is due to the dissimilarity in economic, social and cultural conditions of the farming villages (Ibid:15).

Studies on agricultural change have primarily observed the patterns as well as determinants of change and its economic outcomes. In some of the recent studies, agricultural innovation and innovation process have been advocated as a strategy of climate change adaption. Chhetri et al. (2012) for instance, found that farmers-institutions alliance and recent shift of institutional arrangement from top-down approach to participatory approach has released thirteen different rice varieties in Nepal, among them four varieties are cold tolerant which are targeted for the high-altitude region, and nine of which are drought resistant targeted for marginal rice growing areas. Similar evidences have been found by Bhatta et al. (2015) in which they stated that community-based approaches have become a viable option promoting innovative practices in remote rural villages of Nepal. Several agricultural stakeholders have actively engaged to generate innovative practices through the interactive learning that has helped farmers to adapt with climatic and other impacts.

Besides, farmers-institution alliances and community-based approaches, the significance of indigenous knowledge has been recognized as an important basis for farmers to adapt with climatic effect Manandhar et al. (2011), however, the study suggested that the external support through governmental agencies is equally important to develop other location-specific adaption strategies such as development of irrigation facility and promotion of climate resilient crop varieties. Moreover, considering the recent climatic and other uncertainties of Himalayan farming system, researchers such as Aase et al. (2010) and Holmelin and Aase (2013) have suggested that Himalayan farmers have abundant of

unexploited resources that could make farmers more flexible in terms of resource use and that possibly increases the resilience of farmers to adapt with changing situations.

The review of major previous studies show that the existing studies about agriculture practices and innovation in the Himalayan region can be categorized into three distinct groups. The initial set of studies recognized the farming practices and farmers of the Himalayan region as the causes of socio-economic and environmental crisis which were remained influential until 2000s. Since, then concern has been given towards the understanding of agricultural dynamics and driving factors of agricultural change. In recent years, farming flexibility as well as farming system innovation have been suggested as the ways to cope with changing situations. However, the question of how and in what ways innovation in farming system can be brought seems missing to be explored in the Himalayan context. This thesis is an attempt of investigating farming system innovation analyzing evidences of two farming villages from Arun valley which is located in the Himalayan region.

1.5 Research questions

This research is envisioned to fill the current knowledge gap regarding farming system innovation of the Himalayan region. Therefore, the main objective of my research is to build knowledge about how rural farmers in the Himalayan region can enhance their innovative capacity that possibly makes them adaptive. To accomplish this objective, the following research questions are raised.

- What is the current farming system in the study villages of Arun valley?
- What are the emerging innovative changes in farming system during last ten years in the study villages?
- What and how various actors, factors, their networks and interactions influence the farmers' innovative capacity?
- Do the farmers' innovative practices raise their capacity to adapt to climatic and other uncertainties?

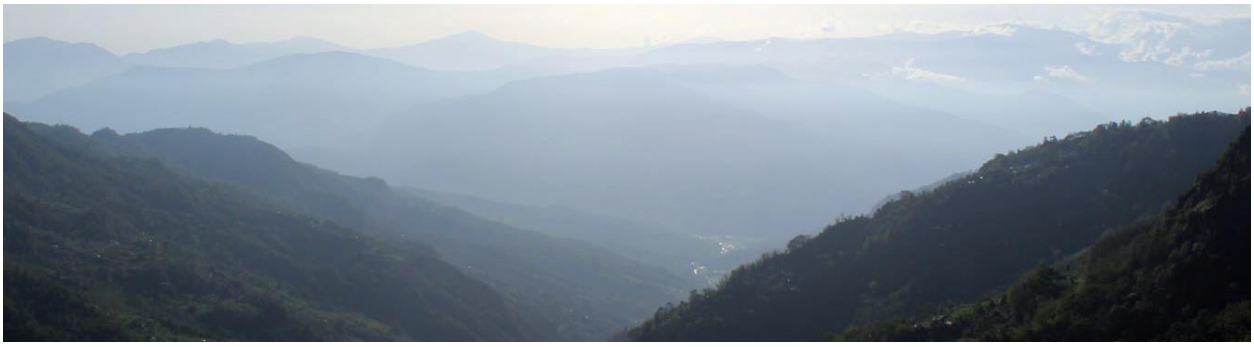
Theoretically, I raise the question, whether the integrated innovation system framework that combine the concepts of "innovation system" (Mytelka, 2000) and "innovative place" of

(Aase et al., 2013) is useful for analysis the influencing factors and actors of farmers' innovative capacity in the context of climatic and non-climatic uncertainty?

1.6 Structure of the thesis

This introductory chapter includes general background of the issue and statement of problem, a brief of analytical concepts, some review of previous studies and research propose. Chapter two provides overall information of the study area, its context and some changes of agriculture that are relevant for the case. Chapter three presents the theoretical consideration, specially focusing on innovation theories and concepts. It also includes the analytical framework. Chapter four contains the methodological approach of this thesis and the methods that have been used for data production in the fieldwork. Chapter five mainly concerns to address the first research question. It presents the current farming system of the study area based on farming system approach. Chapter six maps the innovative changes in farming system in both villages. It highlights the novelties in agricultural practice that have been emerged during last ten years' duration. Connecting to the theories and concept, chapter seven analyzes various factors/actors, network and their dynamism that influence the farmer's innovative capacity. The final chapter include the concluding remarks on the issue. The last four chapters (from chapter five to end of thesis) mainly concentrate to clarify and explain the issue based on empirical evidences. The chapter five, six and seven contain the summary of each on it and the final chapter includes the conclusion.

CHAPTER 2: ARUN VALLEY



Picture 2.1 The Arun valley

> "The Arun River is older than the Himalaya. (….) she begins her journey from Tibet, crossing Tibetan border she enters through the gateway of Mountains. (….) Passing the hills and plains she meets Ganges River in India and finally, terminates journey reaching the Bay of Bengal" -The Arun: A Natural History of the World's Deepest Valley (Cronin, 1979)

2.1 Nepal Himalaya

The Himalayan range is the newest mountain range in the geological history of the earth. It consists of several ice caped mountains including world's eight highest peaks. The range extends from north to southeast, crossing five different countries i.e. Bhutan, India, Nepal, China and Pakistan. The entire region is characterized by a complex geological structures, irregular slopes, extensive glacial systems, heterogeneous geography and higher climatic variability (Zurick and Pacheco, 2006). It is also known as water tower of Asia that feeds several perennial rivers such as Ganges, Indus, Brahmaputra, Yellow, and Yangtze in which nearly one and half billion people, several flora and fauna are directly and indirectly depended (Immerzeel et al., 2010a).

Nepal is both anthropologically and geographically characterized as a diverse region. It has various unique and distinct features. A Swiss geologist Hagen (1969) documented Nepal as a kingdom of the Himalayas and the ethnic turn-table of Asia. He divided Nepal into seven distinct physiographic divisions: Tarai, Siwalik Zone, Mahabharat Lekha, Midlands, Himalaya, Inner Himalaya and Tibetan marginal Himalaya for the first time (Gurung, 1962). The major physiographic regions: Tarai (also called *Madhesh*), Hill (*Pahad*), Mountain (*Lekh*) which are commonly understood. These regions are different from each other in terms of climate, lithology, gradients etc.(Upreti, 2001). Tarai is located in the southern part of the country which is more flat and fertile. Most of the productive land is in this zone. Hill region

is located in the middle part and mountain is located in the northern part of the country. The Hill and Mountain regions are topographically rugged and have irregular slope. Majority of people live in the Hill and lower land of the region than the upper Himalaya. The study of this thesis take place in the Hill region.

The Hill region consists of a number of gorges, wide river valleys, and slope lands. Sub-tropical and temperate climate of this zone are appropriate for cultivation of different cash-crops, vegetable crops and horticulture (Upreti, 2001). Thus, the whole region is rich in agro-biodiversity (Gurung, 2002). A distinct human-nature relation and adaption can be found in people's varied living styles, diverse settlement patterns and different livelihood activities (Guillet et al., 1983). It is believed as a home of many ethnic, linguistic and religious groups. However, it is predominated by Hindus and Buddhists (Toffin, 1993). Agriculture activities are the foremost livelihood strategies of the local people. Multiplicity in farming system can be found along with geographic and cultural diversity in the entire area of the region.

2.2 Arun river valley: a brief history and geography

Arun valley[2] lies in the Koshi zone of Nepal. It covers most of the areas of one mountainous district, Sankhuwasabha and two hilly districts, Dhankuta and Bhojpur. Arun valley is said to be a home of various (*jatt and jaati)* castes and ethnic groups. In history, this region was the origin place of '*Kirat'*, an ethnic group which includes the *Rai* and *Limbu* castes[3] (Shrestha, 1989). Before the unification of modern Nepal (i.e. during 17th century) many *Kirat* leaders ruled this place when region was in the central section to *Kirat* territory called '*Majh Kirat'*(Subedi and Aase, 2002). It is believed that *Kirant* belongs to the 'Tibeto-Mongoloids' ethnic group who specially speaks Tibeto-Burman language (Toffin, 1993). The majority of *Rai* and *Limbu* are settled in the mid-hill region of the Arun valley and the Sherpa is dominantly settled on the upper ridge of valley. On the lower valley area, more *Brahmins* and *Chhetris* are inhabited. The lower occupational castes such as *Damai* (tailor), *Sarki* (cobbler),

[2] The Arun valley in this study refers to the area of Arun river basin, which lies only within Nepal because more than 80 percent of the total river basin area lies in the Tibet, an autonomous region of China, where it is known as *Bum-chu (wikipedia.org)*. The terms 'Arun Valley', 'Arun river Basin' and 'Arun region' have been used interchangeably.

[3] Nepalese society was categorized into different hierarchy of castes. There was discrimination between 'Clean or higher' castes *(Brahmins and Chhetri)* and unclean or lower castes (*Damai, Kami, Sarki)*. *Janajati* are ranked in the middle of the hierarchy. The constitution of Nepal of 1990 prohibited the caste based discrimination. The people's movement 2005/06 *(Jana Andolan 2062/63)* has also established several rights for lower castes. Although in law doing discrimination is illegal, its effect in society still exists.

Kami (blacksmith), and *Sunar* (gold smith) are also spreading in limited numbers around the entire Arun valley (Bista, 1967).

Arun River is the largest trans-Himalayan river of eastern Nepal. The river enters from Tibet and it has extensive snow- and ice-covered in the Nepal Himalaya area including Makalu Mountain in the west and the Kanchenjunga in the east side (Kattelmann, 1990). River flows 155 meter inside of Nepal joining with Sapta Koshi River system which is one the main rivers system. The valley of this river is believed to be the deepest valley in the world (Cronin, 1979). River's gradient in Hill and Mountain region is a quite steep. Therefore, the rate of soil erosion has been estimated considerably high (Shrestha, 1989). The total area of Arun river valley is extended about 36000 sq. km in China and Nepal, however, only 5028 sq.km or 14.17 per cent lies within Nepal (Subedi and Manandhar, 2002). Arun valley's Nepal section is located between 26^0 50' and 27^0 to 50' northern latitude in the eastern part of Himalaya.

Arun valley includes lower river valley in the south and mid-hill as well as higher ridges in the north. Upper ridge of valley is rich in medicinal herbs whereas the mid-hill and valley include sub-tropical and temperate forests and vegetation. The altitude starts from 150 meters in southern lower valley and it increases towards mid-hill and northern ridges, height goes up to of 8,470 meters of mount Makalu (Olen et al., 2015). Due to the altitudinal variation, the climate of this region varies from warm and moist temperate to alpine and arctic. The region gets a lot of rainfall during the monsoon season. Climate is characterized by pre-monsoon with thunderstorm in April and peak rainfall during July (Shrestha, 1989). Field study villages of this thesis are located in the mid-hills of Arun valley.

2.3 Agricultural practices

Agriculture has been an important source of livelihood of the people in this valley. Majority of people have been relying on subsistence agriculture for years (Shrestha, 1989). Cultivated land is dominantly occupied by cereal crops. According to governmental statistics of agriculture 2014, paddy and maize are still dominant crops in all three districts; Dhankuta, Sankhuwasava and Bhojpur of Arun valley (MoAC, 2014).

Agricultural land is locally classified into three major land categories i.e. *Khet, Bari* and *Pakho*. These land categories have their own meaning. The *Khet* is irrigated terraced land

especially used for paddy cultivation, which has sufficient water holding capacity. It also has higher land value, as rice is preferred crop. The *Bari* is un-irrigated upland in which maize is a primary crop but millet, wheat, pulses and potato are also the other corps that have been traditionally cultivated. Most of the *bari* area is depended on rainfall for the crop cultivation. Some *Khet* lands have river water access for irrigation. The *Pakho* land generally indicates the uncultivated slope land, which is used as grassland. Besides these three common land categories some other land categories can also be found in this area. For instance, a land which is considerably flat and large in size, is locally called *Tar*. The study of Chapagain (2003b) has also recognized the identical types of local categories of agricultural land in Ilam, a neighbor district of the study area.

Agroforestry is a traditional feature of agriculture in Arun valley in which farming system is formed within a complementary relationship of crops, trees and livestock (Neupane et al., 2002). Farmers grow varieties of fodder trees *(dale ghas)* in edges of the cultivated and slope land. Farmers also use forest-based resources such as fodder grass and bedding materials. Before three decade slash-and-burn, a traditional agroforestry was part of farming systems of this region (Chaudhary and Kunwar, 2002). It is locally known as '*khoria.* Marginal farmers in mid-hill zone commonly practiced *khoria* up to the time of 1990s (Bhandari et al., 2002). In this practice, farmers clear the vegetation cover first and cultivate one or few years continuously and leave fallow for a year or more. The study of Subedi and Pandey (2002) found that farmers have converted *khoria* land into more productive land such as *bari* and *khet* in upper hill of Arun valley.

Agricultural practices have been traditionally affected by several socio-economic factors. One of the important factors is uneven land distribution and ownership. This is rooted to the historical landlordism and traditional land entitlement practices. In Nepal, two major land tenure systems introduced by Shah and later used by Rana regime were *Raikar* and *Kipat. Raikar* system i.e. state owned land and *Kipat* was communal land. Arun valley was under the *kipat* system owned by *kirat* who were regional ethnic group of eastern Nepal (Gurung, 1980 cited in Gautam, 2011). *Kipat* is a customary and communal land tenure system. During 17th century Shah Regime granted eastern Nepal to the *Kirant.* In this system, all the villagers commonly used natural resources. In Arun valley wild grass, grazing land, dry firewood, bamboo, medicinal plants etc. were treated as common properties (Daniggelis, 1998).

During Rana regime (i.e. 1846 -1951), majority of farmers cultivated under the *Raikar* tenure system and they had to pay tax to the state. The tax collectors were called *Jimidar.* In the local level, tax collectors were called *Tharis* and *Subbas*. Some of land were gifted by state to the nearer of Ranas, and their workers such as priests, *Jimidar*, soldiers and noble families that was called *Birta* (Sugden and Gurung, 2012*).* They were benefited and got large size of land. However, these systems made small farmer more stagnant due to the tax system and state ownership. The long-term negative impact of traditional landlordism might have impeded the agricultural practice of small landholders in this region.

2.4 Innovative changes in agriculture

Arun valley has large area coverage with large altitudinal variation therefore, the agricultural practices may vary from village to village. The traditional agricultural practices have been gradually changing in particular area of the valley. Cultivation practices of traditional cereal crops progressively have been shifting towards the market oriented and cash generating crops. One of the noticeable recent progresses is the beginning of off-season vegetable crops cultivation which has been practiced well in the upper part of the valley along the highway. Villages (such as Khoku Chhintang, Patle Dhankuta) located in southern part of the valley are famous for sweet oranges and tangerines. A (HVC) high value crop, the large cardamom is popular in Sankhuwasava and Dhankuta districts. In addition, tea cultivation is one of the major cash crops in Dhankuta.

The recent report of NPC (2013) has also identified several improvement in agricultural practices in particular area of this valley. Report states that diversification of agricultural production has increased the agricultural surplus which has raised the household income. Adoption of new inputs and crop varieties have raised the marketable goods. Significant improvement in traditional production system have been occurred and the commercial utilization forest resources has increased since last decade.

Nonetheless, agricultural development of several villages is still insignificant where majority of farmers produce less than they need and some surplus production do not meet market demand. District level figure shows that only 19 percent people in Dhankuta and 21 percent people in Sankhuwasava are producing sufficient food for the whole year (MoAC, 2015). The large variation in agricultural improvement exists within the villages of the valley. In this thesis, two different villages have been selected for the study of farming system innovation.

2.5 The study villages

Fieldwork was conducted in two farming villages; Aahale and Majuwa of Arun valley. These two villages were selected for comparative analysis of agricultural innovation. The table 2.1 displays the brief information of the two study villages. Aahale village is located in Murtidhunga *gaun bikas samiti* VDC (Village Development Committee)[4] of Dhankuta district and another village, Majuwa is located in Tamaphok VDC of Sankhuwasava district (see, Map.2.1). According to the census 2011, about 11,133 people live in these two VDCs. Koshi highway is the main highway that connects village to the capital city and other part of country. Aahale and Majuwa both are located in same agro-ecological zone in altitude of average 1900 m.a.s.l.

Farmers in Aahale are cultivating cash-generating crops and the place is located relatively in an accessible place in terms of road, market, and service centers. Sidhuwa is the nearest market center located in southeast of Aahale. It takes about an hour on foot and 20 minutes by bus. Sidhuwa is also a place of periodic market (*haat bazaar).* Periodic markets are traditional forms of market held in open-air and once-a-week in a particular location (Stevens, 1996). Different places for *haat bazaar* have been fixed for different days of the week. In certain day of the week, farmers sell, buy and also exchange their products. People living in town area are the main buyers of local products such as vegetables, pluses, grains, butter (*ghee*), eggs etc. Farmers also exchange their agricultural products with household necessities such as soap, salt, sugar etc. with shopkeepers. This type of market system can be found in almost all districts of eastern Nepal (Gautam, 2011). This system helps local farmers linking them in market access where they can negotiate and barter their products. Jitpur is another market place for periodic market for farmer of Aahale which is located in the northwest direction. It is smaller than Sidhuwa. An earthen road connects Jitpur and Aahale to the Koshi highway in Sidhuwa. Load carrying vehicles (tractor) go to the village to carry agricultural products such as vegetables, milks etc. Buses can go only during dry season up to the village. Aahale farmers have adequate access of water resource for irrigation. There are two small rivers, Mahabhir Kali Khola in northern and Laxmi Khola in southern part of the village.

[4] A (VDC) *gaun bikas samiti* is the local level government unit in Nepal. Each district has several VDCs, and each VDC is further divided into wards that is lowest units of political division. Normally a ward is equivalent to a *gaun* but not to the *tole*, a ward could have more than one *tole*.

Some formal and informal institutions are working in Aahale village. For instance, there are two schools, three farmers' groups, one drinking water consumer group, one community forest user group, three local cooperatives and some mothers' groups *(Aama Samuha).* Among them famers' groups and local cooperatives are directly associated with agricultural improvement and progress of the farmers.

Table 2.1General profile of study villages

Study Village	Case Characteristic	Closest market center	V.D.C	Population of VDC	Number of Household of VDC	Average Altitude (a.m.s.l)
Aahale	Cash-crop oriented	Sidhuwa 1 hr.	Murtidhunga	4075	852	1923
Majuwa	Substance dominant	Mudhe 1.5 hr	Tamaphok	7058	1580	1941

Sources: Fieldwork, 2016

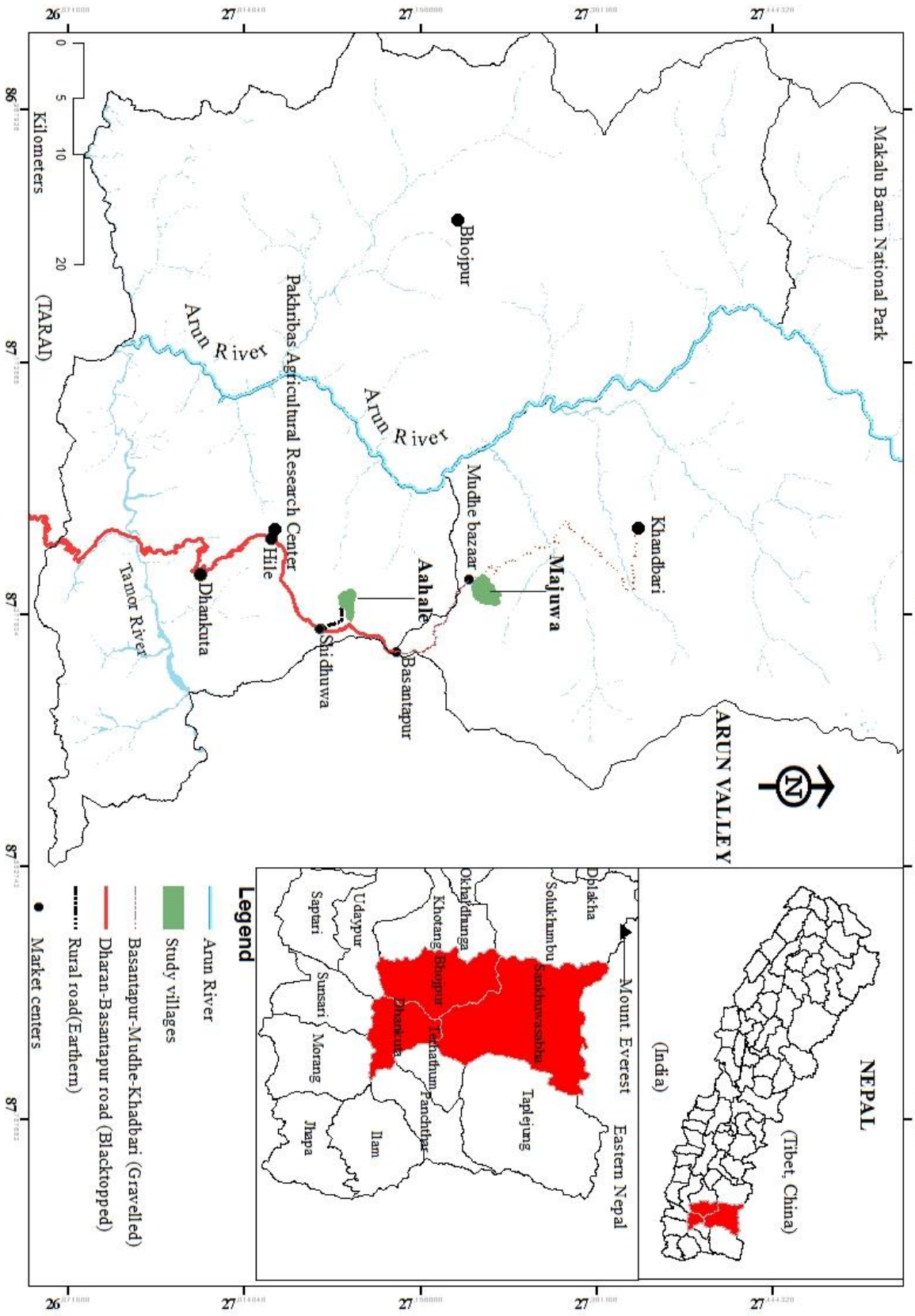
Another study village, Majuwa is located in Tamaphok VDC. It is situated southern part of Sankhuwasava district. It is relatively a remote village than Aahale village. The access of road, market, service centers seem insufficient. Only a gravelled road connects Mudhe bazaar with Koshi highway that usually disturbed during rainy season. Mudhe is the nearest market center where farmer can sale and buy goods but there is no road access between village and Mudhe. Farmers have to walk about one and half hour to reach Mudhe. Mudhe is also a place of periodic *haat bazaar* (see. picture 2.1). Every Saturday people from nearby area gather to sell, buy and exchange their products.

An unpaved road goes up to Khandbari i.e. headquarter of Sankhuwasava district Governmental administrative (local level) service centers and agricultural service centers are located in Khadbari. Agricultural practices in this village are more subsistence which has low productivity and profitability but farmers have other sources of incomes such as large cardamom, timber (from private forest) and remittance. Labor migration is higher in comparison to another village.

Picture 2.2 Mudhe periodic *haat*

In this chapter I have given a brief account on the study area that provides some features of Arun valley and some introductory descriptions of both study villages. The details of farming practices will be presented in the later section of the thesis.

Map 2.1 Arun valley and study villages



Sources: Survey Department, Ministry of Land Reform and Management, Government of Nepal (Data: Topographic data base, 1999/2002)

CHAPTER 3: INNOVATION THEORIES AND CONCEPTS

A theory indicates the "organized and patterned sets of ideas' from which researchers can obtain guidance for a research (Cresswell, 2012). Theories help researcher to understand and interpret the reality in a logical way. Over the time numerous innovation theories and concepts have been emerged in the field of agricultural innovation. Using these theories and concepts several academic and non-academic researchers have attempted to find better understanding intending to reform the agricultural practices and improve the farmers' livelihood. This thesis is also an attempt of generating knowledge and bringing more clarity on agricultural innovation. Therefore, it is crucial to look through the different innovation concepts and ideas. This chapter begins giving an account on concept of innovation and innovative capacity as the basic ideas of this thesis. Then, the chapter reflects upon different innovation theories particularly from the conventional liner approach to recent approaches. At the meantime, the chapter highlights the innovation system approach as an analytical framework of the thesis. It also presents a brief account on farming system approach to analyze farming system of Majuwa and Aahale. At the end, it shortly deals about the epistemological basis for this thesis.

3.1 The concepts of innovation and innovative capacity

The term 'innovation' has been used in various disciplinary contexts, for instance, industrial economics, agriculture, business, communication, management sciences etc. where the approaches to conceptualization and ways of application are different. In a historical account of Schumpeter, 1939 cited in Breschi and Malerba (1997) the concept of innovation is defined as a way of setting up of new production function through the technological and organizational reformation. He argued that innovations can only be promoted in technological frontier. The Schumpeter's concept is more directed towards the concept of invention rather than innovation (Mytelka, 2000). According to Rogers (2015), innovation is 'an idea, practice, or object that is perceived as new by an individual or other unit of adoption'. Rogers's concept emphasizes on the arrival of novelties in existing condition. These novelties comprise different components which can be indicated by questions of what is new, how new, and new to whom Johannessen et al. (2001). In an account of Barnett (2006) innovation is defines as

use of new ideas, technologies and practices in particular place adopted by people who have not used previously.

Predominantly, different theories and concepts of innovation have been elaborated in a broad range of economic and industrial issues. Where innovation has been considered as a key element of business success, as a component of entrepreneurship, as a means to create viable competency or as an economic significance etc. (Johannessen et al., 2001, Gebremedhin, 2009). It is argued that innovation is a specific tool of entrepreneurship through which entrepreneurs can apply principles of innovation to achieve successes (Drucker, 2014). Therefore, it can be defined as a way to success of any products, processes and firms. Concepts of innovation have also been used by different academic and non-academic (developmental agencies) agricultural researches, organizational and policy documents such as Clark (2002), Engel (1995), Hall et al. (2001) in the various contexts of agriculture, for instance; crop production, livestock, agricultural goods processing and agribusiness. However, conceptual difference between "innovation" and "innovative capacity" is not well documented.

This thesis is particularly concerned with the innovation in agricultural activities in rural context in which innovation and innovative capacity are not used interchangeably. In this thesis, the concept of innovation is defined as an introducing or adopting new crops, cropping patterns, new breeds of livestock, and new way of cultivation etc. in particular rural setting within certain period. The concept of 'innovative capacity is defined as capacity to innovate new practices or improve their existing farming activities. In other word, innovative capacity can be defined as capacity of farmers helping to be more innovative. Agricultural innovation is a newness that might has already taken place in other time and places but not in that particular time and place. In agricultural research mapping innovations and understanding innovative capacity is important because it could provide the better policy implications for agricultural development and its progress. For a many years, different theories and approaches have been appeared clarifying the nature as well as process of agricultural innovation. Notable innovation approach begins from the liner approaches.

3.2 Linear approaches (science push, market pull)

The initial thought of agriculture innovation is rooted to the widely recognized era of "Green Revolution" of 1960s and 1970s. Throughout the time of green revolution, most of researchers believed on the invention and discovery based production system. This thought

has been recognized as "linear model" that typically oriented into two dimensions: the science push model and market pull model (see.Arnold and Bell, 2001, World Bank, 2006). In science push linear model, the linearity of innovation begins with basic research. Basic research gives the basis for the technology development and those technologies can be transferred through the applied research to solve the particular problems agricultural production and to increase production (Arnold and Bell, 2001). It is argued that the innovation starts and moves in a step-by-step process, as a sequence of activities (Marinova and Phillimore, 2003). The core thought of this model is that the performance of research and scientific activities bound within certain linear processes in which technological discoveries are considered as the booster of agricultural innovation. For instance, discovery of chemicals, herbicides, pesticides and the discovery of biotechnology (for example DNA) have a significant impact on the agricultural sector (Jarrett, 1985). It is said that the investigation on recombinant genetics is expected to contribute for development of plant virus research (Ibid:225) .

Another dimension is market pull or demand driven model. Principally this model is more directed towards the market function rather than science and invention in which focus has been given to the role of market place for innovation (Arnold and Bell, 2001). It has been stated that existing demands in local and global market are considered as causes of innovation (Marinova and Phillimore, 2003). The market pull model was mainly advocated by economists in response to the view that only focus technology and science, however, the nature of linearity is parallel to science push model. These linear models include the successive stages of agricultural innovation where science and technology are considered as independent to the social and institutional factors (Klerkx et al., 2012).

During the period of green revolution, the technology and science based innovation and production system extended into the global level. Particularly introduction and adoption of modern or high-yielding crops varieties (hybrid) with modern technologies in Asia and Latin America has largely increased crop production (Evenson and Gollin, 2003). These models demanded the large investment in agricultural research and science to flow the knowledge and technology towards the farmers to diffuse the production.

3.3 Diffusion of innovation theory

The diffusion of innovation theory was initiated by Gabriel Tard in 1903 and popularized by Everett Rogers in different edition of his book "Diffusion of Innovations Rogers (1962)". Conceptually the diffusion of innovation and linear models of innovation overlap each other since both theories are concerned with technological innovation and adoption in a sequence of time (Godin, 2014). However, the diffusion of innovation is more concerned with a process of diffusion that appeared as adopters adopt new product, practices and thoughts (Kaminski, 2011). In the researches of technology adoption, the diffusion of innovation diffusion theory has got large attention in various fields, including agricultural. According to Rogers (2010) diffusion is a 'process by which innovations (i.e. new ideas, technologies) are spread or communicated through certain channel over time within the society'. The communications such as media can play significant role to create and exchange the knowledge of innovation. The interpersonal channel (i.e. person-to-person communication) also helps to change the attitudes and behaviors of people regarding new adoption in society. Innovation, communication channels, time and the social system are considered as major elements in the diffusion of innovations model (Ibid:12).

Rogers plotted the process of adoption in which he distinguished innovation adopters into different five categories; innovators, early adopters, early majority, late majority and laggards (Kaminski, 2011). In the initial stage, few adopters adopt the innovations and over the time adoption diffuses until a saturation level. According to Rogers (2015) emergence of idea is a mental process of the innovation adopters so that the adoption of innovation may differ from person to person. Adopter's decision-making process passes through the five different steps; knowledge, persuasion, decision, implementation and conformation within a certain time frame. Another component, 'social system' in this model indicates the set of interrelated units that is formed by individuals, informal and formal groups or organizations within a boundary in which innovation is diffused (Ibid:380).

Conventional linear approaches and diffusion model of agriculture development and innovation have focused on technology based agricultural production. The production pattern is largely characterized by mechanization and specialization. The goals of production have been considered to raise the quantity with large economic profit generation (Ikerd, 1993:152). Utilization of new technologies are thought to solve the production constraints. However, application of these approaches has raised several issues on the local and global level. For

instance, these approaches have failed to address the resource availability of small-scale and local level resource poor farmers (World Bank, 2006). Use of technologies, fertilizer and pesticides has been questioned because of having negative effect on environment and food quality (Ikerd, 1993). Mechanized and specialized production system of large-scale farms has caused to decrease the market price that directly affected the small-scale farmers. Moreover, these approaches were blamed for ignoring indigenous and local knowledge sources and the socio-cultural effect on innovation. In addition, the questions have been raised regarding to the conceptualization of the interlink among the successive stages (Arnold and Bell, 2001). Agricultural researchers and policy makers have started to think about agriculture developments and innovation in a new way, with system approaches.

3.4 System approaches in agricultural research

According to Colin and Crawford (2000), agricultural researches often guided by 'problem solving' or 'action-oriented' approaches. Those approaches offer different ways of agricultural development and innovation. For instance, some approaches advocate the technical change as a way of agricultural development. Other approaches insists the role of institutions, policies, farmers knowledge etc.(Ibid:3). Over the years different system approaches have been emerged which have primarily oriented to knowledge based production system and advocated the sustainable way of agricultural development focusing on multiple enabling factors not only technology or market (Ikerd, 1993).

The early-emerged system approach is (National Agricultural Research System) NARS that comprises some features of linear approach and has certain link with technology transfer perspective. NARS approach promotes the agricultural research at the national level, especially maintains to provide technological, managerial and policy support to the national agricultural research (World Bank, 2006:28). This approach advocates that, agricultural innovation and development can be achieved through public research and training. Investing public research and raising the capacity of agricultural science is considered as a way of technology adoption and production raise in agricultural practices. However, it has been only beneficial to those clients who can access technology. It has also become unsuccessful to capture the market potentialities and value chain effects in agriculture.

During the 1990s the system approaches directed towards new way of explanation of agriculture development and innovation i.e. termed as Agricultural Knowledge and Information System" (AKIS). This approach has emphasized the pluralistic research and also

attempted to establish connection among the research, education, extension and farmers demand (World Bank, 2006:6). In this approach, agricultural organizations and farmers have been considered to be mutually engaged and performed in the process of utilization of knowledge and information for innovation generation (Roling 1990 see in Klerkx et al., 2012). Thus, it believes on learning and innovation as an interactive process. The core theme of this approach is to incorporate different knowledge and information in the process of innovation (World Bank, 2006). However, this approach has poorly recognized the role of markets, private sector and supporting policies for the improvement of innovation capacity.

3.5 Agricultural innovation system: A theoretical framework

In recent years, innovation system approach has become popular among the agricultural innovation researches and studies. Analytical foundation of this thesis will be based on this innovation system approach (AIS). This approach initially explained by Mytelka (2000) in which innovation is defined as "knowledge based interactive process ". The interactive collaboration of different agents and institutions is believed to be played a significant role to bring innovations. Mytelka argues that innovation system approach is concerned with linkage, investment and learning process among the different actors of production (Ibid:18). Conceptually this approach does not agree to equalize the innovation with invention. She argues that innovative changes not merely emerge in developed countries such as Japan, USA but it is equally imported in developing countries in the local level and small size firms. Thus, both local and national policy are critical in which policy makers need to care behavior and practices of the local actors (Ibid:20). Innovation system approach focuses on the continuous process of quality improvement, design, modification of institutional arrangements, market restructuring and environmental sustainability.

Innovation system approach is considered as a heuristic method to assess the innovative capacity in agricultural innovation research. This approach has been explained by (Hall et al., 2001, Hall et al., 2004) and has given detail account in (Hall et al., 2006) as well as World Bank (2006). The tnnovation system framework conceptualizes the agricultural innovation in more systematic, interactive and evolutionary terms, which is a conceptual response to the conventional science based linear innovation models (Hall et al., 2006:7). Agricultural innovation system includes a network of diverse social organizations, enterprises and individuals. Exchange of knowledge, technology, rules and mechanisms within those networks strengthens the agriculture sector (World Bank, 2006).

This approach provides the suitable framework to explore stockholder partnership, institutions and learning process associated with agricultural innovation (Clark et al., 2003, Klerkx et al., 2009). However, the research implication of innovation system can vary by the contexts as well as research issues. According to Hall et al. (2004) there are conceptual differences in industry-based innovation system of developed countries and agriculture-based innovation system in developing countries. Agriculture-based innovation system is primarily concerned with diverse and complex production context which tend to achieve socially responsible economic growth. Whereas industry-based innovation system concerned with uniform production context to gain higher economic growth (Ibid:6).

Range of conceptual opinions about innovation system can be found in different innovation research and studies. The "functionalists" perspective in innovation system advocates the existence of different functions in agricultural innovation system. For example, the study of Hekkert et al. (2007) suggests different functions to be embedded in innovation system, such as entrepreneurial function, knowledge development, knowledge diffusion network, guidance of the research, market function, resource mobilization, creation of legitimacy etc. Some researchers have considered agricultural innovation system as "support infrastructure" in which focus has been given to the infrastructures that promote the agricultural innovation (Klerkx et al., 2012)

Adoption of new production mechanisms and use of new knowledge are the major considerations of innovation system approach (Clark, 2002). It considers agricultural innovation process as a social system in which institutional collaboration and policy support are the fundamental pre-conditions of agricultural innovation process (Hall et al., 2004:111). Since farming activities are directly associated with natural resources, it is relevant of look agricultural innovation process through the natural system prospective. Considering such understanding, a recent research paper of Aase et al. (2013) has raised a wider conceptual explanation about innovation system. It argues that the framework of innovation system can be understood as "innovative place' because agricultural activities depend on farm resources such as land, labor as well as natural resources such as climate, water in addition to social organizations and institutions (Ibid). It possibly gives a directed pathway to the policy arena to make decision as well as to take action in the local level.

The framework of agricultural innovation system frames different actors and factors that can be involved in the processes of agricultural innovation. The interaction of the actors and

factors has been considered to be at the center of innovation system that combines the multitude of activities which tends to increase the farmer's innovation capacity (World Bank, 2006). It has been argued that, the flow knowledge and information is the core aspect innovation system. It helps to investigate multiple-dimensions of agricultural innovation system. It provides wider conceptual frames to evaluate and analyze the farmer's innovation capacity. It also provide guidance to explores the interactions and relations of multiple stockholders involving in knowledge sharing and exchange in agricultural innovation (Scoones et al., 2009).

3.5.1 Some elementary insights of innovation system framework

In innovation system framework, 'linkage' and 'network' are the two key insights which indicate the association or collaboration among the actors and factors. It is significant to create the wider linkages among the actors to share and exchange agricultural knowledge (Hall et al., 2006). For example, two or more farm households could decide to form a farmers' group that may help them to act collectively. In addition, involvement of actors and factors are other key insights. In this framework, the term 'actors' indicates person and organization (cooperatives, farmers group etc.) who can take action to influence the innovation. The term 'factors' refers that, the things that are not able to take action to influence the innovation but exist in innovation system, for instance, water, land, physical as well as knowledge infrastructures etc.

Innovation system framework intends to improve agriculture sector to be able to cope with changing circumstance. Changing circumstances here indicate both environmental and social changes that could be in local area and in the globalized world. According to Hall et al. (2005) 'changing to cope with change' is another insight of innovation system which is a vital policy implication for agricultural development. It is argued that, actors of agriculture innovation system can arrange alliances and partnerships to face with future uncertainties.

3.5.2 Value chain and innovation system approach

Value chain concept can be supplementary for the agricultural innovation research because sometime value chain and innovation system share the partners and actors (World Bank, 2006). The concept of value chain has been pioneered by Porter (1980). It is defined as 'firm's value-adding activities'. According to Kaplinsky (2000) value chain indicates a broad range of value adding activities of agricultural production system from the conception, production, transportation to delivery of particular goods and services. Value chain concept

has been used in agricultural research to explore the market dynamics and to examine the interaction of various actors. It helps to seek the activities going beyond the farm in which it analyzes the nature and the determinants of competitiveness of value chain (Rich et al., 2009). Agricultural value chain approach is an analytical tool (Kaplinsky and Morris, 2001)), that supports to understand the impact of developmental interventions at different levels, particularly that intend to provide production and marketing of high value crops to the smallholder farmers (Gebremedhin, 2009). It maps the various actors and their functions in production, processing, transportation, distribution and sell of productions.

It has been argued that innovation may occur anywhere along the value chain so that we can observe innovative changes along the value entry point of a products (Anandajayasekeram, 2011). Innovation system facilitates in creation, exchange and flow of knowledge as well as information among the actors. This knowledge and information may trigger innovations in different stages of value chain (Gebremedhin, 2009).

In this thesis, the study of value chain will help to understand how and what interventions in different stages of production and marketing of agricultural goods and services promotes the innovations. Management and coordination of every steps of agricultural activities are significant to gain environmental and economic viability. Thus, this approach is assumed to fulfill the theoretical lack of innovation system approach to study the innovation capacity in the rural context.

3.5.3 Basic assumptions for analysis

Agricultural innovation system approach provides the conceptual frame as well as structure to build analytical model for this thesis. Thesis assumes that innovations in agricultural practice are an index of innovative capacity, and innovative capacity is an index of adaptive ability in climatic and non-climatic uncertainties. The basic analytical assumption is that innovation in face of agriculture emerges through the interactive process in which several 'inducements' are involved, that are believed to be located in four conceptual categories farmers; institutions, farming resources and infrastructure (see, the figure 3.2). The inducement[5] refers the things which encourage innovation in agriculture. First, identification of emerging innovations during last ten years and making inventory of them helps to generate understanding of innovation capacity of particular village. The thesis assumes that if a village has many

[5] The meaning of inducement in oxford dictionary is "things that persuades or leads somebody to do something"

innovations in agricultural activities during the last ten years, that village has high level of innovation capacity.

Then, the analysis focuses on roles of various actors and factors in raising innovative capacity to gain more innovations. For instance, if a farmer and his family members are well educated and trained, they may introduce more innovations. If various formal and non-formal institutions or organization are actively supporting to the farming village, that farming village could have more innovative farmers and innovations. Similarly, attention will be given to the policy environment, availability farming resources, infrastructural arrangement and technologies etc. Lastly, analysis focuses to the innovation capacity as adaptive capacity of the global changes.

3.6 Agricultural innovation system model for analysis

A model is an abstraction of the real world. It helps to simplify the complexity of reality (Gober, 2006). Using abstractions researchers or investigators can simplify the reality. One of the difficult tasks of researchers is to search the hidden observations because he/she need to conceptualize the observations to know the reality (Aase and Fossåskaret, 2007). To conceptualize the field observations and to generate meaning from those observations, a model provides the simplified guidance. There are several agricultural research practices which have prepared and used the abstraction of real phenomenon of agriculture using system model. A system refers to any 'set of interrelated part'. In those system models, farming activities have been considered as 'a workable whole or system' that helps to understand and solve the farmers' problems (Tow et al., 2011). As a model, farming system consist of range of components and interrelated parts from micro-level components such as plant, crop, and animal to the whole farm, to multiple enterprises. This systems intersect with physical and social system (Swinton and Black, 2000).

According to Swinton and Black (2000), agricultural system model provide a simplified description of important system components and their interaction. For this thesis, conceptual model (i.e. innovation system model) is designed (see. figure 3.2) to study the innovation capacity. The model consists of four conceptual categories that are relevant to be analyzed. Data collected from field will be located on these four conceptual categories. It highlights the significant features of innovation system which have been theorized by various innovation theories and concept as mentioned above.

3.6.1 **Farmer as a vital actor of agricultural innovation system**

The first conceptual category of the analytical model is 'farmer' and farmer's socio-demographic attributes. I will analyze field evidences related to farmer and farmer's socio-demographic attributes that influence the innovative capacity. Conventional linear models focused to the top-down transformation of technologies and ideas from science to the farmers where farmers where considered as the passive actors and they were believed to locate at the bottom. Farmers were thought to receive the technologies and ideas from the top where science and research located. However, in recent studies it has been argued that farmer and his family member's socio-economic background, attitude, abilities and behaviors are significant in innovation system as they directly influence the decision of farming activities (Willock et al., 1999). Innovations in agriculture can be flourished by the (human capital) farmer's creativity, necessity, knowledge and practices. According to Wolpert (1964), farmers concerned with satisfactory alternative while making decision as they have different goals, different levels of knowledge and capacity to tackle with risks. However, they always face the challenges of knowledge situation and environmental uncertainties.

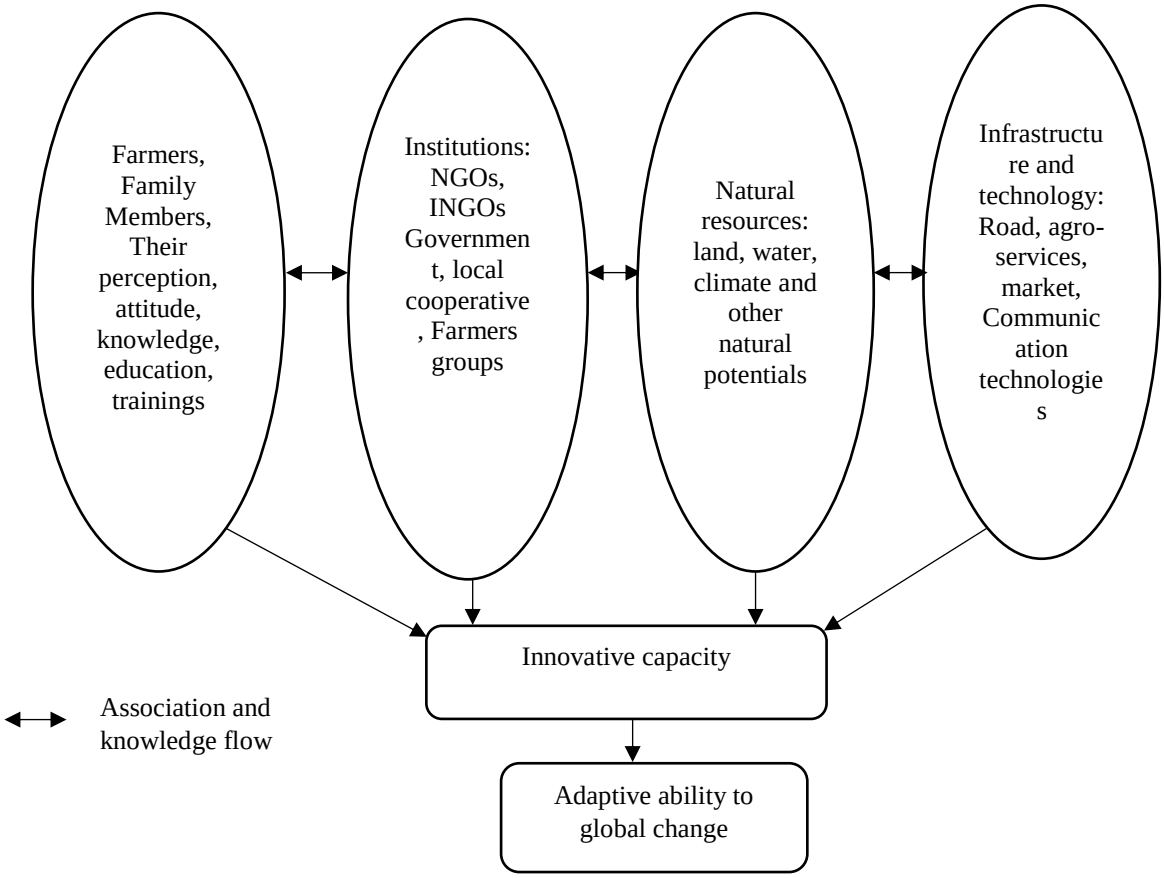


Figure 3.1: Model to analyze innovative capacity in Arun valley

3.6.2 Institutions and/or organizations

Apart from farmers and their families, social institutions and organizations have direct and indirect influences on agricultural innovations. Each society is formed by the collections of institutions (Berger et al., 2002). The forms of institutions can vary by social and historical context. Thus, definitions and usages of institutions are varied in different context of social sciences. Some researchers search the definitional clarity of institutions in its practicality and context of usages (Hodgson, 2006). Institutions are considered as 'sets of formal and informal rules and norms that shape interactions of human with natures and others'(Agrawal and Gibson, 1999). In similar way, Leach et al. (1999) believe that institutions are the regularized forms of behavior among the people in society. They also maintain that institutions also mediate the people-environment relations. Hodgson (2006:18) has provided two distinctive explanations for 'institutions' and 'organization. For him 'institutions are system of established and embedded social rules that structures the social interaction' whereas 'organization are special institutions' that may have criteria for establishment, principles and chain of command. The structural description of institutions can be found in Gidden's 'structuration theory'. Institutions as rules and resources; are continuously reproduced through the day to day or routine practices (Aitken and Valentine, 2014).

Formal and informal institutions influence the agricultural innovation. For example, national and international agricultural policies, marketing and trade policies, agricultural INGOs, INGOs, farmer's groups, cooperatives, local agricultural traditions and norms etc. Thus, in this thesis institutions and organizations will be assessed to understand their effect and role in agricultural innovation.

3.6.3 Natural resources

According to Turner and Brush (1987) a farm consists of various farm and environmental resources. Agricultural innovation is also affected and determined by availability of natural resources such as climate, land and water (see. Aase et al., 2013:9) . It is also affected by physiographic factors such as altitude, aspect and farm location. One of the major critics in the success of 'Green Revolution' was negligence of resource-poor farmers. This has been recognized after failure to reduce poverty of resource poor farming families in various developing countries particularly Asian and Sub-Saharian countries (Chambers and Ghildyal, 1985). The resource-poor farm families refer to the families whose access of land, water, labor and capital do not secure their livelihood (Ibid:3). Hence, access of farm resources may

create obstacles as well as offer opportunities for innovative practices. Availability as well as favorability of natural resources for agricultural innovation is significant. Farmers who have limited land access are more depended on other natural resource such as forests, pastures etc.(FAO, 2014b). In this thesis access to farm resources as well as natural resources will be analyzed.

3.6.4 Infrastructures and communications technologies

The fundamental determining factors of agricultural innovation is adequate development of physical infrastructures. In remote villages of Himalaya reducing infrastructural bottlenecks is the major challenges because of the topographic complications. Infrastructural development possibly increases the capacity of farmers by generating cost-competitiveness through value chain (OECD, 2015). Agricultural infrastructure such as agro-service centers, road, electricity, market and communication technologies play vital role to bring innovations in agriculture. Thus, I will explore the infrastructural differences in two villages.

3.7 Farming system approach

Farming system approach helps to understand the complex mechanisms and practices of agriculture of a particular area. According to Turner and Brush (1987) farming system approach analyzes and describes the agricultural production practices of a farm unit. In this thesis, farming system approach provides the basis to present the description of current farming system of two different villages of Arun valley. Specially, household and villages level farm components, their interaction and function will be assessed. This general overview of farming system opens the way to assess innovation in each village.

A farming system is defined as "any level of unit (s) that engaged in agricultural production as it wedded in a social, political, economic, and environmental context" (Turner and Brush, 1987: 13). Operational units of agricultural production can be from the small level farm household to the larger level village or region. That operational unit may contains various farm components such as climate, soil, labor, policy, market etc.(Tow et al., 2011). These components can be divided into three different sub-system such as human, environmental and genetic. According to Shaner et al. (1982), farm system is an arrangement of farm components such as water, soil, livestock, labor etc. Particularly, farmers manage their household resources within environmental settings.

Farming system approach focuses on recognizing and addressing the problems through the farmer's standpoint. The policy implication of this approach has been considered to seek solutions looking into the farmer's objectives and agro-ecological environments (Norman, 2002). This approach has concerned with farmer-based crop yield increment in which the holistic farm management strategies have been taken into account. According to Turner and Brush (1987) "farming system approach focuses on the need to work upstream from the farm level to the scientists level". It insists to understand farmer's behavior, and decision. Seeing from the multidisciplinary window, it emphases on sustainability, social equity and natural resource protection.

3.8 The epistemological basis

Researchers observe and explain the reality based on the philosophical theories. Each theoretical understanding has its own claim about true knowledge which guides the research process differently. Basis for any research process can be found in epistemological aspects of a theory that is associated with 'how we know what we know' (Couper, 2014). Different theories have been used in multiple disciplines. Here I will briefly discuss about the epistemological foundations for this thesis.

In geographic as well as other researches, theorists have been divided into two major groups while dealing with the reality. One group of thought, for instance, positivism advocates the real, solid and tangible knowledge that can be obtained using scientific principles, logics and analytical reasoning. It believes on natural process, events and mechanisms that do not depend on human's thinking (Peet, 1998). On the flip side, for instance, humanism, feminism, social constructivism etc. believe on human and socially created truth and knowledge (Cresswell, 2012). According to Sayer 1984/1992 see in Holt-Jensen (1999) social sciences closely associated with the 'open system' that has more complex events and mechanisms to analyze. However, the naturalist's traditions framed by positivists are concerned with 'closed system' that may exist naturally. Thus, closed systems are associated with natural matters (Aitken and Valentine, 2014).

While seeking to combine both social and natural realm of knowledge, Roy Bhasker, (1975/1978) has provided three different domains of reality; real, actual and empirical (Holt-Jensen, 1999:164). This theory is known as 'theory of critical realism'. In this theory, the 'real' indicates to the hidden mechanisms and structures that are not observable but has possibility of existence with right contingencies (Cresswell, 2012). Hidden mechanisms for

example, successful crop yield of a new crop variety in new piece of land may depend on various natural and social mechanism that may not fully obvious to observer. Whereas the actual level of reality includes both events and non-events that are generated by hidden mechanism and structures. The empirical level of reality can be observed and experienced, however, it may affected by certain structures i.e. human conceptions, rules and regulation (Holt-Jensen, 1999).

The epistemological base of this thesis is rooted to the Roy's critical realism since the whole research process is associated with real, actual and empirical domain of reality. In the real level, I have attempted to analyze both the social and natural causes, mechanisms of agricultural innovation applying the model of agricultural innovation system. Here, the concepts of 'innovation system' and the 'innovative place' theoretically permit to enter the real level of reality. I have used tabulation, data categorization and analysis of empirical evidences from the actual field, which is associated with the actual level of reality. In the empirical level, I have experienced and observed the events and phenomenon of agricultural innovation during the fieldwork. As said by Roy, empirical level of reality might be have influenced by my own perceptions and conception about the particular agricultural practices.

CHAPTER 4: METHODOLOGY

Theoretical foundation is linked to methodology and epistemology (how we know what we know) so that we can make choice of fieldwork procedures (Cresswell, 2012). Designing and applying the systematized fieldwork procedures to collect empirical data is one of the important parts of a research. According to Locke et al. (2009) the processes of research begins when a researcher sets the questions and outlines a systematic way to gather information in field. Fieldwork provides the opportunities to observe the inside mechanisms of reality (Aase, 2007). I have conducted fieldwork for this thesis from mid of May to end of June in 2016 both study villages. Most of the primary data for this thesis were collected during that time. This chapter begins with dealing the methodological orientation of research then discussion departs towards the fieldwork issues and concerns. Afterwards, it presents the field methods that I have used during fieldwork and it includes the ethical issues as well as issues of reliability and validity.

4.1 Qualitative and quantitative methodology

There is a long practice of geographical inquiries which have adopted quantitative and qualitative methodological domains of research. Quantitative research is shaped by positivist epistemology which maintains that reality is out there to be researched and understood whereas qualitative research is shaped by post-positivist traditions that deal with reality can only be approximated (Denzin and Lincoln, 2011). Both research traditions have different way seeing reality and they use different forms of ideas, tools and evidences. The use of methods in geographic inquiries also depend on what sort of phenomenon is to be researched.

Qualitative research assumes a socially constructed reality and this is related to the study of qualities of entities, meaning and process (Denzin and Lincoln, 2011). Quantitative research involves the analysis of causal relationship using mathematical modeling and statistical techniques to understand geographical phenomena (Clifford et al., 2010). Moreover, qualitative methods always intend to understand human environment, individual experiences and social process so that qualitative researchers need multiplicity of conceptual framework (Hay, 2000) . It is a set of interpretive activities and usages different methodological practice such as semiotics, narrative, content, discourse, archival, phonemic analysis etc. (Denzin and Lincoln, 2011).

In human geography, many research practices are based on such qualitative methodologies. However, there is a distinct tradition in research that claim to use combination of both quantitative and qualitative methods to capture holistic understanding with greater validity of the topic under study (Jick, 1979). It is argued that mixed method provides opportunities to merge various evidences to get a deeper understanding. The field of mixed method is called a "the third methodological movement" which involve collecting and integrating both quantitative and qualitative data aiming to get complete understanding of a research problem (Creswell, 2013). The research based on mix method employ the information which are in both narrative and numerical form that can address a range of issues (Teddlie and Tashakkori, 2009).

This thesis is based on combination of both qualitative and quantitative research methods; however, more emphasis is being given to qualitative research methods. Various socio-demographic data and data related to farm assets, production and its changes, inputs in the household level have been gathered using semi-structure questionnaire survey. Farmers' innovative decisions, planning and action in responding to multi stress uncertainties have been retrieved employing qualitative methods such as key informant interview, focus group discussion and observation. The innovation inventories and various farming system elements are analyzed with direct quotation of key informants' responses as well as quantitative data and figures.

4.2 Fieldwork challenges and issues

As planned, I reached Nepal in early May 2016. Considering monsoonal effect, I had a few days to stay in Kathmandu in my plan for review some documents related to the field study area as well as to print questionnaires. Unexpectedly, I encountered a viral flue after three days of stay in Kathmandu, I guess this was due to changes of food, polluted air and chaotic environment. I took a few days' rest with some normal medicines and then I headed back to my village to meet my parents after traveling twenty hours by bus and two hours of on foot. In village, everybody was expecting surprise with me as they thought I came back from *bidesh* (Foreign country) nobody concerned whether I was coming as a student for my fieldwork. I was in dilemma of *bidesh bata aako chhoro (*son coming from foreign country) and a student. It had been already late to reach field, so I postponed my plan to meet other relatives. I

marched towards the study field from home in the mid of May. First, I travelled to the field area of Aahale village, as I had already planned.

After staying around four weeks in Aahale, I travelled to next village of Sankhuwasava district for fieldwork but I had only proposed a tentative area before. While moving around the area to confirm the field, I faced the problem of mist because pre-monsoon was already started. Due to the poor visibility, in even a few meters of distance, I could not see anything. That day I failed to reach the target area where I anticipated and I went to Mudhe Bazaar, a small market center of that area, to stay for that night. The day after, I met a man coming from Majuwa village. I managed short conversation with him and I requested him to show direction to the village, eventually he became ready to show me the way to reach me there. In the second week of June, I started fieldwork in Majuwa.

4.3 Status and Role: influence on access to information

While doing fieldwork consideration of roles and statuses of my own as well as all the informants are crucial. According to Linton (1936) status is defined as a position in a social arrangement connecting with designated rights and obligations, while role denotes the dynamic aspect of a status. In every single society and all groups, each member has some function or activity with which he/she is associated and which carries with it some degree of authority. What an individual executes, we usually call his role. Linton says, in society there are two types of statuses. Statuses that are given to individual at birth for instance age, sex, kinship, race, and caste are known as ascribed status. These are given to the people by society without individual efforts whereas achieved statuses are any social positions held by an individual because of her/his personal accomplishment (Ibid:115).

As a young Nepali male from (remote) rural farming village and now studying in University of Bergen, my statuses in the field varied in terms of both ascribed and achieved. The flexibilities and transition between the positions have happened several times during the whole fieldwork period. On the other hand, as I carried out my fieldwork in two different locations, changes in statuses have happened. Aahale village has been socially connected with my village for the generation. The practice of arranged marriage (*maghi bibah*) between two villagers is common. Some of my cousin's sisters have got married with people from Aahale. So, I was approached as a guest first, those who know me as *maitiko vai* (a brother of maternal home), I was invited for food and lodge. It was difficult to convince them with disagreeing because in Nepalese culture there is an utterance *athiti devo bhava (*guest are like

gods). I kindly refused their request considering the possible distractions in fieldwork process due to the family matters and personal conversation.

I arranged accommodation in a *Tamang's* house as a paying guest with the help of secretary of the local cooperatives. Being a paying guest was the first effort to shift my status of guest to a researcher. When I moved around the village with secretary, unfamiliar people indirectly questioned him about me. Since he clarified about my purpose and presence, my status as research student had been become more obvious. He was helpful person and was my first key informant as well as facilitator in Aahale.

As I was grown up in farming family and I spent more than two decades helping parents in farming activities so that people in Aahale ascribed me as a son of farmer and perceived me as a known and experienced person of farming activities. When I asked questions to them related to farming system, its procedures, past and present situations, income from it etc. they did not consider those questions seriously. One of the answers I got from some villagers in translated form is:

"*You should know everything about the activities; it's same as your parents and others do in your village".*

This expression shows that the relationship of researcher with informants and the "map of consciousness" of informants influenced my access to the information (Mullings, 1999). I was unable to gain the full status of a researcher. Therefore, my first task was to change the informants thought about my status and manage wrong impression about me. According to Berreman et al. (2012) settling the impression is significant part of social interaction that may determine the researcher status. Various informal conversations with different people in different time gradually changed the impression about my status and me.

Majuwa village and villagers were stranger for me and vice-a-versa. When I entered the village, most of them thought me as a project worker because in the local level people who move around the village with the form of questionnaire and asking questions to the residents are either NGOs worker or local government workers. The higher-level academic activities as I was doing are rarely conducted in that area. In rural area, the category of student is perceived as a person who goes school or college wearing the uniform and carrying a bag of books. The status of project worker did not remain longer because I utilized more time with local people in different way. Sometime I went to the farmers' farm helping their work. Some time I attended the cultural programs for instance *Dewali*.

4.4 Sampling procedures

Sampling procedures in social science research is often debated between survey and field researcher. They have been avoiding each other to give scientific credentials for their work for a long time. Quantitative researchers suspect the qualitative researcher using non-probability sampling, its generalizability and representativeness and they argue that only probability sampling can be generalizable and representative (Gobo, 2004). However, mollifying argument has been grown that is intended to legitimate both types of work and their sampling procedures by classifying generalizability in two ways. One generalization is about population drawn from statistical logics using probability samples which is used in survey research and another is "theoretical sampling" which is conducted based on the concept that is thought to be theoretically relevant.(Glaser and Strauss, 1967 cited in Gobo, 2004).

There are several sampling strategies in qualitative research, which are principally associated with non-probability sampling or theoretical sampling. For instance, purposive sampling, quota sampling, the emblematic case, snowball sampling etc. (Gobo, 2004). The sample selection in this thesis is based on purposive or selective sampling that is associated with the theoretical sampling. Purposive sampling is a based on practical needs of the research that allows researcher to assess a wide range of situations in order to maximize the variation (Ibid). In this sampling procedure, researcher visits the site first and decide whom to sample for propose of study. The logic and power of purposive sampling lies in selecting information-rich cases for in-depth study of the issues in questions (Coyne, 1997).

4.5 Methods of data collection

I have used different methods for primary data collection. Secondary data were collected from various secondary sources. The primary data collection process completed using five different data collection methods. With these five methods, the continuous observation helped to understand the situation in more details. Use of each method in each consecutive phase, additional information was expected. The first task was to build rapport with informants and get closer to information. During this phase, I managed the issue of familiarities. In the next steps, I did household survey using semi-structured questionnaires. The selection of sample households was purposive. Because while studying the farming households, researcher can include essential units in purposive sampling such as rich and poor households, upper and lower castes, small landholder and large landholder etc. (Aase et al., 2013). In third phase, I

conducted focus group discussion, followed by key informant interview in forth and farmer case study in the fifth phase.

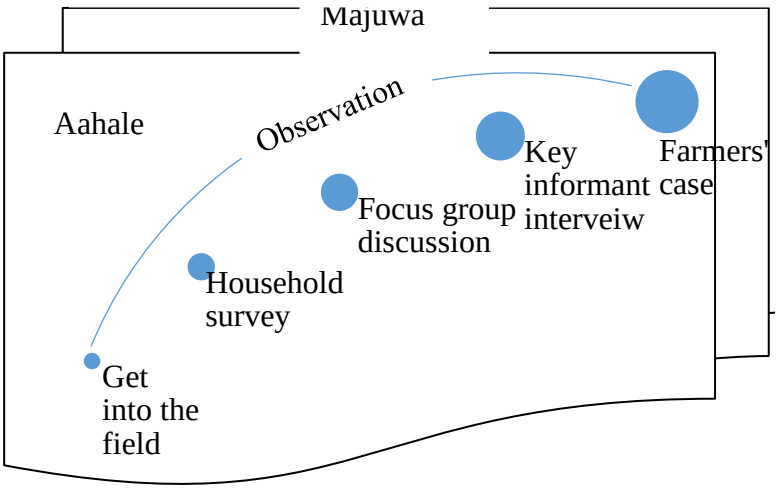


Figure 4.1: Scheme of primary data collection

4.5.1 Household survey

Household is a vital unit for the farming system analysis. So, in this research, I have conducted questionnaire survey using semi-structured questionnaires with 50 households (N=50) during my filed work. The households in rural area of Nepal are mostly scattered due to the topographic variations. Survey was relatively time-consuming due to long distance form one household to another. Twenty-five semi-structure questionnaires have been conducted in each farming village. Some questions were close-ended and some were open-ended. While doing survey, I used to start with informal conversation that helped me to make informants ready to answer the questions. I also kept some notes, in case some information came in addition to the questionnaires.

In geographic research, questionnaire survey has been a vital tool for a long time, which was used first time in the field of behavioral geography to evaluate people's perception, behavior and choices (Clifford et al., 2010Rushton, 1969; Gould and White, 1974 cited in). It is a method for accumulating evidence related to people, institutions, social, political and environmental issues etc. Questionnaire design is the crucial part of the survey because that should acquire the information what the research aim is intended to evaluate.

The information related to the socio-economic status of household such as cropland change, ethnicity, education, income, occupation etc. gathered using the questionnaires. In addition,

emerging agricultural innovations in agricultural activities during last ten years were also collected in household survey.

4.5.2 Focus group discussion

Focus group discussion is a qualitative method of data collection. In this method, a focus group indicates the group of informants, generally gathered in informal setting for the group conversation in particular issues (Longhurst, 2003). The discussion in focus group often based on pre-scheduled issues. The major task of focus group discussion in exploratory research is to create new ideas, collective thoughts, opinions and attitudes (Fern, 2001). For the collective views on the issues of agricultural innovation and innovation capacity, two focus group discussions in each village were conducted. Propose of focus group was to discuss and comment on particular issues formed in the social context, based on farmers' personal experience and knowledge.

The process of recruiting participants for focus groups must avoid systematic biases (Powell and Single, 1996). To avoid this, I went to the dairy collection center, where farmers gather to sell their milk in Aahale village[6] and requested farmers to participate in discussion. According to their attendance, I formed two different groups with 8 to 10 people in each group and fixed the date and time for group discussion. While conducting focus group discussion, it provided a social environment in which each and every farmer (participants) got chances to provide opinions with cross questioning to others views. This helped me to gain farmers perspectives issues. It also revealed the farmers' disagreement in particular issues.

4.5.3 Interview with key informants

In geographic research, interview has emerged as an effective data-gathering tool. The classic definition of interview is "face-to-face verbal interchange in which interviewer attempts to elicit information or expressions of opinion or belief from interviewee" (Maccoby and Maccoby cited in Hay, 2000:101). There are more than a few arguments that can be found about the form of interview. Generally, positivists believe in "pure" interview enacted in a sterilized context that is expected to provide "mirror reflection", whereas post-positivists suggest that unstructured, open-ended interview can and does elicit "authentic accounts of subjective experience"(Miller and Barry, 2010:131).

[6] In Aahale everyday morning farmer collect their produced milk in Siddhakali cooperatives office and they send it to the larger cities such as Biratnagar.

I have conducted interview with key persons during the fieldwork. Particularly cooperatives staffs, some experienced and old age farmers were interviewed to get detail information. NGOs and Government staffs who are directly and indirectly connected to the local level agriculture were also interviewed for the official information of their intervention and networking to the local farmer. In both villages, two staffs from two different local agricultural cooperatives and some experienced farmers were interviewed.

Picture 4.1: Glimpses of key informant interview and household survey

4.5.4 Comparative case study

Case study describes the real life situation of contemporary phenomena investigating depth and exploring details (Yin, 1981). In the word of Gerring (2004), case study is 'an intensive study of a single unit'. In case study research, researcher can use both qualitative and quantitative evidences that can be gathered from various sources (Yin, 1981a). In this thesis, I have used different sources of evidences while dealing the case. The conceptual link of using multiple evidences is associated with the 'triangulation' in research (Jick, 1979).

This thesis is a comparative case study of two farming community from the Himalayan Hill. According to Mills (2010) the comparative case study examine in rich detail the context and features of two or more instance of the same phenomena. The comparative case analysis reveals the contrasts, similarities or patterns across the cases. The structure of comparison can be either within case or between-case study. Within-case study, for example might include several organization within a specific industry (Yin, 1981). This thesis is within-case study in which two villages are selected for the study of agricultural innovation. I have also conducted two case studies of individual farmer in each village. I have employed this method to gain intensive information about farmers' innovative practices.

4.6 Ethical considerations

Research in social sciences is primarily concerned with society, social relations, people and their dynamics. Ethical consideration in research is related with the act of treating people and place, which are being researched, with integrity, justice and respect during research process (Hay, 2010). The whole process of research from fixing the objectives to documentation of findings is embedded with ethical considerations. Guillemin and Gillam (2004) state two major dimensions of ethics in research: procedural ethics and ethics in practice. Procedural ethics in qualitative research are ethics that fixed by the research committee, which have formal ways to be approved. However, day-to-day ethics in research processes are 'ethics in practice' which may not be covered by the established code of conducts. Thus, ethics in research are formal and informal code of conducts that need to be carefully considered. "Ignoring ethical issues in research processes are like start to move downwards on a slippery way"(Silverman, 2016).

According to Mitchell and Draper, 1982 as cited in Hay (2010), to behave ethically is to assure the favorable research environment. Behaving morally and assuring informants' rights are the crucial part of ethical considerations. While primary data production, researchers use informants directly and indirectly. The information provided by informants, their experiences and practices are the main basis of analysis. Informants also provide their time and effort for the research. Thus, during the fieldwork and data interpretations of this research, all kind of informants' consents have been established. For instance, before asking question and using voice recorder with key informant, they were clearly informed about being recorded. For every informant and field supporter, a great sincerity has been expressed after finishing the fieldwork for informants' time and their information. Moreover, when data is interpreted farmers' name and their castes have not been exposed or anonymized in this thesis. This helps to preserve the issues of sensitivity arisen form personal information.

Maintaining the justice and reducing the additional burden for informant is one significant way to avoid doing harm. The theory of research ethics says, researcher need to behave balancing the benefits and burden (Hay, 2010). In this research, taking farmers' time is one of the crucial aspects that need to be considered in ethical issue. During the key informant interview, group discussion and household survey, I tried my best to reduce the time burden of farmer created by my fieldwork. This was the most important for my field area because fieldwork time was the peak cultivation season and farmers were too busy. To minimize risk

of obstructing farmers' time I went to the dairy collection center in the early morning of the day where farmers gathered and did group discussions. Doing this reduced the farmers' time, which would have consumed from formal process of group discussion. Similarly, for the household survey sometime I went in the lunch time and evening when farmers were relatively free.

4.1 Observation and conceptualization of observations

Respondents' statements and responses on a particular issue are the main sources of information during fieldwork. However, being *in situ* a researcher can utilize the whole period closely observing the complex issues. According to Watson and Till (2009), observation comprises the description of expressive events, emotional experiences and everyday activities than the objective information. The lived experiences of social events can be achieved through the observation during fieldwork period. I involved continuous observation during my fieldwork. Even the time of using other field methods or during the spare time, I used to observe the respondents' responses, expressions as well as everyday agricultural practices and cultural activities. Going beyond the verbal process (questioning and answering), observation provided me general understanding of the issues from the subjective prospective which would not be recorded or documented.

The fieldwork process involves the accumulation of observed data from reality. Observed data cannot be used in research without conceptualization. According to Aase (2007), observations must be conceptualized and interpreted before of its application in analysis. The conceptualization and interpretation of information is a cognitive process. In empirical level, we generally sense the reality through the colours, sounds, smells, shapes, hardness and movement. We locate our observations in category thence we get meaning. However, researcher need to be aware about the cultural variations of concepts and categories (higher level abstraction) of observation Wadel 1991:77, in Aase (2007). In this research, cultural meanings and values of informants' responses are carefully considered during analysis.

4.2 Reliability and Validity

Research process consists of various systematic procedures from ideas growing in researchers' mind to drawing result. Since the result is drawn, it reaches to the public and academic fields. Generally, public and academia make certain judgements about the quality and trustworthiness of research result as well as soundness of research process (Long and

Johnson, 2000). The quality or rigor of qualitative research is evaluated based on how and in what degree the finding matches with reality or evaluated based on objectivity. According to (Kirk and Miller, 1986) objectivity or rigor of particular research and its findings can be understood through the two components: reliability and validity. The understanding of reliability and validity may vary by the research procedures and theoretical basis of particular research. Initially, reliability and validity were used in quantitative research procedures. It is argued that reliability and validity are tools of an essentially positivists epistemology (Winter, 2000 as cited in Golafshani, 2003). However, Kirk and Miller (1986) says, these can be transferred and used in qualitative research.

The concept of reliability is concerned with the "consistency of measuring instruments"(Long and Johnson, 2000). It is repeatability of the research findings. This tells about in which extent research methods produce the similar result whenever and wherever it is carried out (Kirk and Miller, 1986). In qualitative research, the concept of reliability is associate with the concept of transferability (Kapborg and Berterö, 2002). In the word of (Hammersley, 1992a:67 see in Silverman, 2016) reliability refers the degree of consistency with which instances are assigned to the same category by different observer or by the same observer on different occasions.

The concept of validity includes the degree to which the finding gives the answers to the topic in question (Kirk and Miller, 1986). It is about how finding is close to the expected outcomes that determines the trustworthiness of the research result. Validity in qualitative research can be understood in two ways: internal validity and external validity. Internal validity is related to demonstrating informants' knowledge and their participant in research through a constant line and quotation. Whereas, external validity is concerned with transferability of finding to the similar situation (Kapborg and Berterö, 2002).

According to Denzin,1978:302 cited in Jick (1979) triangulation is the vehicle of cross validation. In this research, methodological triangulation has been established using both qualitative and quantitative methodological tools for the data production. Applying different methodological tools, the cross validation of data has been achieved. For instance, the trustworthiness of household information has been crosschecked during the key informant interview. Moreover, the open debate during group discussion produced the general agreements and rejection of ideas among the farmers. To ensure the internal validity, I have directly quoted the key informants responses. Information has been collected from the various

socio-economic categories of household such as lower castes, higher castes, poor family and wealthy family using purposive sampling. Doing so effort has been made to reduce the statistical biasness in information.

CHAPTER 5: CURRENT FARMING SYSTEM

Farming system consists of various components such as soil, crops, water, livestock, labor etc. where complex and interdepended relationship among the components exist (Shaner et al., 1982). These components reside in a specific political, environmental, social and economic context which make them more dynamic. The objective of mapping actual innovations is to recognize the level innovative capacity. Therefore, before mapping actual agricultural innovations of both study villages, it is crucial to assess the current farming system. This chapter is intended to explain the overview of present as well some of the past situation of farming system. Presenting overview of farming system of Aahale and Majuwa I will identify the differences and dissimilarities between the farming systems of two villages. Farming system overview will be presented based on the farming system concept provided by Turner and Brush (1987) and Shaner et al. (1982) which was discussed in previous chapter. The arrangement of farm components, their interaction, changes and present status of farming system will be briefly examined. This overview of farming system helps to make inventories of innovations in agriculture in the subsequent chapter.

5.1 Current farming system of Majuwa: subsistence agriculture

Farming system of Majuwa village is characterized by subsistence agriculture. In subsistence agriculture farmers produce all products to meet their household consumption need and the flow of cash is very insignificant (Blaikie et. al.,1977 cited in Schroeder, 1985). In this village, farmers have been practicing agroforestry farming system for many years. This is one of the traditional features of farming system of the Himalayan region. Agroforestry farming system consists of three major inseparable and interrelated components: forest, crops and livestock (see figure 5.2). Inseparable relation among the crops, forests and livestock preserves the nutrition cyclic on soil and controls the soil erosion. Therefore, it is a sustainable agricultural practice in Himalayan hill region of Nepal (Neupane et al., 2002). Crops cultivation, animal[7] husbandry and large cardamom farming are the major sub-systems of agroforestry farming system in Majuwa village.

Picture 5.1: Maize in bari of Majuwa

[7] Animal, in this thesis indicates the domesticated animal. The words domesticated animal and livestock have been used interchangeably.

Production system is based on a few stable crops such as paddy, maize, millet and potato and fertilizer use is relied only on livestock manure. The ways of crops cultivation and animal husbandry are mainly guided by local knowledge and traditions *(parampara)*. In recent years with increasingly developed physical infrastructures, for instance, construction of rural road has expanded the opportunities of adopting new agricultural practices. Most of the farming activities such as production, operation and management of a farm are primarily run by the family labors. This kind of farming has been recognized as family farming in which relation between farm and family exists FAO (2014b). The gendered division in the decision making of agricultural activities exist. The senior male in the household is considered as head of the family and he makes all the decision. Female's role in decision-making is largely constrained by the social norms. This is the common phenomenon in most of the area of Nepal.

5.1.1 Crops cultivation and cultivated land

Cereal crops are dominantly cultivated in two major local categories of land i.e. *bari* (non-irrigated sloping terrace) and *khet* (irrigated terraced). Paddy is the main crop grown in *khet*. Famers also cultivate maize, mustard and wheat in *khet.* Maize, millet and potato are grown in *Bari*. Besides the cereal crops, farmers also cultivate some root crops such as sweet potato, yam, soybean, and bean in *bari* for additional support to the family consumption. Most of the farmers cultivate local varieties of vegetable crops in small area around the house. *Pakho* (uncultivated and non-irrigated slope land) is normally used for fodder (green grass) and bedding collection for livestock. In recent years, farmers have planted and preserved naturally grown trees in *pakho* due to the market access for commercial timber selling. Majority of farmers have also been cultivating large cardamom for four decades.

The cultivated lands both *bari* and *khet* usually occupy whole year by only one or two staple crops. This indicates that there is low crop intensity with limited numbers of cropping patterns. Cropping pattern varies according to land category. For example, paddy-maize and paddy-fallow are the common cropping patterns in *khet.* Whereas practice of crop intercropping such as maize-millet and potato-maize are main cropping pattern in *bari* (see cropping calendar in figure 5.1). Farmers cultivate maize-millet intercropping in *bari* of lower altitude i.e. in about 1700 m.a.s.l., which is the middle of the village. It has been stated that relaying millet in maize field is a kind of traditional intercropping farming strategies in mid-hills of Nepal (Subedi, 1996). The practice of potato-maize intercropping in *bari* is found in relatively higher altitude area of the village i.e. about 1900 m.a.s.l..

5.1.2 **Cropping calendar**

Each crop has own time of sowing, irrigating, manuring, weeding and harvesting. According to Shaner et al. (1982) cropping calendar illustrates the usual planting time for each crop, length of time a crop spends in the ground and the usual harvest time that could vary according to agro-ecological and land category. For instance, maize cultivated in *khet* (located low altitude) and maize cultivated in *bari* (located high altitude) has different sowing, weeding and harvesting time. The total period growing also varies due to climatic factor. Since Majuwa village is extended from low altitude to high altitude, area is potential to grow several crops.

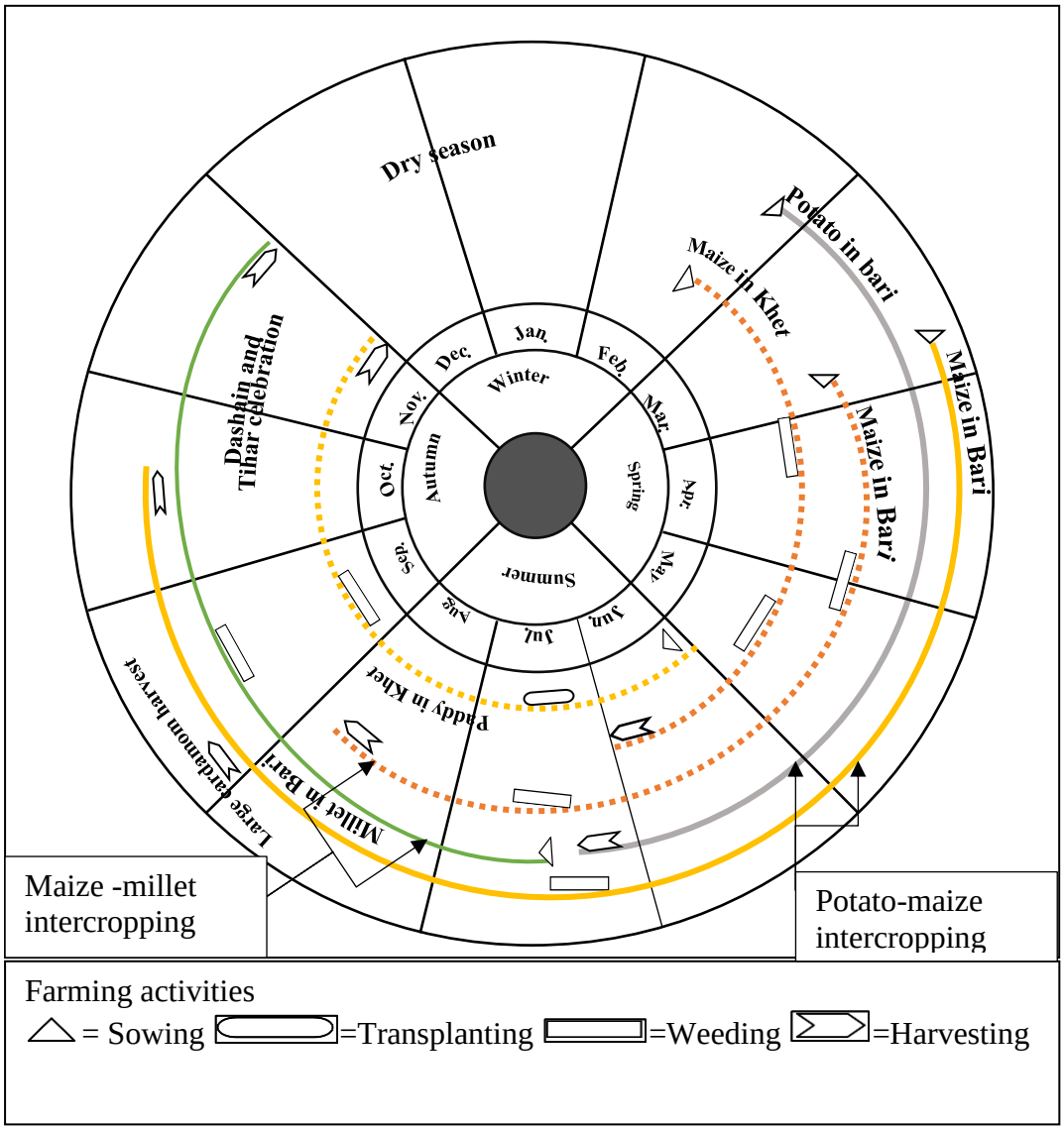


Figure 5.1: Cropping calendar of Majuwa

As shown in figure 5.1, the period of December-January seems almost dry and lean season for agricultural activities in Majuwa village. The main cropping season begins with the land ploughing and manuring for maize cultivation in *khet* in the early February of the year. Farmers cultivate maize in *khet* if they got irrigation facility or if they got early winter rainfall. If not, they normally leave *khet* fallow until the beginning of monsoon and during monsoon, they cultivate paddy on that land. After maize sowing in *khet*, farmers start to prepare land to cultivate maize in *bari* i.e. in the month of March. In fact, rainfall is the main determinant of exact time of field ploughing and maize seed sowing in *bari*.

Maize needs two times weeding however; time differs in *khet* and *bari.* The first maize weeding in *khet* is done in early April. After that farmers prepare seed bed *(bad rakhne*) to sow the paddy seeds and prepare land for paddy cultivation in *khet*. Farmers harvest maize of *khet* in June which would be the time just before of paddy transplantation. After finishing maize harvest, farmers transplant the paddy seedlings in the end of June and in the beginning of July; this would be the peak time of monsoon in Nepal. After paddy transplantation in *khet* farmers come back to the *bari* and start to weed maize. Meantime they also transplant millet seedlings within maize field. August-September is the time for large cardamom harvesting. During harvest farmers clear the old stalk of cardamom plant.

Maize of *bari* is also harvested during August specially in middle part of the village. The clearance of maize residuals and weeding of millet go simultaneously before of the celebration of *Dashain* and *Tihar* (the greatest festivals of Nepal). Maize residuals are preserved as livestock fodder for dry season. After celebration of *Dashain* and *Tihar*, during the October to November, farmers start to harvest paddy in *khet* and millet in *bari*. This is the main harvesting time in whole Nepal. Maize-potato intercropping is found in *bari* located higher altitude of the village. These crops have longer growing season. Potato is sown in early February and after one month, maize is intercropped in the potato field. When potato seed tubers emerged out from the surface, farmers dibbled the maize seed between the potatoes plant. Local breeds of potato such as *sole, hale* are grown. First weeding of maize and soil mounting for potato are done at the same time. Harvesting of potato is done in end of July during that time, farmers also weed maize which is harvested during October. This cropping pattern has the longest growing season.

5.1.3 **Animal husbandry**

Raising animals as a component of farming system is much more common in mid-hill and higher Himalaya (Schroeder, 1985). It is also a significant part of farming system of Majuwa. Farmers have been raising different types of domesticated animals for meat, milk and manure. Cow and buffalo are main domesticated animals which are kept for milk and manure. Farmers prefer to keep buffalo as well as local cows because buffalo also can be sold for meat and milk of local cow contains high fat percentage. This is important to have high fat contained milk to make butter (g*hee*) in traditional way. There is a lack of market so that most of the farmers do not have access to sell milk. Only few farmers sell their milk for town people. Thus, farmers either have to consume all produced milk or make butter traditional way and sell in local *haat bazaar*. One of the reasons of avoiding high breed cows such as Jersey is lack of milk selling facility in village. However, recently one cow farm has been established in village which has some higher breed of cows as well. With the partnership of four local farmers, this farm officially registered three years ago. Everyday about 75 liter milk is produced in that farm which is sold in Mudhe bazaar. Besides cows and buffalo, goats and chickens are commonly kept in all households for meat, eggs and manure. Some households have a pair of oxen for field ploughing.

Household-wise variation in preference of animal exists that primarily because of the cultural norms and ethnic believes. For example, the upper castes such as *Brahamins* and *Chhetries* do not keep pig. They believe pig is not accepted in their religious rituals of Hinduism. In classical Hinduism, contrast between ritually pure and impure (*sudhha- asudhha)* can be found (Aase, 2002). Pig is considered as an impure (*asudhha)* animal. Thus, only *Dalits* and *Janajatis* (but not *Newars*) keep pig. For the *Brahmins* and *Chhetries* cow is considered as very necessary animal to be kept in their home. Because they believe cow as a holy creature (as Laxmi Goddess) and her milk, dung and urine are essential for several ritual activities of *Brahaman* and *Chhetries*. The animal slaughtering during ritual and cultural occasions is also varied according ethnicity. For example, during Dashain festival animal sacrifices in the name of *Durga* Goddess is a kind of cultural norms. *Magar, Rai* mostly sacrifices the pig but *Gurung* sacrifices male buffalo. *Brahamins and Chhetries* sacrifices male goat. It indicates that the socio-cultural norms and religious beliefs also influence farmers to prefer the animal to be kept.

Over time, the cultural taboos of animal keeping have been gradually changing. Before five-six decades, Brahamans and Chhetries did not keep and eat chickens. "*In my grandfather's time, we were not allowed to keep or even to touch pig and chicken. If we touched pig and chicken accidently, we had to wash the hand before entering to the home. But these days, the socio-cultural context is changing. Now we keep chickens but mostly for sell." (male 63).* The main reason of change is increasing market value of animal products and social awareness of the food.

5.1.4 **Large cardamom**

Among the all farming activities, large cardamom has become the main source of family income of Majuwa farmers. Large cardamom production is a type of agro-forestry system. It is transplanted just before the beginning of the monsoon. After three to four years of plantation, it starts to give production. Usual harvesting time of large cardamom is in August. The Himalayan alder (*Alnus nepalensis*) and large cardamom (*Amomum subulatum*) are grown together in which alder provides the shade for large cardamom. This shade loving plant is native to the Sikkim Himalaya of India where it has been domesticated by the *Lepchas*, an indigenous tribes (Sharma et al., 2002). In Nepal, it started for the first time in Ilam district, about 40 - 60 years ago. Its production is mostly concentrated in Eastern Nepal. It is a very high valued spice crops, which is specially sold in international markets. For last two decades, farmers' attraction towards large cardamom cultivation has significantly increased because of its high market value. The study of Adhikari and Chapagain (2013) state that during 40 years, the market price has increased from 100NPR/kg to 2200NPR/kg.

In recent years, farmers have started facing problem of production decline. The recent study of Partap et al. (2014) has observed that the large production has considerably declined in Sikkim Himalaya. A primary cause of production decline has been attributed the viral diseases such as *Chhirke* (mosaic streak) and *Furke* (bushy dwarf). The old plantation, poor farm management and lack of irrigation have been observed as other reasons of lowering the volume of production. In Majuwa, asking farmers why the production declined, they also responded the similar causes. Some of them also responded that, "*this is probably the cause of pesticides use to control wild animals and pests such as Jhusil kira (a kind of insect)" (male, 52).* Some farmers in Majuwa have started replantation of large cardamom removing old infected plants

However, the rapid decline of production in the recent years has become one of the greatest threats to the large cardamom producer. The primary cause of production decline is effect of viral disease such as *Chhirke*, *Furkey* and other insects. The erratic rainfall, warmer weather and increasing extreme climatic events as well as week shade management, less farm caring, lack of proper irrigation are observed as the other causes of lowering the production (Sharma et al., 2016, Partap et al., 2014).

5.1.5 Integration of forest, animal husbandry and crop cultivation

The farming system of Majuwa is formed by close interlink of forest, livestock and crops. Figure 5.3 shows the interrelation and material exchange among the major farming components. In this farming system, the cycle of nutrition moves from soil to crops and thence to the livestock and livestock to soil (Thorne and Tanner, 2002). Forests (private as well as community) are the sources of input for livestock and crops cultivation.

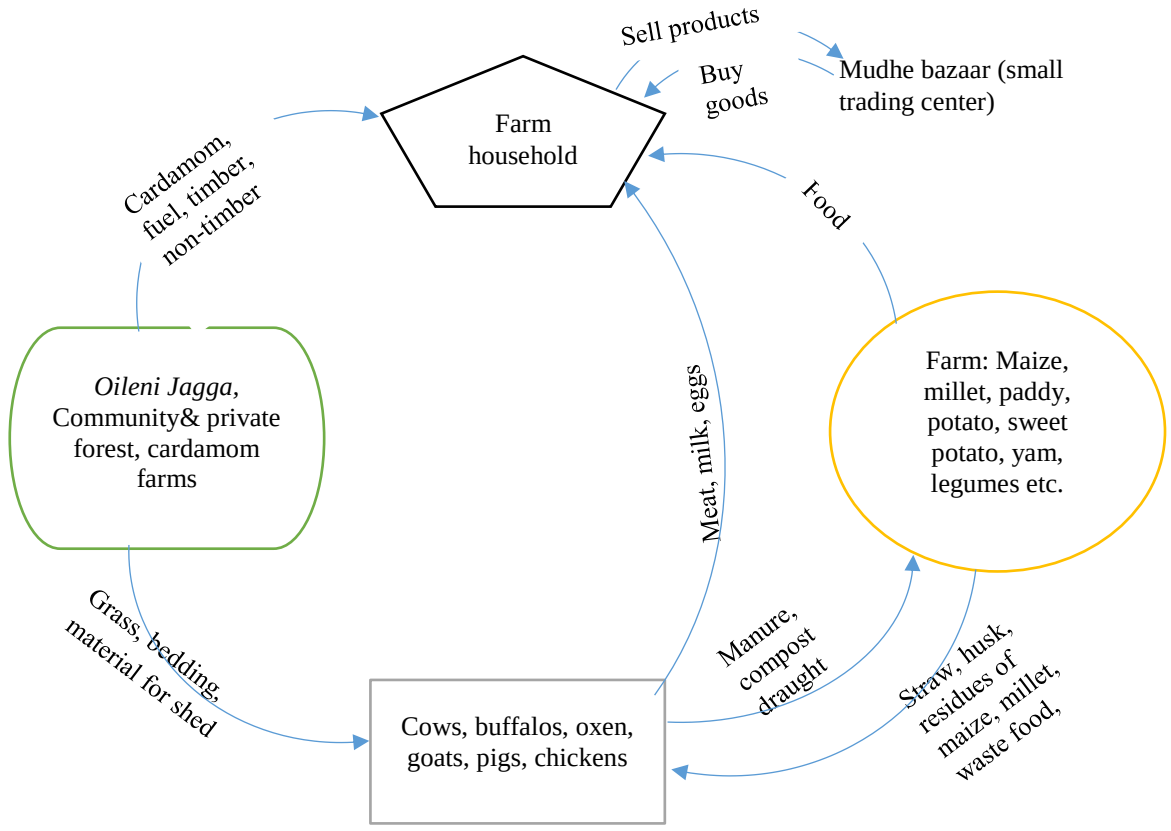


Figure 5.2: Farming system of Majuwa Based on field work, 2016

Community forests and *oileni jagga (*non-registered land) are known as common property resources which are considered as vital resource for agriculture (Neupane et al., 2002). In

Majuwa, farmers collect fodder and bedding materials for animals in Baisjhore community forests, *oileni Jagga,* and own private forests. The community forest user groups[8] have made certain rules to use the forests resources. According to a key informant (who is member of community forest user group) farmers are free to collect green grass which is found on the surface and bedding materials as such as *Titepati* (*Artemisia*) and *Banmara (Lantana camara), Uniu (Dryopteris), pattai (plant litter)* etc. anytime but for fuelwood, timber and non-timber collection they have to follow the rules. From *oileni Jagga,* farmers collect grass and beddings. The *oileni jagga* is a kind of common property resources found in the village which includes scrubland, river banks, wasteland etc. but it does not remain under the category of community forestry. During winter season, some farmers also graze cattle and goats in this land. Farmers have planted varieties of fodder trees such as *Dudhilo (Ficus nemoralis), Newaro (Ficus rosenbergii), Gogan* (*Sauraria nepalensis)* etc. as well as bamboos in slope and edges of the terraces of cultivated land. These fodder trees mostly used in dry season.

The use of forests resources as fodder and bedding is varied by location and time. Farmers collect more fodder from forests during winter season than summer due to lack of enough fodder in own land. Farmers get green grass under the tree shadow and side of river where moisture is high. "*I do not go to forest during summer to search green grass but during winter, it is necessary to go because milk producing cow or buffalo do not sustain with dry fodder (straw, millet residual) - (male, 29)".* Traditionally farmers have been using beddings for animals. They collect beddings from nearest forests and put on animals' bed. Everyday farmers change the bedding after removing the dung. This helps to make animals' bed clean and warm. This is also the traditional way of making compost from forests resource mixing with animal dung. Bedding material use is affected by the cropping patterns of the farmers. The study of Andersen (2002) found that the farmers on ridge of Arun valley area used forest resources such as *Titepati* (*Artemisia*) and *Banmara (Lantana camara)* as bedding for animal whole year, whereas farmers in lower valley used bedding for animal only during summer. Because for potato cultivation in ridge area farmers used more manure than other crops in mid-hill and lower valley. Thus, there was association between the bedding used and the cropping patterns.

[8] During the mid of 1970s the concept of community forests has launched mid-hill of Nepal. However, the Forest Act of 1993 has legally handed over the national forest to the local forests user groups ACHARYA, K. P. 2002. Twenty-four years of community forestry in Nepal. *The International Forestry Review,* 4**,** 149-156.

The interdependency between livestock and crop production is reflected in various agricultural activities in Majuwa (see. figure 5.2). Grain, crop residuals are used for livestock feeding. Farmers preserve straws (paddy and wheat), millet and millet residuals as livestock fodder during the harvest time. These crop residues fulfill the fodder scarcity during dry seasons. Farmers also give grains' husk and maize flour to the animal. Milk producing livestock only get maize flour with husk. In returns of this, livestock provide manure and animal drought power for crops cultivation.

5.1.6 **Cropping inputs: labour and manure**

In traditional agriculture, most of the families worked for themselves as family labor. Each child born in family was considered as potential agricultural labour force. There was traditional practice of labour exchange between the farming families i.e *Purma*. Particularly in this system, one household send their members to the others during plantation, weeding or harvesting. In returns of this, they get equal numbers of labour (Kshatrī and Hutt, 2008, Chapagain, 2003b). The agreement for time between the labour exchangers is made based on their labour necessities. Few wealthy farmers and farmers who are engaged in service sector or business only hired wage labour. Poor families, their production do not meet the household basic need were engaged in wage labour.

The forms of agricultural labour have been changed. In recent years, the availability of wage labour has become less. Several young and adult male workers in village has either moved as labour migrants to different countries or moved to different cities within country for searching the opportunities. The workload has been added to the female and old age members of the family. From the economic perspective, sectoral wage variation and low labour productivity in agriculture is the main reason of sectoral movement of labour. Few timber loaders in Mudhe bazaar from the Majuwa villages were asked the reason of not working in agriculture and they replied, "*We get per day 200Npr in agricultural activities whereas, here we get 700Npr with food." (36, male)*.

Farmers have been using animal dung as main fertilizer for crop cultivation for ages in this area. Nobody use chemical fertilizer. Farmer carry manure in bamboo made cone shaped basket *(doko)* and spread on the field before ploughing. During winter season farmers located in lower altitude keep cattle in cultivated land after crops harvesting and before ploughing for new plantation. Livestock are transferred from one terrace to another after few days of

keeping. In this way, farmers should not carry and transfer manure. However, farmers located in higher altitude keep livestock in shed (stall feed), carry and spread the manure.

5.2 Current farming system of Aahale: new agriculture

Picture 5.2: Vegetable crops in Aahale

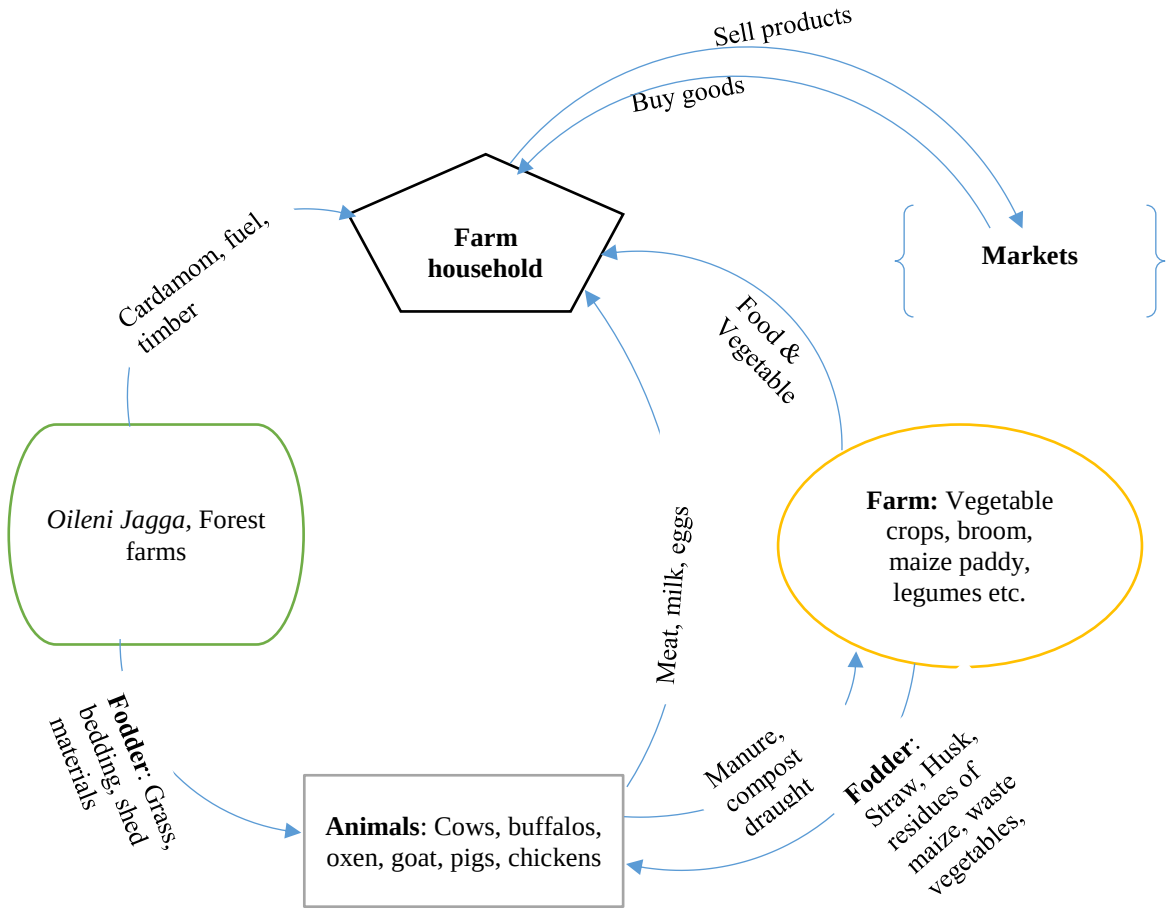
Farming system of Aahale village is characterized by marketable production and diversified cropping pattern. Farmers have been attempting to rise the production and profitability in agriculture. Traditional subsistence farming system of Aahale village has been almost shifted towards the new agriculture in which farmers have introduced several agricultural innovations. Presently improved varieties of vegetable crops are extensively covered most of the *bari* in which farmers are engaging in different farming activities such as seeding, transplanting, weeding and harvesting almost all time of the year. Animal husbandry and production of milk hold more than half of the households' source of livelihood. The broom[9] grass *(Thysanolaena maxima)* locally known as *amliso*, plantation has become one of the important cash generating agricultural product and resource for livestock. It has been argued that such kind of dynamic and new agricultural practices are more volatile, however farmers frequently get considerable income and employment opportunities (World Bank, 2006:9). Aahale farmers also cultivate large cardamom in substantial area. Vegetable cultivation, animal husbandry, broom grass, large cardamom are the major sub-systems of Aahale farming system.

The farming system of Aahale shown in figure 5.3 illustrates the different sub-system and components of farming system. Some of the features are as same as the farming system of Majuwa, for example the reciprocal relationship among the farming system components such as livestock, crops and forest exists in which material of one component would be resource to another. However, the difference in Aahale farming system is, the market-oriented dairy production is interlinked with cash generating vegetable crops production. Since the beginning of last decade, small-scale vegetable and raw milk production have become one of the successful agricultural practice of this village. A wider and strong market chain exists here

[9] This perennial grass plant is found in hilly region of Asian countries including hilly region of Nepal. Broom grass is local name because its flower is used to weep the floor. The plant is also a vital source of fodder for livestock.

that has significant influence on success of vegetable and raw milk production. Due to good market access farmers can easily sell their products and buy agricultural inputs.

5.2.1 Cultivated land and crops cultivation



Based on field work, 2016

Figure 5.3: Farming system of Aahale

The local categories of land in Aahale are much more identical to Majuwa village (i.e. *bari, khet and pakho)* as described in previous section of this chapter. However, farmers in this village owned more *bari* and *pakho* than *khet.* In *bari* farmers mostly cultivate vegetable crops such as cabbage, cauliflower, pea, radish, potato, Chinese onion, carrot, pea etc. Cultivation of cereals in *bari* such as millet, maize is hardly found. Most of the crops are planted in separate patches of land. Only few farmers grow crops such as bean and soybean in the edges and slope of terrace planting. As in Majuwa village, Aahale farmers also have some *oileni* land. However, the ways of utilizing *oileni* land in this village has been changed. As reported by a key informant, in traditional practice the *oileni* was common land and farmers commonly used land to graze their livestock, collect fodder and bedding but three decades ago

villagers divided it to all the villagers making separate patches of land for each household and started to use as private land. Now farmers have planted broom grass, Napier *(Pennisetum purpureum)*[10], trees and large cardamom.

Although, cereal production in *khet* in Aahale village still exists, the volume and area of production has been gradually decreasing. Few farmers cultivate paddy, maize and wheat but none of my informant reported that they are satisfied with the costs of outputs. It is because, *khet* land are located away from household so that farmers have to walk more distance form household to the paddy field. In addition, as paddy cultivation needs more labor inputs, the cost of production is also high. So, that farmers are changing their paddy land into the large cardamom that gives more profit in low labor input. Another category of land, *pakho* in this village is mostly covered by Napier, broom grass and fodder and non-fodder trees. Before introduction of Napier and broom grass, farmers collected naturally grown green grass during summer form the forest.

As far as the change of crop cultivation concerned, it is important to note that the major changes have emerged over last two decades. Agricultural production system of this village was more subsistence oriented where farmers cultivated cereals in most of the land and vegetable crops only cultivated in small area before two decades. The National Planning Commission report stated that few vegetable crops, such as cabbage and radish were introduced in the upper ridges of Koshi Hills more than two decades ago (NPC, 2013). Some changes have started before the last decade but cultivated land have been intensively used for vegetable crops cultivation which seems radical change in production system in this village over the last decade.

5.2.2 **Cropping calendar**

Aahale village has altitudinal variation that results the diverse climatic condition. Due to diverse climate within the village, potential of producing multiple crops is high. Cropping calendar is mainly featured by off-season vegetable crops. Cultivation of crops outside the regular cropping calendar or production of vegetable beyond the normal season generally refers to off-season vegetable (Schreinemachers et al., 2016). Aahale farmers have been producing both seasonal and off-season vegetables. Cabbage, cauliflower, radish and pea are

[10] *Pennisetum purpureum is known as Napier grass. It is a species of perennial tropical grass. (https://en.wikipedia.org/wiki/Pennisetum_purpureum). In Nepal, this grass has been used as important fodder for livestock.*

the major off-season vegetables crops grown in Aahale. These crops are typically winter crops however, can also be cultivated during autumn and rainy season in mid-hill region of Nepal in altitude of 1500 to 2000 meters m.a.s.l (USAID, 2011). The economic value of off-season vegetable is very high due to the high demand in tarai (plains) and tropical regions of India. The production of vegetable is often affected because of heavy monsoonal rainfall in these areas. The monsoon season in Nepal is characterized by high rainfall, high temperature and high humidity that directly affects the vegetable production and supply in the plain area (Ibid). Thus, the lower supply and high demand causes to increase in price of off-season vegetable. In Aahale, farmers also grow other vegetables such as hot chili, capsicum, carrot, winter cauliflower etc.

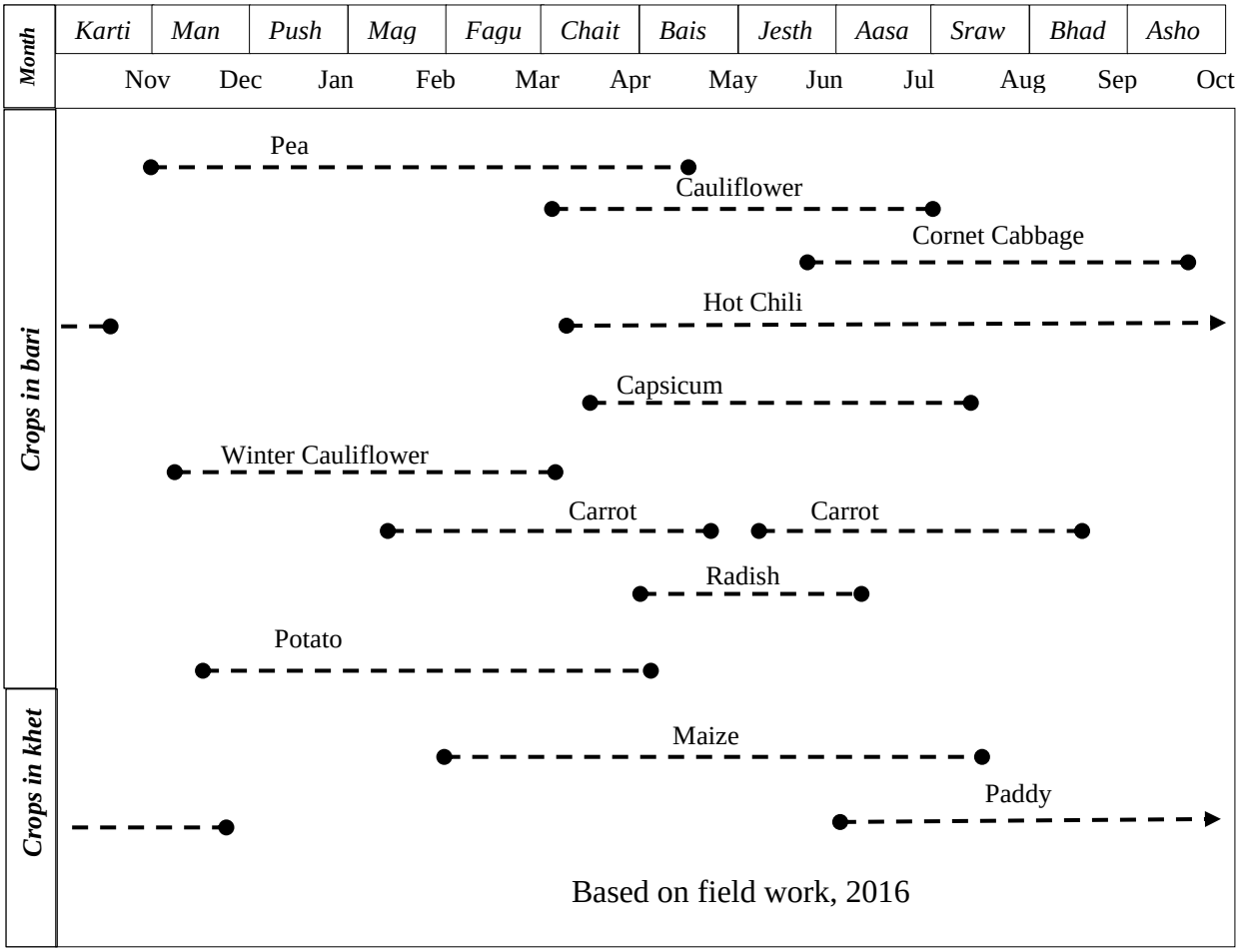


Figure 5.4: Cropping calendar of Aahale village (dotted lines represents the growing period to harvesting

The cropping calendar of this village is dynamic and complex. It seems dynamic because farmers cultivate various crops in the same season. Some farmers also practice the crop rotation system in which they seasonally change the crops. Generally, they change the

cultivation plot for the crops such as cauliflower, hot chili and pea. A study of Adhikari and Basnyat (1998) from the mid-hill of Nepal argued that the practice of crop rotation for instance maize and tomato has certain advantage to the soil and crop. The change of crops make cropping pattern more complex. Generally, one cropping pattern of Aahale village consists of more than two vegetable crops and each crop occupies the cultivated plot at least three months. However, the nursery time overlaps to each other. For instance, when pea is ready to harvest, the seedlings of cauliflower are also being ready in the nursery to transplantation.

Figure 5.4 shows the main activities of crops cultivation in Aahale village which include various cropping patterns. More dominants cropping pattern of *bari* is pea-cauliflower-cabbage. This cropping pattern begins during November-December with pea seed sowing. Pea is harvested during March-April. After harvesting pea, seedlings of cauliflower are transplanted. The cauliflower is started to harvest in June. After this farmer cultivate cabbage in that field. Hot chili has longer growing season. Seed bed of hot chili is kept in Feb/May and seedlings are transplanted in April. Hot chili starts to give product from June/July which will be continue up to October/November. Radish and carrot have the shortest growing period, i.e. about two and half to three months whereas hot chill remains longer time in the field. These crops can be cultivated twice and more in same plot. The *"Madhuri"* type cauliflower and potato are sown in early winter season which is ready to harvest in April.

Almost all varieties of off-season crops are sown in winter season and harvested during monsoon. Farmers prefer to cultivate multiple crops in the same season dividing their entire land. For example, if a farmer has ten *ropani bari*, he/she will generally divide two *ropani* for capsicum, one or two *ropani* for hot chili and in the same way he/she divide the land for four to five other crops. Asking farmers why they want to diversify their crops, one of respondents reported that "*It is difficult to be sure the market price of offseason vegetable, sometime hot chili get higher price and sometime capsicum so it is good to plant different crops instead of planting one crop in entire land. (male, 37).* Cropping pattern in *khet* is similar to the Majuwa village. Mainly farmers cultivate maize and paddy. Farmers of Aahale also cultivate soybean at the edge of *khet* terrace during the paddy transplantation.

5.2.3 **Cropping inputs: fertilizer and crop seeds**

Since crop cultivation of Aahale is market-oriented which includes hybrid varieties. Farmers mainly focus on proper management of agricultural inputs such as seed, water, manure,

chemical fertilizer, pesticides and labour. For hybrid crops, carefully selection of cultivated land, weeding in time, using proper amount of water and fertilizer is needed. However, most of the farmers do not have long experiences of vegetable cultivation. Thus, management of cropping input is perceived as a great challenge. *"I don't know sometime what happen; in same terrace capsicum is produced more than 50 kg, sometime produced only 20 kg" (female, 31).* A quote of said by a key informant indicates that there are more production uncertainties in vegetable crops than the traditional staple crops.

In village *chok*[11], there is a local cooperative i.e. Siddhakali Agricultural Cooperative which distributes different types of vegetable seeds, chemical fertilizer and pesticide. Farmers mostly buy seed of off-season vegetable crops (capsicum, hot chili, carrot, cabbage, cauliflower, radish etc.) from this local cooperative. And they also preserve seed for paddy, potato and pea themselves from their harvest. However, sometimes they necessarily have to buy seeds of these crops, for instance, if they lost their previous harvest due to climatic threats such as hailstorm, wind and heavy rain or non-climatic threats such as disease, wild animal and pests. There are few private agro-vets (shops which sell seed, chemical fertilizer, and pesticide) in Sindhuwa. Farmers also buy agricultural inputs and sometime get technical supports from these private agro-vets.

Picture 5.3: Use of manure and chemical fertilizer

Farmers use substantial amount of chemical fertilizer along with manure. The common types of chemical fertilizers used in Aahale are DAP (*diammonium phosphate*) and urea (*carbamide***).** Cows, goat and buffalo dung has been a primary source of fertilizer. However, with adoption of new crops farmers have also started to import large volume of chicken manure from the poultry farm located in Tarai. Chicken manure is considered high quality manure which is particularly used in potato cultivation. On an average, farmers use 40-50

[11] Chok refers to a kind of place where locals gather for different propose such as community meeting, assembly or discussion.

doko of cow and buffalo manure per *ropani* per season (See picture 5.3 in the left). Farmers use chemical fertilizer in potato, cauliflower and cabbage. However, the amount of using manure and fertilizer depends on the types of crops and time of use. Chemical fertilizer is used for two times, first is during plantation and next is during weeding for the cabbage and cauliflower.

5.2.4 **Animal husbandry: raising improved cows**

Farmers in Aahale are raising improved breeds of cow which is important part of raw milk production. Besides cows, farmers also have kept other animals for production of milk, meat and eggs. Mostly animals are kept in permanent stall because no grazing land is available in village. Practice of rising improved cows has been started since the establishment of local milk collection center and market access. Before this, farmers used to keep local breed of buffalos and cows, few numbers of goat, chicken and pig. Farmers sells/used to sell some animal products such as homemade butter, eggs, chickens and he goats in local periodic markets held in Sidhuwa and Jitpur bazaar.

In contrast to Majuwa, most of the farmers prefer to keep improved breed of cows than the buffalo because it gives more milk and farmers get more profit in this village. It has been found that most of the farmers in this village have average two or more milk producing cows and they sell average 10 liters milk per day. Every morning they arrive in Aahale *chok* carrying milk cans in their hand where Siddhakali agricultural cooperative, small tea shops and a milk collection center are located. The Siddhakali agricultural cooperative organizes and manages the collected milk and transfer to the larger cities. Every fifteenth day of the month, they get cash of their milk. This shows that milk production has become one of the important livelihood in Aahale which is significantly supporting to enhance the living standard of farmers. The study of NPC (2013) also states that, raising livestock has significantly helped to reduce the poverty of the Koshi hill's farmers.

Nowadays, some farmers have also started to keep chicken, goat and pigs for monetary propose. There are two small private poultry farms in village, where broiler as well as local chickens are raising. A pair of oxen has been kept and used as animal draught power. Farmers still use pair of oxen for field ploughing. Farmers have multiple options to sell their animal products. They can sell their product in village either for intermediaries coming from Sidhuwa or for local cooperative. A traditional practice of animal trading exists in village. The sterile (unproductive) cattle are sold in cheap price for the mobile merchants locally called *kharite*.

Kharite come to the farmers' house during dry season and buy unproductive cattle those can walk. They collect large numbers sterile cattle from nearby villages and transfer along the foot trail to *Damak pasuhat;* an animal bazaar located in Jhapa and sell some of them in that place. In *Damak pasuhat* Indian merchants buy and take the animals to the Indian market crossing the Indian broader. Some merchants started to transfer such animals carrying on a truck after the road construction.

5.3 Summing up

Descriptions of farming systems of two farming communities from Himalayan hill region reveal that there are few similarities with several variations in farming components and their relations. One of the important similarities in farming system in both villages is close and complex interrelation among the major three sub-systems: livestock, crops and forest resources. However, traditional characteristics of hill farming system such as subsistence orientation (Ashby and Pachico, 1987) only existed in Majuwa village. Cereal domination, traditional animal husbandry and consumption based production pattern depicts the subsistence nature of farming system in this village. Nevertheless, cultivation of large cardamom has a significant support on the farmers' livelihood and livelihood pattern. The farming system in Aahale has shifted towards market oriented production system. Dynamic and diverse cropping pattern and improved animal husbandry have been observed as main features of farming system in this village. Adoption of a numbers of new cash generating farming practices such as off-season vegetables, dairy, broom grass and large cardamom have significantly raised the farmers' level of income and living standard.

Since my intention is to understand the innovation in farming system, further concern is directed toward how and what short of new and innovative practices have emerged in farming system both villages within the last 10 years. In addition, the focus will be given on the issue of why variations in innovation have occurred, even within a short distance of same region and same altitude? The following chapter will discuss about these issues

CHAPTER 6: MAPPING INNOVATIONS OF FARMING SYSTEM

Agricultural innovation is concerned with adoption of new practices and changes in traditional farming system. It is about reorganization of farming system components such as crops, land, market (Klerkx et al., 2012). Occurrence of innovative changes and restructuring in farming system components of a particular area is driven by social, economic, political and environmental circumstances (Asfaw et al., 2016). Thus, existence of innovations differs from one farming community to other. There is variation in adoption of new practices in farming system in different farming communities in the entire region of Arun valley. Even in the same ecological zone and within a short physical distance, adoption and application of new agricultural practices such as growing new crops, application of new cropping patterns, use of agricultural tools and techniques are assorted. In previous chapter, I have presented the overview of farming system of both study villages (i.e Aahale and Majuwa). That highlighted the agricultural dynamics presenting features and trends of current farming system of both villages. In this chapter I will map the innovations in agricultural practices that have been emerged over the last 10 years' duration. The innovation mapping here indicates the effort of examining new practices or observe the use of new knowledge in farming system (Hall et al., 2003). This possibly helps to identify the variation in adoption of innovative practices in both the farming villages that will determine the degree of innovativeness of each village. Innovative practices in agriculture of both villages will be presented here in a comparative way. The subsequent chapter analysis why and how variations in innovations emerge in two different villages.

6.1 Mapping agricultural innovations

Agriculturally, Aahale village is probably the most developed village among the villages of Arun valley. Several new changes in agriculture have been occurred in this area over the last decade (i.e. 2005-2015) whereas the instance of Majuwa village is sharply different. Except some minor new changes, most of the farmers are still doing traditional agricultural practices. Here, my concern is what new changes have occurred in both villages. Thus, mapping of innovation is based on exploring new changes in certain components of farming system over the last decade. According to OECD[12] guideline innovations can be measured in four areas

[12] Organization for economic co-operation and development (OECD) and Euro-sate prepared guidelines for collecting and interpreting innovation data.

which are product, process, organizational and marketing innovation (Mortensen and Bloch, 2005). This framework has been proposed for multidisciplinary innovation studies such as industry, business and technology including agriculture. Evenson (1974) and Van der Veen (2010) have mentioned the following particular components of farming system in which (different) innovations may occur.

i) **Crops:** Farmers can innovate crop both biologically (bring new plant species) and/or genetically (bring new breeds). Proposes of change can be to get higher yield or adapt with extreme weather and soil condition or resist diseases (can have adaptive ability with climatic and non-climatic uncertainties). New crop species that may extend/change cropping calendar, may need new technologies, turn subsistence farming system to commercial or cash generating crops such as cereals to vegetables, vegetables to fruits, low value crops to high value crops etc.

ii) **Livestock:** This is related to introduction of improved domesticated animals, adopting new ways of husbanding, plantation new fodders, adoption of new feeding techniques, making improved sheds, new ways of dairy processing and marketing to extend the profitability etc.

iii) **Technologies and implements:** This is about adoption of new tools and machines for the agricultural activities such as ploughing, harvesting, cutting, water lifting, irrigating etc.

iv) **Cropping pattern/management:** Farmers can innovate the mode of production, use of additional/different fertilizer or manure, making terraces, raising soil depth and quality, switch to surplus production, sharecropping, multi-cropping or single cropping, tunnel farming etc.

In this chapter, innovations mapping covers small, radical and gradual improvements in all the above components of farming system of both the study villages. In fact, innovations in agriculture can emerge in different ways in different times (World Bank, 2006). Small improvements can be seen within a short period whereas larger and radical changes may take longer time (Van der Veen, 2010:3). For instance, the effect of using new fertilizer by an individual farmer (in his farm) can be observed within a year. Whereas plantation of multi-year plant such as kiwi fruit may take more than a year to observe it's benefits because kiwi plant gives production after three years of plantation.

6.2 Innovation in crops

Crop production is one of the major components of farming system. I have asked farmers (mostly to head of the household) about their new changes in crops and crop seed during the last decade in both villages. Based on farmers' response, table 6.1 summarizes the new crops as well as crop seeds of different crops introduced by farmers in both the villages. Average twenty-two out of the total surveyed farm households have planted four new vegetable crop varieties over the last decade in Aahale. All crops were off-season vegetable crops (carrot, hot chili, capsicum, Chinese onion). Some farmers started to cultivate these new off-season vegetables crops five years ago and most of the farmers are producing these crops in a significant amount now. The economic value of off-season vegetable is very high because of high demand in large cities of Nepal as well as India.

Table 6.1: New crop varieties introduced by farm households

Innovation in crops		**Aahale n=25**	**Majuwa n=25**
Crops introduced (new species)	Carrot	25	0
	Chinese Chinese onion	24	0
	Hot chili	23	0
	Capsicum	17	0
	Ground apple	3	0
	Kiwi	6	0
	Chiraito	0	2
Introduced seed varieties (Genetic changes)	Cauliflower	25	2
	Cabbage	25	3
	Pea	25	2
	Radish	25	2
	Paddy	25	4
	Maize	25	9
	Potato	25	9

Field survey 2016

Recently, some of the Aahale farmers have planted kiwi fruit *(Actinidia)* which is a new crop to them. This fruit is believed as a native fruit of China and grown especially between 1000 to 2500 m.a.s.l. The economic as well as environmental value of kiwi fruit in mid-hill of Nepal has been highly recognized (Huang et al., 2004). According to ICIMOD (2013) kiwi fruit is an important means of livelihood since it provides higher profitability and it also contributes in sustainable land management controlling soil erosion of slope land. Kiwi fruit has been

cultivated in other part of Nepal for some decades, however, it is new for the Eastern Nepal. The commercial cultivation was started in Eastern Nepal from Ilam district in 2007. Farmers started it in Aahale village three years ago. Six households among the total surveyed households have planted kiwi fruit in their *bari.* Similarly, three households have planted another new root crop, yacon (*Smallanthus sonchifulius*) a Peruvian ground apple. The yacon is a species of perennial root crop, it looks like a sweet potato or yam. It is believed that yacon has been brought in Nepal from Japan a decade ago. Since then, commercial cultivation has been increasing due to the higher demand in and out of country[13]' A study shows that, yacon is good sources of nutrition and has various long-term health benefits (Genta et al., 2009). In Aahale, farmers planted it as trial two years ago.

The commercial production of both kiwi and yacon have not been started yet in Aahale. However, farmers are very much aware of higher market price of both new crops those who have planted for trial. A farmer states that, "*I heard that kiwi fruit can be sold in 500-900 NPR/ kg in Kathmandu, it has good possibilities for income generation in this place so that I have planted it just for trial" (group discussion*)

Picture 6.1 Chiraito field in Majuwa

Farmers of Majuwa village have not introduced any new vegetable and cereal crops. Nevertheless, two out of twenty-five farm households in this village have started commercial cultivation of *chiraito*. *Chiraito* is a biennial or perennial medicinal herb with seasonal growth. It can grow within the altitude of 1500 to 3000 m.a.s.l. It is one of the most important medicinal plants of the mid-hills and upper-Himalaya of Nepal (MOFSC, 2014). Traditionally, it has been collected from forests for local use as *Ayurvedic medicine*[14] for fever and other diseases. Recently farmers have started *chiraito* cultivation in their *bari* and *pakho* (mainly located in higher altitude). Farmers produce and dry it before selling to the local traders. Local traders sell it to the regional traders or herb processing centers in different cities of Nepal and India. The average market price of *chiraito* ranges from 1000 to 1200 NPR/kg.

[13] http://therisingnepal.org.np/index/news/2446

[14] Ayurvedic medicine (Ayurveda) is a traditional health care system in Himalayan region. In Ayurvedic system, *Chiraito* is dipped few hours before given bitter juice to patent of cough, cold, fever and diabetes.

Introduction of new seed varieties of existing crops has been observed in both villages. Most of the farmers in Aahale have introduced hybrid seed of the cereal crops such as paddy and maize. They have also introduced improved seed varieties of off-season vegetable crops (the crop species of these crops were introduced more than a decade ago) such as cabbage, cauliflower, pea and radish. In Aahale, now most of the farmers are growing high yielding hybrid seeds of cereals and such off-season vegetable crops. Only average five out of the surveyed farm households have introduced new seeds (hybrid) of maize and potato in Majuwa during last decade. Other farm households have been using seed from their own previous harvest of potato and maize. For the paddy, mostly farmers use local seed, which is kept in a traditional way. During the time of harvest, farmers collect healthy and large bunch of ripen paddy. Then they mix it with ashes and store in grain store room. Farmers believe that selection and preservation of seed in such a way support to raise the total production. The local community seed bank also distributes the crops seed in this village. From this locally managed seed bank, farmers can borrow seed anytime when they need and can return after harvesting.

6.2.1 New cropping pattern and changes in cropland

Introduction of new crops has brought new cropping pattern and caused overall changes in cropland. Table 6.2 shows the average area changes in cropland among the surveyed household during the last two decades in both villages. In the decade of 1995-2005, cereal crops were dominated the cropland in both the villages. During that decade, some farmers of Aahale village have started to cultivate radish, cabbage, cauliflower and pea but the major changes have occurred during last decade (i.e. 2005-2015). In Aahale the traditional maize-millet cropping pattern of *bari* has been replaced by multiple off-season vegetable crops (see. picture 6.2). Similarly, the unproductive *pakho* land has been converted into the broom and Napier grass land. In recent years, the practice of planting trees in private land has increased. Farmers have planted *Utis* trees for the commercial timber sale in both villages. The study of NPC (2013) also shows that the timber export from private forest has increased in Koshi Hill area. Particularly farmers plant trees in marginal and unproductive lands.

Picture 6.2: New cropping pattern (replacing maize-millet)

Cropping pattern and cropland change has been observed in Majuwa village. Cultivation of cereal crops such as millet, maize and paddy shows the decreasing trend but not in large scale like in Aahale. The traditional practice of crop intercropping i.e. maize-potato and maize-millet has also found to be decreased. One of the important reasons (as provided by key informant) of decreasing cereal production is farmers attraction towards large cardamom farming.

Table 6.2: Cropland change (%)[15] during past two decades (n=25 each village)

Villages	**Aahale**			**Majuwa**		
Crops/Decades	1995-2005	2005-2015	% change	1995-2005	2005-2015	% change
Paddy	25.09	6.66	-18.43	27.15	23.73	-3.42
Maize	26.57	7.99	-18.58	28.96	20.18	-8.78
Millet	16.03	1.33	-14.7	25.1	13.64	-11.46
Cabbage	5.57	13.32	+7.75	0	0.91	+0.91
Radish	6.97	9.99	+3.02	0	2.73	+2.73
Cardamom	6.27	10.66	+4.39	9.05	18.18	+9.13
Cauliflower	2.09	7.99	+5.9	0	1.82	+1.82
Potato	4.18	7.33	+3.15	7.24	12.64	+5.4
Carrot	0	6	+6	0	0	0
Hot Chili	0	4.66	+4.66	0	0	0
Pea	3.48	10.66	+7.18	0	0	0
Ground apple	0	1.33	+1.33	0	0	0
Chinese Chinese onion	1.05	3.33	+2.28	0	0	0
Kiwi	0	0.67	+0.67	0	0	0
Chiraito	0	0	0	0	0.45	+0.45
Napier/broom	1.39	4.73	+3.34	0	1.36	+1.36
Private forest	1.3	3.33	+2.03	2.05	4.36	+2.31
Total	100	100	-0.01	100	100	+0.45

Field survey, 2016

The conversion of cereals field into large cardamom field is found in both villages. Initially, large cardamom was cultivated in marginal land, gullies, sloping land and side of small river banks. However, nowadays farmers are increasingly using *khet* and *bari* (crop cultivated land) for large cardamom plantation. Cereals production need more labour input and in other side the availability of labor in village has become less due to high labor migration. Thus, farmers have been interested towards the large cardamom plantation instead of planting cereals. In this case, an adult farmer says

[15] The unit of measurement was 'ropani' and presented in percentage (%)

> "*I have planted large cardamom in 8 ropani khet. If you compare all the inputs used for paddy cultivation and its production, it is almost same. Suppose I produce only 8 kg large cardamom per year, it will be more than the income of paddy production. In addition, the Utis trees can also be sold in 3000 NPR per tree after 10 years of plantation.*

From the above quotation, it has become clearer that, the main reason of converting cereal land into large cardamom is the high income as well as low labor input in large cardamom cultivation.

6.2.2 **Innovation in crop management**

During the last decade, two important innovations in crop management have taken place in Aahale village. One of the important innovative crop management practices is use of nursery-raised saplings in cultivation of large cardamom. A key informant reported that, to cope with the recent problem of massive production decline of large cardamom, farmers in Aahale have started to prepare nursery-raised saplings for large cardamom plantation. In conventional practice, generally large cardamom is transplanted separating rhizomes from adult plant. This practice may spread diseases from infected plants to new plants. Thus, preparation of nursery-raised saplings through seed has become popular among the farmers which is an innovative practice in cardamom cultivation. Large cardamom seed is prepared in the scientific way in particular lab or seed producing centers. The healthy and ripen seeds are selected from virus free large cardamom farm and treated for quality improvement. For nursery farmers prepare seedbed first, and sow large cardamom seeds during pre-winter season. The seedbed is covered with plastic nets (see. picture 6.3).

Picture 6.3: Large cardamom nursery

Picture 6.4: Kiwi fruit as shade for large cardamom

When saplings cross about 18 months in primary nursery, farmers transfer it to the secondary nursery during the pre-monsoon season. Saplings need to be kept about a year in secondary nursery before transplantation in the field.

The popularity of using nursery-raised sapling has increased because it is believed that such saplings reduces the transmission of viral diseases. According to Chaudhary et al. (2015), use of treated seeds of large cardamom for new plantation plays a significant role to produce virus-free saplings. Thus, the practice of nursery is suggested to be developed in the village to cope with increasingly spreading viral diseases and control production decline. In Sikkim, the governmental agencies and the Spice Broad has promoted the nursery-raised saplings providing technical and financial supports to nursery-raised cultivars (Partap et al., 2014). In Aahale, farmers removed infected large cardamom plants and started to use nursery-raised saplings for new plantation. According to a farmer, in such new practice they have not faced the problem of viral disease. Some farmers have also noticed higher yield form nursery-raised saplings.

From the commercial perspective, production of nursery-raised saplings has also become successful in Aahale. It has higher economic profits to the large-scale saplings producers. A single nursery-raised large cardamom sapling can be sold in 8-12 NPR in the village. Five households are producing nursery-raised saplings for own use as well as for supply to fulfill the other farmers demand in and out of village.

Use of kiwi fruit as natural shade for large cardamom nursery is another new crop management practice in Aahale. In such practice, farmers get two-way benefits utilizing the same land. Especially, after the primary nursery, saplings are transferred under the area of kiwi plantation (see. picture 6.4). Doing so, the necessary costs for shade management in large cardamom nursery are reduced. Some farmers are using kiwi fruit as shade to the large cardamom saplings. In Majuwa, farmers have not adopted any of these new innovative crop management practices during last the decade.

6.3 Innovations in livestock

In Aahale, farmers have adopted several innovations in livestock sector, for example, the beginning of farm registration practice, introduction of high milk yielding breeds of cow, plantation of new types of fodder, and building improve-shed. The beginning of registered private livestock farm is an important structural transformation and sign of commercial beginning of small-scale farmers (Pingali et al., 2005). This has led farmers towards the more

official and formal way of livestock farming. Recently, farmers of Aahale have started to register small-scale cow/livestock farm in the office of District Livestock Service Center (DLSC) as well as in the office of Small and Cottage Industries. This practice was actually promoted by recent livestock farming policy of Nepal government. Until the time of fieldwork, seven households have registered their livestock farm in village. Official registration of livestock/cow farm has opened many opportunities to the farmers such as getting low interest loan, subsidies in fodder cutting machines (i.e. chaff cutter), subsidies in trainings and learning programs. Aahale farmers have brought three types of improved breeds of dairy cows (i.e. Crossbreed, Jersey and Holstein) from other part of country during last decade. These breeds of cows are kept under the zero-grazing system (stall-feed). The introduction of each improved breed cow is primarily concerned with more profit generation under the raw milk market. Crossbreed[16] cows were brought before last decade in this area, which produce less milk than other two breeds (Jersey and Holstein). Jersey and Holstein are higher-ranking dairy cows they give average ten liters milk per day.

The figure 6.1 shows the time of cow breeds that have been adopted by farmers of Aahale. Most of the farmers (18 out of 25 households) are keeping jersey cows, only few farmers are raising crossbreed and Holstein cows. Besides improved breeds of cows, few farmers are also raising hybrid chickens (*broilers*) and hybrid goats (*Jamunapari*) for the commercial meat production. However, these practices are not seen under the official farm registration as well as large-scale meat production.

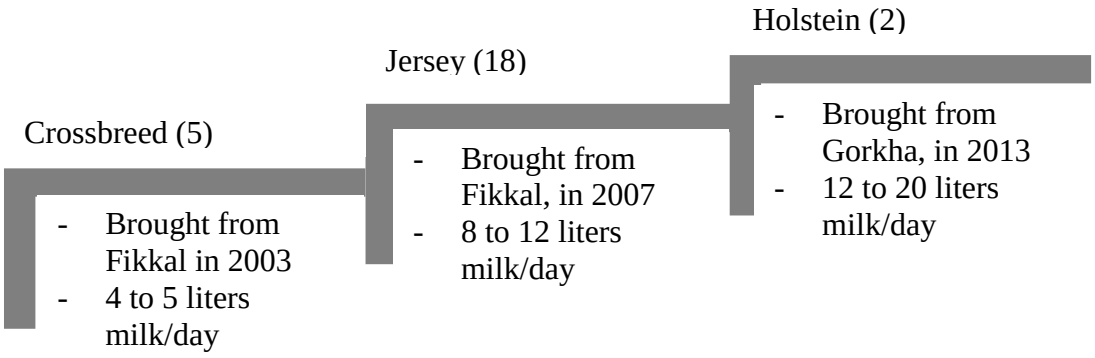


Figure 6.1: Types of cow breeds in Aahale (n=25) [17]

Field survey, 2016

[16] Crossbreed here indicates the mix breed of local and Jersey cows.
[17] The number inside of parenthesis indicates the households which have adopted particular breed of cow.

Along the adoption of new breeds of cow, other new changes in livestock sector such as plantation of new fodder grasses, adoption of new feeding techniques, livestock food preparing machines (chaff cutter) and improved sheds have been found in Aahale. As an important new fodders grasses, farmers have planted Napier and broom grass. Plantation of Napier grass has increased the fodder supply among the farmers because it has higher grass yielding capacity due to its rapid growing nature. During the summer season, normally grass can be harvested in every 6 to 7 weeks if proper water and fertilizer is given. It is considered as good fodder. A study of Anindo and Potter (1994) found that the nutritious value of Napier grass is higher than other grasses. Farmers in Aahale village have also experienced that animal gives more milk when they feed Napier grass.

Livestock fodder and feeding techniques have also been changed in Aahale. This is because higher-breed dairy cows need nutritious fodder to yield higher amount of milk. Thus, farmers of Aahale have started to feed more nutritious fodders. A study of Maasdorp et al. (1999) also shows that the milk yielding capacity of a higher-breed cow is directly associated with type of fodder and fodder intake. For this reason, more milk yielding cows need to feed with cereals and other nutritious fodder. Since the production of cereals has become less in own farm, farmers in Aahale started to buy grain's flour *(bran dhutto)* and oilseed cake from nearby Sidhuwa market. However, farmers who have own maize product, do not buy grain's flour. Besides the imported grain's flour feeding, farmers have adopted new technique of grass feeding in which all the fodder grasses are chopped first and given to the cattle. This new way of feeding has become possible after the introduction of grass cutting machine, a chaff cutter. Before the introduction of chaff cutter, the cattle were provided the whole part of grass but now farmers chop different varieties of green and dry fodders using chaff cutter and feed animals. The more common green fodder grasses are Napier, broom and locally available native grasses. They mix some dry fodders such as straw and *furkekhar* (a kind of grass found in unproductive land which is cut before beginning of winter and save it after making dry) with green grasses and prepared fodder to the animals. The way of making homemade mix of different grasses, crops' by-products and dry fodders using chaff cutter is good way to balance the fodder intake as well as reducing the labor-intensity (Erenstein and Thorpe, 2010:682).

In Majuwa village, innovative practices in livestock sector have hardly appeared. Most of the practices are similar to their ancestors. Animals are mostly local breeds. Recently, only one private livestock farm (Tinjure Agricultural Production Centre) has been opened which is a small evidence of new change in livestock sector of Majuwa. This farm was officially

registered in 2011 and is being operated under the partnership of three local farmers. Most of the cow breeds in this livestock farm are crossbreeds, which were brought from nearby villages and some jerseys cows were brought from Ilam district. The livestock farm sells milk in Mudhe bazaar (for the daily consumption of town people). Since the market for the raw milk is limited to the small town, farm have been facing problem of market uncertainties. The demand of milk fluctuates daily in Mudhe bazaar because there is no any system of fixed agreement between buyers and sellers. Sometime farm's supply cannot meet the demand whereas sometime they have to return milk from bazaar to farm because of lower demand. The returned milk is somewhat a waste because of the lack of other options of dairy processing. One of the owners of the farm said,

> "*The main problem here is the lack of market, we can't sell our milk all days, we don't have cream producing machines, but we are planning to buy chilling machines and open dairy processing center so that we can make cheese, paneer*[18] *and so on." (male, 42, an owner of Tinjure Agricultural Production Centre)*

In addition to the problem of market, the scarcity of fodder is equally hitting hard to the new livestock farm in Majuwa and discouraging other famers in improvement of livestock sector. The new fodder grasses such as Napier and broom plantation has just started in small area which is not enough. The livestock farm is managing the daily fodder need buying grasses from nearby villages. The farm also buys straws from the lower part of the villages.

6.3.1 Innovative cattle-shed with urine collection system

The focus of innovation mapping is to search the adoptions and occurrences of new practices or examine the use of new knowledge in every segments of agricultural development (Hall et al., 2003). These new practices can be interlinked with each other. For instance, the adoption of new practice in livestock sector of Aahale village can be seen in a new way of cattle-shed management. The practice of improved cattle-shed is directly interlinked with the rising of higher-breeds dairy cows. The higher-breed dairy cows need cleaner and well-managed shed. More than once-per-day cattle's bed cleaning is needed. Thus, to make easy to clean cattle's bed frequently, farmers in Aahale village have built improved shed and bed for cattle. Bed floor of improved cattle-shed is made up of concrete or joining of large flat stones so that

[18] Paneer is a kind of fresh cheese which is common food in South Asia, particularly in Nepal and India.

farmers can easily clean dung using spade and also can wash using water. The fodder (mix of chopped grass, straw) giving concrete boxes are attached with the cattle's bed.

Picture 6.5: Improved shed with urine collection system in Aahale (a, b), Traditional shed in Majuwa (c)

Another important part of improved shed is having integrated urine collection system on it. As shown in picture b. urine of cattle is collected in a tank (plastic tank) and use in crop both as bio-fertilizer and bio-pesticide. The use of urine in crop cutlivation has been considered as efficent way to reduce and replace the use of chemical fertilizer such as urea, DAP. A report HELVETAS (2014) states that collection and use of urine through simple restructuring of cattle's shed using local materials such as flat stones, waste plastic drums and a few additional materials, is very useful way to supply significant level of nitrogen to the soil. Use of animal's urine and dung is considered as sustainable and organic agricultural practice (Horrigan et al., 2002).

Since the farmers in Aahale village are cultivating market based hybrid crops, the cropping intensitiy and demand of soil nutrients is increasing. It is argued that market-oriented production system demands more soil, water and humna resources (Brown and Shrestha, 2000). Hence, to supply adequate soil nutrients, farmers have been increasingly using chemical fertilizers such as urea and DAP. However, costs of chemical fertilizer is increasing every year. On other side, the supply of chemical fertilizer is always affected by unstable political situations of Nepal, for instance strike, embargo and rally. In this situation, the use of urine as bio-fertilizer is one of the innovative response to the uncertain supply of chemical fertilizer in Aahale village. An adult male farmer 52 says:

"*I have been collecting and using cattle's urine for three years, specially I use it for Chinese onion. It is very good because when I started to use cattle urine in Chinese onion, the size of Chinese onion has become larger."*

In the case of Majuwa village, the adoption of improved cattle-shed management practice has not been found. Most of the cattle are kept in locally made shed which is built from bamboo

and wood. Even the cattle's beds are not covered with flat stones. Farmers use thick layers of bedding materials to maintain the cattle's bed. Farmers also do not have idea of using cattle urine as bio-feritlizer and bio-pestiides.

6.4 Innovation in agricultural tools and operational viability

Adoption and use of modern agricultural tools and machines has been considered as a way of commercialization, mechanization and means of successful economic growth of agriculture. In recent years, technology adoption and innovation has got wide recognition in the context of climate change adaptation (Smithers and Blay-Palmer, 2001). In the case of Nepal, technology innovation has been seen as possible way to tackle increasing environmental and socio-economic challenges (Chhetri et al., 2012). However, the issue of sustainability in terms of energy cost and environmental effect of new technology is still debated. Moreover, the operational viability or handling capacity of newly adopted tools and machines (such as hand tractor) to the smallholder farmer is believed to be inadequate (Novo et al., 2013).

Picture 6.6: New agricultural tools in Aahale: hand tractor, sprayer and chaff cutter

Farmers of Aahale village have introduced four different new and modern agricultural tools; sprinkler, sprayer, chaff cutter and hand tractor during the last decade. However, among these, some farmers brought the sprinkler and sprayer more than a decade ago. The use of traditional equipment such as *halo* (plough), *dande*, (leveler) and *kodalo* (spade) is still significant. In this village frequencies of adopting sprinklers and sprayers are higher than chaff cutter and hand tractor (see. table 6.2). Most of the farmers have sprinklers and sprayers because off-season vegetable crops require regular supply of water and pest control. Besides sprinkles and sprayers some cow farmers have chaff cutter machines. Farmers who have registered their cow farms in District Livestock Service Centers, have been subsidized to buy chaff cutter by governmental agencies. This support has become one of the important inducements of adopting chaff cutter machine in Aahale. Famers are efficiently using chaff cutter which optimizes the utilization of fodder resources. The chopping method reduces the fodder loss because cattle can eat all parts (stem, leaf, and flower) of chopped fodder grasses.

Table 6.1: Frequencies of adoption of new agricultural tools

Adoption of new agricultural tools	Aahale n=25	Majuwa n=25
Sprinkler	24	3
Sprayer	23	0
Chaff Cutter	7	1
Hand tractor	2	0

Field survey 2016

In Aahale, two hand tractors were brought for land ploughing three years ago. Farmers' group brought one tractor for their common use and an individual farmer brought another. However, currently none of them are being fully used because of some reasons such as the problem of stone on the terrace surface, lack of operating knowledge and higher energy cost. A member of farmers' group says, "*It has become useless because only one member of our farmers' group was trained to operate this but two years ago, he went to Saudi (Saudi Arabia) as a labour migrant. After that it has become useless" (male, 46).* It indicates that achievement of technological adoption is conditioned by farmers' capacity as well as its relevance in particular condition. All technologies would not fit in all conditions. Henceforth, association between the social, economic and physical condition and adoption of new tools need to be established to gain the success on innovative practices.

Majuwa farmers have introduced very limited numbers of new agricultural tools during the last decade. The technological innovativeness seems vary unremarkable. A few households have sprinklers to irrigate large cardamom during the winter season and only a registered cow farm has a chaff cutter machine. Still traditional cultivation tools are the primary equipment of agricultural activities.

6.5 Summary

In this chapter I have explained and presented the occurrences of innovative changes that have emerged in the farming system of two study villages of Himalaya region. The figure 6.2 depicts the summary of innovative changes that have adopted by farmers in different components of farming system in both villages. The level of innovativeness or frequencies of innovative changes in agricultural activities have been observed in multiple components of farming system such as crops species, crops seed, cropping pattern, crop management, livestock, livestock fodder, livestock shed and agricultural tools. The numbers plotted inside the figure refers the frequencies of agricultural innovations.

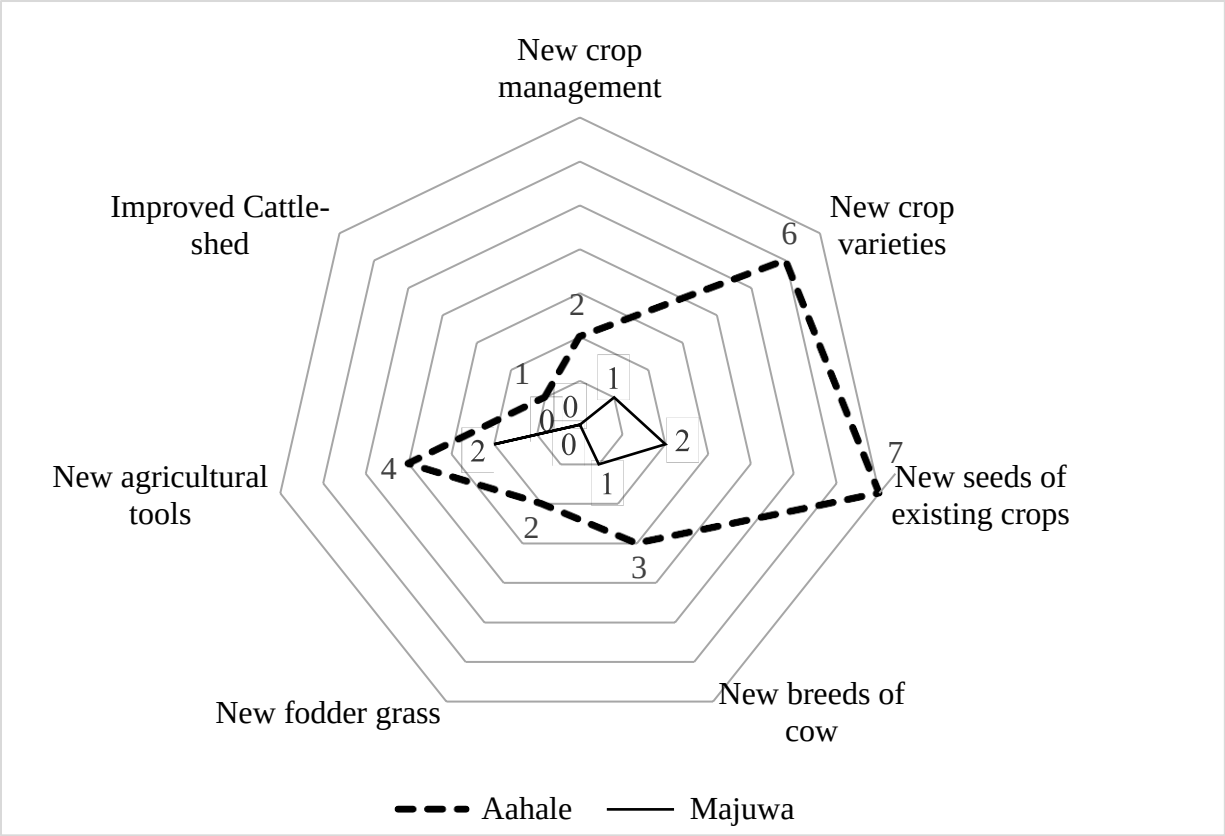


Figure 6.2: Frequencies of agricultural innovations in Aahale and Majuwa (n=50)

Adoption of high yielding crop and seed varieties, introduction of dynamic and diverse cropping pattern, and changes in breed of domesticated animal are the major fields of agricultural innovation in Aahale village. During the last decade, farmers have introduced six new crop varieties (carrot, hot chili, capsicum, Chinese onion, ground apple, and kiwi). Among them farmers are successfully producing off-season vegetable crops. The evidence of success of these crops can be understood from the higher living standard of off-season vegetable farmers of the village. These crops have higher rate of economic returns and profitability. The other two crops i.e. kiwi and ground apple are still under the trial phase so that its success is awaited. In addition to new crop varieties, most of the farmers have introduced high-yielding (hybrid) seed varieties of cereals and other vegetable crops. Introduction of hybrid seeds of cereal crops has increased the production however as I have discribed in the section 5.2.3 it has also raised the need of external input for instance fertilizer and persticides. In the case of large cardamom farming, saplings preparation through seed is one of the innovative changes in Aahale. Plantation of nursery-raised saplings is considered as a way to control disease because already treated seed is used to produce the virus free saplings. Hence, it can be said that it is an indication of adaptation with recent challenge of rapid production decline of large cardamom. Using kiwi fruit as natural cover for large

cardamom nursery is another novelty in crop management. This practice has reduced the cost which is needed to build shed such as net or plastic.

In Aahale village, improved breeds of domesticated animal, especially high milk yielding dairy cows have been bought from other part of the country. Because of the high milk yielding dairy cows farmers are producing significant amount of milk than the previous decades. New fodder grasses, new feeding techniques and shed improvement practices are other innovative changes in Aahale. It is said that the system of urine collection and use as bio-fertilizer is one of the sustainable innovation to reduce the increasingly use of chemical fertilizer. Four modern agricultural tools have been introduced during last the decade in this village. Introduction of sprayers and sprinklers are associated with off-season vegetable crops. The chaff cutter machine is efficiently being used to balance the nutrition and optimum utilization of fodder for higher breed cows.

Since the faming system is still dominated by traditional practices, only few innovative changes have been observed in Majuwa village. Plantation of *chiraito* for the commercial purpose is one of the few new practices in agriculture. Beside this some households have introduced high yielding crops seed of potato, paddy and maize. However, most of the other farmers are growing local seed varieties. The innovative practices in livestock sector are also rare. A recently opened new livestock farm has kept some jersey breed cows. In the case of technology innovation, only three households have brought sprinkler for large cardamom.

The mapping of innovative practices in farming system of Aahale and Majuwa presented here provides the frequencies of new changes or new practices, which indorse the level of innovativeness of each village. From the general inventory of newness in agricultural practices of both village, it can be realized that more innovations have emerged in Aahale village during last 10 years. Limited numbers of innovations have been emerged in Majuwa. Hence, Aahale village can be recognized as more innovative villages and Majuwa village as less innovative village. Based on the assumption “actual innovation is index of innovative capacity” (as suggested by prof. Aase), it can be concluded that Aahale village has the higher level of innovative capacity in comparison to Majuwa. Additionally, from the case of Aahale village, the interconnected nature of innovation has been found in which one new change directly interlinked with other. As I explained in the section 1.3.1 for example introduction of improved shed, chaff cutter, new techniques of fodder feeding and plantation of Napier grass have been induced by the introduction of high milk yielding cows.

Exploration and analysis of associated actors as well factors are significant to understand the processes of innovation. Analysis of factors and actors influencing innovation will clarify more about the issue of why and how are those new changes in agricultural practice are initiated (Van der Veen, 2010). Thus, the subsequent chapter analysis the reasons why Aahale village has become more innovative than Majuwa and by whom those innovative changes are initiated.

CHAPTER 7: ACTORS AND FACTORS INFLUENCING THE INNOVATIVE CAPACITY

The main concern of this thesis is to analyze how the farmers' innovative capacity can be raised. Innovative capacity is the competency to change, innovate and improve the traditional farming system so that they possibly can adapt with global challenges. In this chapter, I will analyze the actors and factors influencing the farmers' innovative capacity. Mapping of actual innovations in farming system of Aahale and Majuwa village in the previous chapter revealed that Aahale village has higher level of innovative capacity. Thus, at this point, the question is raised why Aahale village has a higher level of innovative capacity than Majuwa. Analysis of innovative capacity is based on integrated innovation system model (see. in fig 3.1 in theory chapter) which integrates the concepts of "innovation system" of (Mytelka, 2000) and "innovative place" of Aase et al. (2013). It covers the social, cultural and natural actors as well as the factors of agricultural innovation in which special attention is given to global and local institutions, farmers' socio-demographic attributes, availability of natural resources, infrastructural development and value chain effect.

The chapter begins exploring the differences in institutional involvement and their contribution in the two villages. This underlines the role of farmers' groups, agricultural cooperatives, NGOs, INGOs, governmental line agencies and service centers to enable farmers' innovative capacity and to bring actual innovations in agricultural practices. Then, the chapter deals with differences in farmers' socio-demographic attributes between two villages. This highlights the issues about to what extent farmers' education and training influence the innovative capacity. It also explores how farmers' gender and caste/ethnicity can be socio-cultural obstacles of farmers' innovative capacity. Moreover, concern goes towards how availability of natural resources and infrastructural developments support to enable the farmers' innovative capacity. Finally, I will discuss the well-established idea that 'necessity is the mother of innovation".

7.1 Institutional involvement and innovative capacity

Innovation system concept focuses on network and interaction based institutional setting in which production units innovate through learning by doing and learning by interacting (Mytelka, 2000). Significant role of institutional networks and their supports bringing agricultural innovation have been widely recognized (Aase et al., 2013, World Bank, 2006, Chhetri et al., 2012). Thus, exploring the history of institutional involvement and their

contribution may help to understand why there are differences in innovativeness between two villages. Here, my concern is about the differences in institutional involvement and their supportive functions. According to Agrawal (2010) supporting institutions can be sorted into three groups; civic[19] (NGOs, INGOs, community based organizations, farmers groups), public (governmental organizations, administrative agencies) and private (business organizations). During fieldwork, I explored in what ways and how these institutions got involved in supporting the farmers and improving their agricultural practices.

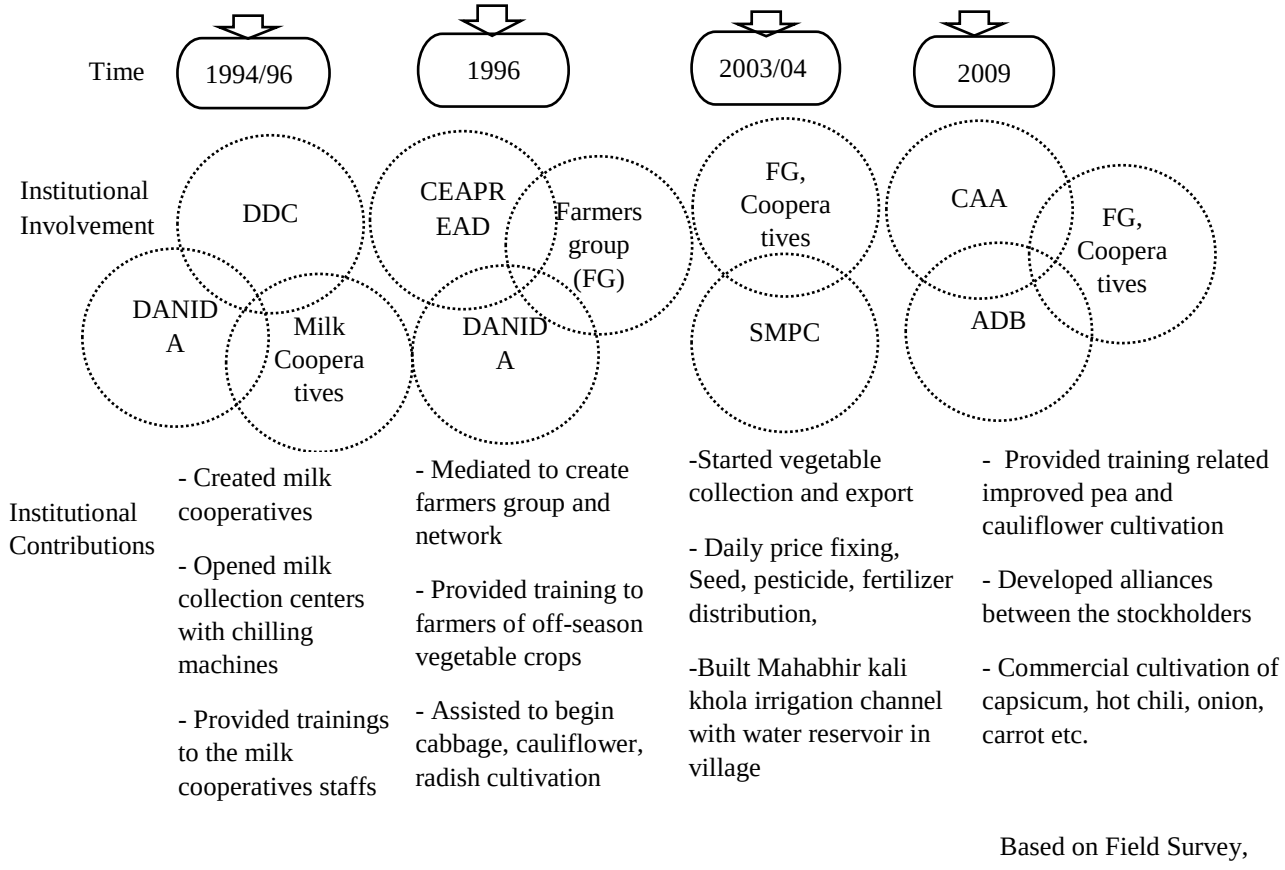
7.1.1 Civic institutions (NGOs, INGOs, cooperatives and farmers' groups)

Initial institutional involvement in both Aahale and Majuwa was the DFID[20] funded regional program KHADP (Koshi-Hill Area Development Program). It was launched during 1990s with broad coverage of all hilly districts of Eastern Nepal. This project has built the Dharan-Dhankuta highway, which connected hill to tarai (plain) for the first time. In addition to this, this program also worked to raise living standard of small-farmers living in Koshi-Hill area through agricultural extension, livestock, irrigation, health and education (NPC, 2013). It opened several opportunities to the remote villagers. However, achievement of several expected outcomes failed due to lack of collaborative policy framework between governmental agencies and program initiators.

Apart from the KHADP program, more supporting institutions are involved in Aahale (see figure 7.1) than in Majuwa. In 1996, a program about off-season vegetable crops cultivation was launched along the Dharan-Dhankuta-Basantapur highway by CEAPREAD (Center for Environmental and Agricultural Policy Research, Extension and Development) with the financial and technical support of DANIDA (Danish International Development Assistance). CEAPREAD is a national NGO of Nepal that works in developmental sector. From this project, only Aahale farmers were promoted. In this program, CEAPREAD mediated the farmers to create the farmers/producers' groups and coordinated to establish their network in the village. It also provided trainings about off-season vegetable cultivation, management and post-harvest handling to the members of production groups. Moreover, it helped to strengthen the market functions providing institutional support to establish market chain to the local cooperatives. This is one of the main factors of agricultural innovation in vegetable sector of

[19] Civic refers to non-profit organization that operates independently of any government, typically one whose purpose is to address the social issues.
[20] The Department for International Development (DFID) is a United Kingdom government department responsible for administering overseas aid. (wikipedia.org)

Aahale. The evident achievement from collective effort of DANIDA, CEAPREAD and farmers in Aahale village is commercial beginning of the three main off-season vegetable crops, i.e. cabbage, cauliflower and radish.



Based on Field Survey,

Figure 7.1: Institutional involvement and their contributions in Aahale

Over the last decade, farmers' groups have been actively involved to change, innovate and improve traditional agricultural practices and to achieve higher profitability in Aahale. In 2009, one farmers' group registered as agricultural cooperative (Siddhakali Agricultural Cooperative), which is one of the leading local level actors of agricultural innovation in Aahale. "Group Managed Improved Pea and Cauliflower Farming" was the first program launched in collaboration of local cooperative, CAA[21] (Commercial Agricultural Alliance) and ADB[22] (Asian Development Bank). It was launched in August 2009 with technical and financial support of CAA and ADB. In this collaborative network, CAA and ADB were

[21]Commercial Agricultural Alliance was established in 2006. It is a regional NGO working in commercial investment and management of agriculture sector. In fact, CAA covers four hilly districts: Dhankuta, Terhathum, Ilam and Panchther.

[22] Asian Development bank is a non-profit financial institution. It helps in developmental sector of Asian countries. (wikipedia.org)

external actors. ADB was the funding institution and CAA was the coordinator and alliances developer among the agricultural stockholders. There was intense interaction, coordination and regulation within the farmers group as well as local cooperatives in Aahale. This program supported farmers providing training about improved pea and cauliflower cultivation. It also focused on capacity development through strengthening market chain and infrastructure. The collective effort of CAA, ADB and farmers' cooperative has had significant impact in farmers' innovative capacity. This collaborative and interactive network between farmers and institutions has promoted farmers to introduce these four new off-season vegetable crops (capsicum, hot chili, Chinese onion and carrot) during the last decade.

SMPC (Sidhuwa Multi-Purpose Cooperative) is another cooperative, which is located in the market center Sidhuwa. Aahale farmers are getting several supports directly and indirectly from this cooperative. SMPC works in multiple sectors such as seeds, fertilizers and pesticides distribution, vegetable collection and marketing, coordinating the donors and public agencies etc. The adoption of new seed varieties of vegetable crops primarily depends on SMPC because most of the farmers in Aahale prefer to buy seeds from SMPC rather than from the local traders. The main reason of this preference is that SMPC sells improved seeds referred by Pakhribas Agricultural Research Center (regional level governmental agricultural research organization). It also sells seed in minimum market price. One more important function of this cooperative is daily price fixing of vegetables. According to the president of SMPC, 70 per cent of produced vegetable is exported to India. Due to daily price fluctuation in India, local market price is also affected which raises the market uncertainties. In such condition, SMPC has established the daily price fixing mechanism in Sidhuwa to provide proper price information to the farmers. This shows SMPC has helped farmers in various ways to enable farmers' innovative practices.

Involvement of supporting institutions in dairy sector is also found more in Aahale than in Majuwa. DDC (Dairy Development Cooperation) was established to promote dairy sector of Nepal during 1960s, and nationwide progress of overall dairy sector started during 2000s. DANIDA provided the managerial support preparing ten-year dairy development plan during 1990-2000 and its implementation has institutionalized the dairy market. Due to DDC's contribution Aahale farmers got the market access to sell their produced milk in 1994/96. During that time, DDC established a large milk collection center with chilling facility in Sidhuwa. It has also formed farmers' milk cooperative (*Dugdha Sahakari*) in the village and established small milk collection center. DDC also provided training about dairy cooperative

management to the cooperative's staffs. Before the access of road, farmers of Aahale village collected the milk and carried themselves to the large chilling centers located in Sidhuwa but nowadays the milk carrying vehicles reach to the milk collection center of the village. This shows that the involvement of DDC, DANIDA and farmers' milk cooperatives is one of the strong collaborative networks of supporting actors in Aahale village, which has had significant impact on innovation and development of livestock sector.

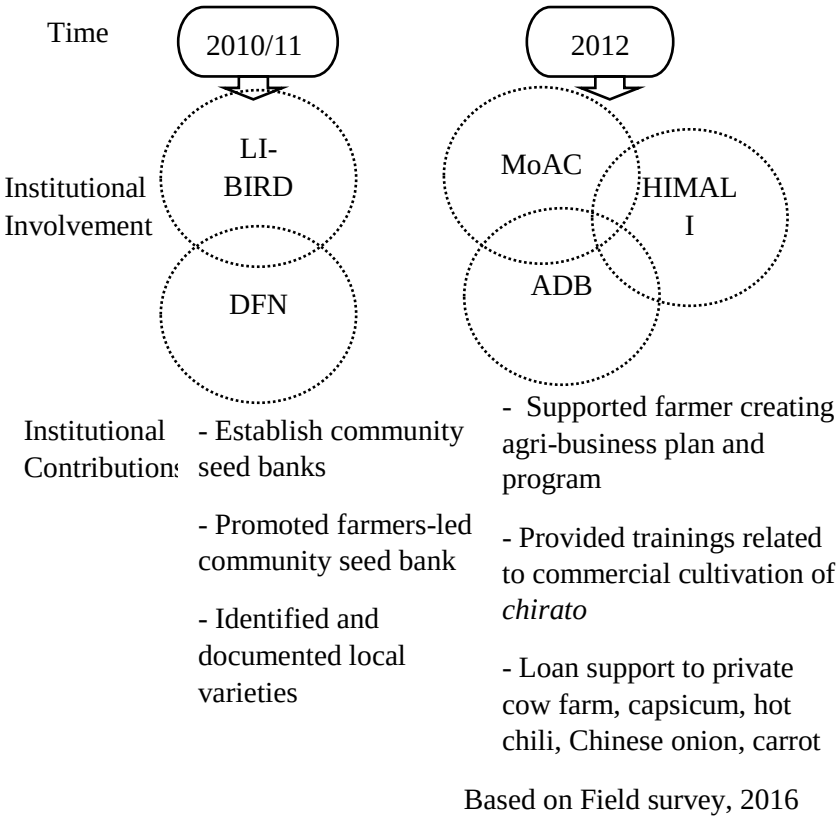


Figure 7.2: Institutional involvement and their contributions in Majuwa

In Majuwa only a couple of supporting institutions have been involved during the last decade (see. figure 7.2). DFN (Development fund of Norway) funded LI-BIRD (Local Initiative for Biodiversity, Research and Development) program has promoted the sustainable agriculture through preserving local seed varieties around Majuwa village. It has facilitated and provided trainings to establish farmers-led community seed bank in this area. Currently two famer-led community seed banks are working. One is located in Mudhe bazaar and another is in Tamaphok VDC center. Different varieties of local seeds are stored and the member farmers can borrow seed from the seed bank. Farmers have to return seed after harvesting more than they have borrowed. For example, if a member farmer borrows 1 kg of seed, he/she has to return 1.5 kg of seed. According to Jimi et al. (2015) collecting and saving local seed varieties

has preserved the agro-biodiversity and maintained sustainable and native agricultural practices.

Recently another project, High Mountain Agribusiness and Livelihood Improvement Project (HIMALI) has been launched in this area including Majuwa village. This project was launched in 2012. MoAC (Ministry of Agriculture and Cooperative of Nepal) executed this project but the donor agency was ADB (FNCCI, 2012). This project intended to support farmers creating agro-business plans, providing marketing information and establishing linkages among the stakeholders. Some of the Majuwa farmers have received training for commercial beginning of *chiraito* cultivation from this program. As I stated in paragraph 6.2, *chiraito* is a kind of medicinal herbs that has been used for generation as *Aayurvedic* medicine. This program provided low interest credit to open an officially registered large-scale private cow farm. However, overall outputs of this project have not been found to be effective. Institutional involvement in dairy sector of Majuwa is also found insignificant where innovations are also observed to be very few.

7.1.2 Governmental institutions and service delivery

The local level governmental institutions such as DADO (District Agriculture Development Office) and DLSO (District Livestock Service Office) are equally available (not equally accessible) for both the villages. Nepal government has established DADO and DLSO in each district headquarter. The tasks of these two public institutions are to mobilize the governmental annual budgets, run and implement the agricultural programs. However, in terms of physical accessibility, these public offices are relatively far away from Majuwa[23]. The longer physical distance may reduce the likelihood of using those services (Choe and Pradhan, 2015). The costs in terms of both money and time to receive/deliver the public service is high for Majuwa farmers. Hence, the public service delivery is being affected by longer physical distance. While asking farmers in Majuwa have you received any extension services during last ten years? except some farmers, the common answer is “not so far”. This means there is a lack of proper service delivery from the governmental institutions.

The case of Aahale is different. Most of the famers’ have been receiving different agricultural services from local level governmental institutions in this village. For instance, DADO Dhankuta enabled the important innovative practice about improved livestock shed-management. A program was launched in Aahale in the name of (*Bhakaro Sudhar*

[23] Khadbari is headquarter of Majuwa village. It takes 4 hours by bus from the village or 12 hours on foot

Karyakram) a shed-management and improvement in 2013/14. In this program, the system of urine collection and use of urine as bio-fertilizer manure as well as bio-pesticied has been promoted. In addition to this, governmental grant scheme and subsidies for officially registered private livestock farm have been coordinated by DLSO. In this scheme government provides about 200000 Nepalese rupees grant if officially registered farm has more than nine milk-producing cattle (it includes cows and buffalo). Farmers also get fifty percent subsidy to buy chaff cutter from District Livestock Service Center.

Besides these two-important governmental institutional networks, the influence of governmental research institution is also high in Aahale village because the regional level governmental research organization, (Pakhribas Agricultural Research Center) is located close to the village. This research center has provided grants as well as trainings for nursery-raised large cardamom sapling producer in Aahale. Moreover, farmers often visit the research center with their problems for technical support, which has indirectly encouraged the agricultural innovation in Aahale. Whereas Majuwa village is a bit far away from the regional research center. Farmers rarely visit for the services in this institution. Thus, diminishing the physical distance between Majuwa and governmental institution is one of the possible ways to create efficient interaction.

This indicates that there is a significant contribution of donors, INGOs, NGOs, local cooperatives and governmental agencies to promote market-oriented production in Ahale village whereas in Majuwa there is a lack of adequate instructional support and linkage in agricultural practices. This means Majuwa farmers seem self-sustained with less institutional dependency. If we presume the uncertain climatic and non-climatic future, the Majuwa farmers will sustain longer. For example, the practice of farmers-lead community seed bank is one of the instances of self-dependency that make them adoptive in the context of climatic and non-climatic uncertainties.

7.2 Farmers' socio-demographic attributes and innovative capacity

Farmer is the main actor of farming system who makes the all decisions and takes entire responsibilities of agricultural activities. As a farm operator, farmer's important interactive role in innovation system is appreciated by World Bank (2006). Thus, the occurrence of innovativeness in farming system is associated with socio-demographic attributes of household head and his/her members. Socio-demographic attributes in this thesis includes

some key variables such as education, training, gender and ethnicity that possibly influence the innovative capacity.

Table 7.1: Education of the household head

Levels of education	*Aahale (n=25)*	*Majuwa (n=25)*
Illiterate	27.7	33.2
Primary	22.0	36.6
Secondary	28.4	24.2
Collage	19.1	4.3
University	2.8	1.7
Total	100	100

Field survey: 2016

It is maintained that farmers' training and education determine the capability and strength for agricultural activities (FAO, 2014b). Farmers' knowledge, skills and training play significant role to enhance innovative capacity and improve the agricultural practices. Since household heads make all the decisions in households of both the villages, their qualifications and agriculture related trainings are significant to analyze the innovative capacity.

The field evidence about the level of education of household head (see. table 7.1) shows that the percentage of illiterate farmers (household heads) is higher in Majuwa village then Aahale. Moreover, the percentage of farmers who have completed college and secondary level education are found more in Aahale. This evidence indicates that the numbers of knowledgeable farmers are more in Aahale where more innovations have taken place during the last ten years. Some empirical studies also clarify that farmers' education plays positive role in introduction of new agricultural practices (Lin, 1991, Jamison and Moock, 1984).

It is therefore crucial to analyze how education influences the agricultural innovation. An explanation advocates that educated farmers have higher risk bearing ability than uneducated farmers (Knight et al., 2003). Education opens the new ideas and increases the creativity of farmers. In Aahale village, some educated farmers have wider relation with supporting organizations in which they have been actively participating in agricultural development activities. They have been approaching for institutional supports. "*We make program proposal, write demand paper, and submit documents ourselves to both governmental and non-governmental offices for different supports," (male, 34).* Only educated farmers can do these kinds of activities. Hence, farmers' education has a significant influence on the

agricultural innovations in Aahale village. Higher illiteracy and weak interactive ability of farmers in Majuwa village might be the impeding factors of innovations there.

Training makes farmers more skilled and they can learn better ways of farming. Training influences the agricultural innovations directly and indirectly. Especially agriculture related trainings are significant to the farmers. Thus, during fieldwork I have explored agriculture related trainings received by farmers in both the villages (see. figure 7.3).

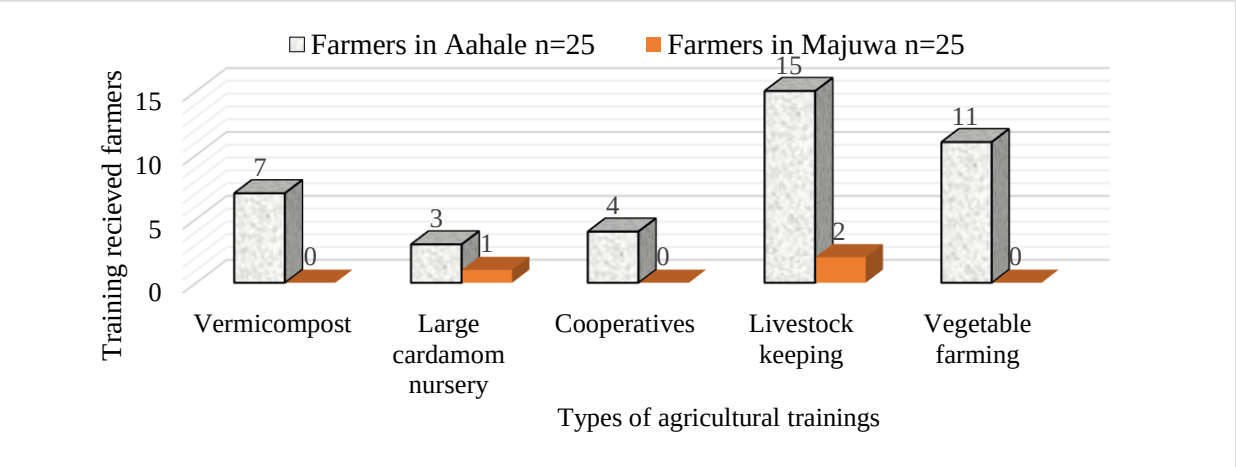


Figure 7.3: Training received by farmers' in Aahale and Majuwa

Fieldwork, 2016

Figure 7.3 shows that Aahale farmers have received (five different trainings) where more farmers have received trainings related to vegetable farming and livestock keeping whereas training received by Majuwa farmers seems insignificant. Training constructs the capacity on farmers to adopt new agricultural practices (Spielman et al., 2009). Therefore, while analyzing innovative capacity the association between actual innovations and numbers of trained farmers can be established. I argue that higher number of trained farmers is one of the main reasons of higher frequency of innovativeness in Aahale. Hence, training is a key factor that raises the farmers' innovative capacity.

Besides education and training, farmers' caste/ethnicity and gender are other two vital social factors that influence the farmers' innovative capacity. In Nepal caste/ethnicity and gender have traditionally ascribed roles in society, which may enable and impede the peoples' capacity (Jones and Boyd, 2011). Nepal government has made several efforts launching policy and program to eliminate gender and caste based discrimination and its influence in society has gradually been decreasing however, it has not been fully eliminated. In these days, especially young generation in society do not believe in gender and caste based discrimination

but those who have been following these social norms for a long years still believe in it. According to Thomas-Slayter and Bhatt (1994) gender and caste/ethnicity are the most essential variables in the context of rural Nepal to analyze the capacity of an individual, household and community because traditional rules of control and access to communal resource are applied in stratified society (Turner and Brush, 1987).

Socially ascribed gender roles and relation of the household head may influence the degree of innovativeness. (Kantor, 2002). In both the villages, family structures have been rooted with patriarchal family system in which man makes all the decisions in household and woman's role in decision-making is undermined. Moreover, women remain limited in access to education, trainings and economic assets.

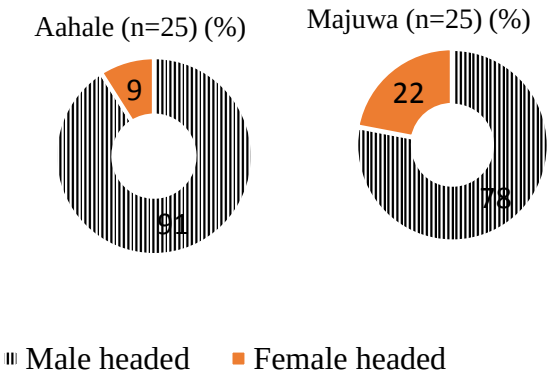


Figure 7.4: Gender of household head in Aahale and Majuwa

Thus, women have been traditionally discriminated in household and society so that they may have less access of resources to innovate. I assume that gender discrimination is a socio-cultural barrier in which female-headed household are not able to innovate because of less access to socio-economic resources in the society. The observed percentage about gender of household head depicts 91 percent of male-headed households are in Aahale whereas 78 percent household are male-headed in Majuwa (see. figure 7.4). Female-headed households are slightly more in Majuwa because of high male labour migration. Hence, gendered differences may have linked with resource access, thereby influenced the degree of actual innovation.

Both villages are characterized by stratified caste/ethnic system. The caste/ethnicity based social order affects the social status of the household (Bista, 1967). Apart from some exceptions, high caste groups (*Brahmin*/*Chhetri*) have higher social status in society and they have been privileged for ages to have wider social access and strong social relation with private and public sector that strengthen their innovative capacity. For instance, they may get enough private loan to invest for new practices or they may frequently be a community representative in developmental projects and program. Lower caste/ethnic groups (middle-*Janajati*, lowest-*Dalit*,) have been discriminated in various manners in society. Thus, this can

be a socio-cultural barrier of innovative capacity for lower caste/ethnic group farmers. The household survey evidence (evidences of ethnic composition of population can be seen in table 7.2 in heading of 7.3) shows that the population of *Dalit* and *Janajati is* relatively higher in Majuwa village than in Aahale whereas more *Chhetri* and *Brahmin* live in Aahale and they have initiated most of the innovative practices in village (own survey, 2016). The evidence indicates caste/ethnicity has had certain influence on farmers' innovative capacity. In addition to this, *Dalits* have been engaging in traditional off-farm activities such as ironwork, stitching, jewelries etc. and several young people of *Janajati (particularly Rai and Limbu)* family go for British and Indian military service. Since they have alternative ways of livelihood, the motivation towards farming activities might be less. Therefore, because of more *dalit* and *Janajati,* the adoption of new agricultural practices in Majuwa might have become less.

7.3 Availability of natural resources and innovative capacity

Small-scale farmers often depend on natural resources (World Bank, 2006) in which land is one of the important natural resources. Land size structures the resource capacity of production unit Ashby and Pachico (1987). During fieldwork, I asked farmers about their land size in both the villages. Table 7.2 summarizes the land size owned by each ethnic group. Most of the cultivated land size owned by farm household is less than one hector.

Table 7.2: Average land size by ethnicity

Ethnicity of farm HH (%)	*Aahale (n=25)*		*Majuwa (n=25)*	
	% of population	Average land size (ha.)	% of population	Average land size (ha.)
Brahmin	19.9	0.51	19.5	0.51
Chhetri	61.0	0.63	25.8	0.31
Janajati	10.6	0.37	31.2	0.28
Dalit	8.5	0.21	23.4	0.10
Total average	100.0	0.43	100.0	0.30

Fieldwork, 2016

Ethnic/caste differences in land distribution exist in both the villages *Dalit* and *Janajati* have the smaller land size than other ethnic groups. This indicates lower caste/ethnic groups are resource poor in both the villages. The average land size has been found higher in Aahale (0.43ha.) than in Majuwa (0.3ha.). From this evidence an explanation can be made, i.e. Aahale farmers have more innovations because of higher land size. The study of Aase et al. (2013) also states that large landholder may bring more innovations than small landholder. However, during fieldwork while doing group discussions only one owner of large-scale

agricultural farm (Tinjure Agricultural Production Center) referred the problem of land size. Other farmers mainly conveyed multiple problems such as market, water, supportive institutions, improved seeds and techniques. This indicates that land size is not the important impeding factor of small-scale agricultural innovation.

Water is another vital natural resource for agricultural development. While exploring availability of water resources and irrigation facilities in both the villages, more water resources and efficient irrigation facilities are found in Aahale. Two small perennial rivers: Laxmi khola and Mahabhir kali khola are the major sources of irrigation in Aahale. For drinking water, people use spring water. One of the main reasons of successful production of off-season vegetables (which are mainly planted during winter and harvested in summer) in this village has become possible because of enough access to water resources.

In Majuwa, there are two small rain-fed rivers *(khahare khola)* in which water flows during rainy season only. Piluwa, a perennial river is located relatively far away from this village. No long-distance irrigation channel has been built yet. The rain-fed rivers are the sources of irrigation for paddy cultivation during summer. One water spring is located in Bhaisjhore community forest. From this spring, a pipeline has been built for drinking water. Most of the farmers of Majuwa village reported that water scarcity is one of the major problems for winter crops cultivation. These situations show that Majuwa farmers have been impeded from lack of enough water resources to introduce dynamic cropping patterns and to bring innovation in agricultural practices.

7.4 Infrastructure, value chains and innovative capacity

While looking at the present level of infrastructural development in both the villages, it helps to understand the role of infrastructure[24] in farmers' innovative capacity. Assessment of accessibility of irrigation, road, market and communication facilities of each village reveals the supportive functions of infrastructures to bring new agricultural practices. It also helps to understand how infrastructure creates the value chain so that farmers gain higher productivity and get motivated to new practices.

Nepal is rich in water resources. Several perennial snowmelt rivers drain the lower basin of Himalayan region which pays important role in irrigated agriculture (Eriksson et al., 2009). Himalaya is also known as "water tower". However, several rural farmers are suffering from

[24] Infrastructure is defined here as access of irrigation, road, market, agro-services and communications

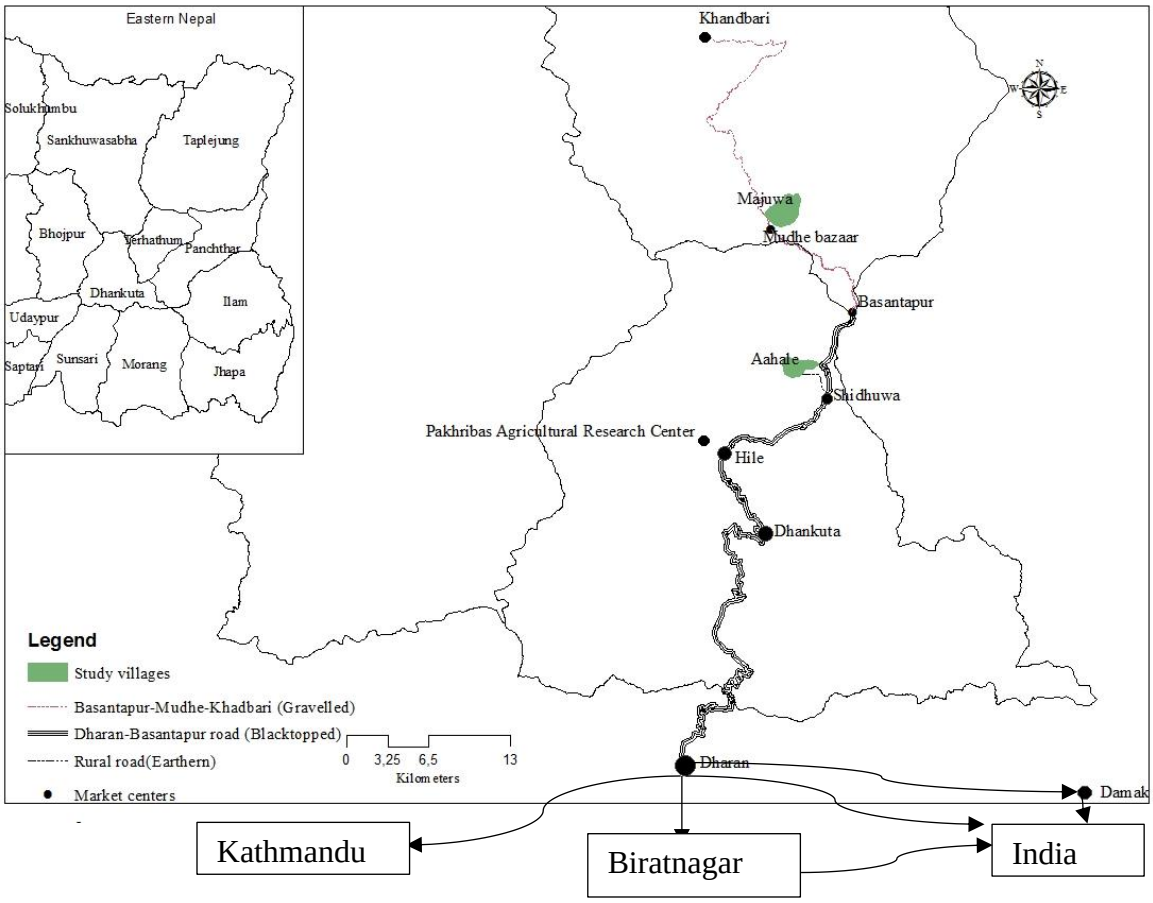
water scarcity. Only 30 per cent of the total agricultural land of Nepal has year-round irrigation facility (Bastakoti et al., 2010). This indicates that development for irrigation system and proper water utilization are the major problems in the rural areas of mid-hill. Similar instances have been found in Majuwa where no proper irrigation facilities have been developed. Farmers themselves have made a small irrigation channel in southern part of the village, which is only used during rainy season especially for paddy cultivation because rivers dry up during winter. Evidence shows that, there is a lack of irrigation facility in Majuwa village. This is one the important factors of impediment the agricultural innovations in this village.

Picture 7.1: Water reservoir in Aahale

Adequate irrigation facility and sufficient water is available in Aahale village. The Mahabhir kali khola irrigation canal is the most important water supply system that provides water for vegetable cultivation in mid and upper part of the village. This irrigation system includes water reservoir (see. picture 7.1) which is built in Aahale village. It is very useful during winter season when water level decreases in river. It was built in 2003/04 with the collective effort of District Development Office of Dhankuta, SMPC and Siddhakali Agricultural Cooperative. Farmers have made certain rules and schedule to use resorvoir water during winter. In addition to this, Laxmi khola irrigation canal is a long-distance irrigation system built during the 1990s. It irrigates the *khet* land located in the lower part of the villages.

Market, road and communication services are the other major infrastructures that strengthen environment for innovation (World Bank, 2006). Aahale farmers have been privileged from the adequate access of all these services. Development of a market corridor between the local markets to Indian market (Sidhuwa-Hile-Dhankuta-Dharan-Birtamod-Siliguri) is one of the important drivers of successful innovations in agricultural practices in Aahale (see. map 7.1). As I described in the theory chapter, actors and factors of innovation system and value chain sometimes overlap and they can be complementary to each other. In this sense, the construction of Dharan-Basantapur highway has extended this value chain effect on the farmers of Aahale. The highway Dharan-Dhankuta-Hile section was constructed and blacktopped two decades ago but Hile-Sidhuwa-Basantapur section was blacktopped during the last decade. This highway has accelerated growth of market centers in terms of both size and numbers. Adequate access to road, market and communication services create stronger

value chain and provides higher productivity and profitability to the farmers (Juma, 2015). The map 7.1 depicts the road and market access in both the villages. Map illustrates the strong market access for Aahale farmers in which there is a vertical integration among the farmers, local cooperatives and private sector, which govern the flow of products.



Map 7.1: Accessibility map of Aahale and Majuwa

In Aahale local cooperatives and local traders collect vegetables, large cardamom and flower of broom grass. They sell these products to big traders or Indian commission agents in three main cities (Damak, Birtamod, Biratnagar) located in Tarai. Some farmers themselves sell their products to the big traders. Big traders and Indian commission agents export products to Siliguri (India) or Nepalese wholesalers of different larger cities such as Kathmandu and Pokhara. DDC is the main milk buyer for the Aahale farmers. Milk cooperatives collect milk in village and transfer to the large chilling centers. After that, the collected milk is transferred to the regional milk-processing center, which is located in Biratnagar. In this center, the raw milk is processed and prepared milk powder, butter, curd, cheese, cream etc. Increasingly expanded communication (especially mobile phones) facilities have also supported farmers to get proper market information system. The access of communication facility is equally

available for both the villages but Aahale farmers utilize more because they have a price fixing mechanism in local market. Aahale farmers can enquire about market price of any product within a minute and make sure the optimum market value before selling their product utilizing the mobile phones.

In the case of Majuwa, there is a road link from Basantapur to Mudhe bazaar but it does not function well since it has not been blacktopped. During rainy season, vehicles cannot move regularly along this road. Because of this irregular transport, the flow of agricultural product as well as agricultural inputs is being disturbed. Mudhe bazaar provides small opportunities to sell local products. This indicates that inadequate road access is one of the impeding factors of agricultural innovation in Majuwa. According to a key informant of Majuwa, the Basantapur-Mudhe road-blacktopping project has recently been approved under the program of UNNATI-Inclusive Growth Program in Nepal. DANIDA and ILO (International Labor Organization) have funded this project. The Project has aimed to enhance capacity of private agri-business and strengthen the value chains of tea, ginger, milk and large cardamom of the eastern Hill districts.

7.5 Multiple actors, factors and their interactions enable the farmers' innovative capacity: A synthesis

According to Mytelka (2000) production unit is a learning organization which embeds within a wider institutional context. Both local and global institutional set up is considered as a powerful force that shape and build farmers' innovative capacity. The analysis of civic, governmental and private institutions demonstrates that the institutional involvement and their collaborative contributions is one of the significant inducements of agricultural innovation. In multiple ways, civic institutions provide support to the farmers that raise their innovative capacity and promote the innovative practices in agriculture. The necessity of networking and knowledge flow among the stockholders is a core premise in the innovation system concept (World Bank, 2006). The analysis shows that interrelation between supporting institutions and farmers (donor-NGOs/INGOs-farmers' groups and donor-NGOs/INGOs-local cooperatives-farmers' groups) in Aahale village have had considerable contributions to bring several innovations in agricultural practices. In this case, the external actors or global institutions (the donors and INGOs) have acted as main fund and knowledge provider whereas local actor/institutions (NGOs and local cooperatives) have acted as facilitator between famers and donors. From these kind of institutional supports, agriculture of Aahale village have been successfully enhanced with several innovative practices. Moreover, both central and local

governmental agencies are equally important for agricultural innovation but proximity of service provider and effectiveness in delivery system governs the influence. Since Aahale is close to the governmental offices, farmers often visit and get more supports from local level governmental institutions. In Majuwa, few civic institutions have been involved. The support from governmental institutions is also remained limited because of inefficient service delivery.

The concept of "innovative place" draws attention towards the role of natural resources in agricultural innovation (Aase et al., 2013). In this thought, an argument has been made that farmers' innovative capacity depends with the availability of natural resources such as land and water. In addition, it is often argued that land size is directly correlated with innovation adoption. However, considering the view of majority of small-scale farmers of Majuwa, it is conformed that the land size is not the main problem of introduction of new practices. Further, the availability of water resources and development of proper resource utilization system is important. The main reason of successful cultivation of off-season vegetable crops in Aahale is the availability of water resource and development of irrigation system. In Majuwa both availability as well as access of water resources is limited, that directly imped agricultural innovations.

Farmers' education and trainings are significant to raise the farmers' innovative capacity. Analysis of empirical evidence of the two villages explicitly clarify that agriculture related trainings are more significant for agricultural innovation. On the other side, traditional caste/ethnicity and gender based discrimination indirectly impedes the innovative practices in agriculture. The discrimination links with resource access and social position thence it influences the farmers' innovative capacity. Especially the lower order caste/ethnic groups as well as women have remain underprivileged. Traditionally ascribed social positons, culturally established roles and responsibilities have acted as socio-cultural barriers of their innovative capacity. On the other hand, higher caste/ethnic groups and male farmers have been socio-culturally privileged because they are having higher social access, wider social relation and broader interactions with supporting institutions, public and private sector.

Infrastructures (mainly irrigation, road and market) and communication technologies are essential factors of overall agricultural development. Aahale farmers have adequate access of irrigation, road and market, which have created the extended the value chain for all agricultural products. Wider market structure has enabled the involvement of private sector in export of agriculture product that directly has boosted the farmers' level of production in

Aahale. Inadequate road, market and irrigation access has hindered the flow of agricultural input and output in Majuwa, which has had negative impact on agricultural innovation.

Table 7.3: Summary of factors/ actors influencing the innovative capacity

Factors/Actors	Aahale	Majuwa
Civic institutions	Many	Few
Service delivery of governmental institutions	Efficient	Inefficient
Market access	Good	Difficult
Water	Sufficient	Scarce
Labor migration/alternative livelihood	Low	High
Impact of gender and caste based discrimination	Low	High

Field work, 2016

Table 7.1 demonstrates the summary of actors and factors that has influenced the farmers' innovative capacity. It shows there is a large difference in influencing factors/actors between two villages. Wide and various institutional association, efficient governmental support, strong market force, sufficient water availability, limited labour migration and low impact of social-cultural barriers have been observed as the major enablers of farmers' innovative capacity in Ahalale village. Higher contrasting conditions have been found in Majuwa village. Lack of promoting factors as well as actors and high impact of obstructing conditions have been found in Majuwa. It is therefore the basic assumption that raised in theory chapter has been empirically clarified because overall empirical evidences show the multiple and interrelated factors and actors that have conditioned the farmers' innovative capacity. Hence, it can be said that farmers' innovative capacity can be upgraded by investing in multiple factors and not only in a single or specific factors and actors. However, a special focus needs to be given to youths, women and lower ethnic groups in society to raise their motivation in agriculture and bring them to the mainstream of agricultural development.

On conceptual level, I have designed an integrated innovation system model combining two interrelated concepts "innovation system" of Mytelka and "innovative place" of Aase to interpret the empirical evidences about agriculture innovation and I have also raised a theoretical question in which I have anticipated to assess the effectiveness of using both the concepts while analyzing farmers' innovative capacity. Mentioning the above discussions, I

insist that the integrated innovation system model provides an effective and broader theoretical framework that can capture the multiple, interrelated and complex factors as well as actors that conditioned the farmers' innovative capacity. However, some thoughts about the circumstances that conditioned innovation and innovative capacity have been taken for granted by academic and public domain. An academic thought, "necessity is the mother of innovation" still has a strong position.

7.6 'Necessity or opportunity is the mother of innovative capacity'

In academic circles, there are multiple thoughts about what determine innovations. One of the well-established assertions "necessity is the mother of innovation" is an old proverb in society. It means when the need for something becomes essential, you are motivated to find ways of achieving it. In academic level this assertion in the context of agricultural innovation was raised by Boserup (1965) where she challenged the Malthusian view of population growth and food production. Malthus believed that the resources are limited to produce enough food to fulfill the food demand of growing population because population of a particular area grows faster than the growth of food production. Thus, he believed that necessity (population growth) is checked by misery, vice, and restraint (Rogers et al., 2012). In contrast to Malthus, Boserup insisted that farmers improve, change, adopt and develop new farming techniques if they need to produce more food. For instance, farmers can improve by terracing sloping land, start replantation, integrate livestock to improve soil nutrition, use of higher-yielding crops, purchase of fertilizer etc. (Ibid:388). This means necessity leads farmers towards innovative ways.

At this argument, it is relevant to bring some points about the circumstances that influence the innovative capacity and innovative practices in both the villages. If we take into consideration the assertion that focuses the necessity, we should expect more innovations from Majuwa. This is because the level of need of agricultural incentives is higher than Aahale. For instance, there is a lack of water resources, supporting institutions and adequate road access. According to assertion if they need something, they should find possible ways themselves. However, in Majuwa efforts to improve their existing agriculture have been remained inefficient so that innovative practices in agriculture have become less. This shows the contradictory understanding than what assertion of 'necessity is the mother of innovation' illustrates. On the other side, if we see the circumstances of Aahale, we can say Aahale farmers are having multiple opportunities to innovate. For example, they have sufficient water resources, adequate market and road access and more supporting institutions. They have been

benefited from those multiple opportunities and institutional supports so that they have improved, changed, innovated their farming activities. Therefore, it is not supported by my data to say ‘necessity is the mother of innovation’ instead, we could say ‘opportunity is the mother innovation’.

CHAPTER 8: INNOVATIVE CAPACITY, GLOBAL CHALLENGES AND UNCERTAIN FUTURE

The analysis so far has disclosed the multiple factors and actors that directly and indirectly influence innovations in agricultural practices in the two case villages. It has been revealed that interrelated factors and actors enhance the innovative capacity that triggers actual innovations in agriculture. Taking into consideration the adaptive ability in rapidly growing uncertain production condition and multiple challenges of the Himalaya, the innovative capacity and the innovative practices can be the important matters. This is because farmers' or farming communities' adaptive ability in uncertain and challenging situations is associated with their capabilities of innovation adoption and improvement of the existing farming system. According to Aase et al. (2013) farmers' adaptive ability in uncertain condition is determined by the households' innovative capacity. To substantiate this claim, at this point, I will briefly resume the recurring issues of multiple challenges and uncertain future of Himalayan farmers, which I have already raised in the introductory chapter (i.e. in 1.1) than I will draw a concluding remark about the innovative capacity as adaptive ability.

8.1 Concern of the multiple challenges and uncertain future: recurring issue of the Himalayan region

Himalayan farmers are being encountered multiple challenges and are likely to face an increasingly uncertain future. This issue has become a great concern among the academic and non-academic researchers, development actors and policy makers. The experiences show that the magnitude and frequency of different problems have been increasing over time (Xu and Grumbine, 2014). Rising temperature and changes in precipitation regime are the most worried climatic challenges of the Himalayan farmers because the rate of change has been predicted higher than global average in this region (IPCC, 2007). It hinders more to the rain-fed subsistence farmers of the remote villages of the Himalaya (Manandhar et al., 2013). A study indicates that the growing variation in precipitation is one of the greatest biophysical drivers of vulnerability and future uncertainty to the farmers of the Himalayan region (McDowell et al., 2013). The degree of climatic uncertainty is higher in this region than in many other parts of the world. Understanding about climatic issues is limited because of the lack of proper data and efficient studies. This is because this region merely includes very few, scattered and poorly maintained regional climate record stations (Xu and Grumbine, 2014) and most studies have relied on estimated and projected data that gives only general

understanding (Aase et al., 2010). This may generate misinterpretation of the situation and could provide wrong understanding of the problem and it could lead toward counterproductive program and policy.

High poverty and growing food insecurity are other challenges of the people of this region. These challenges intersect with climate change impact (Godfray et al., 2010) because farmers who have already been facing problem of low productivity from subsistence agriculture (Gentle and Maraseni, 2012) are more likely to face climate related problems. In addition to this, pre-existing socioeconomic and institutional circumstances have also intensified the multiple burdens to the farmers (Gautam and Andersen, 2017). Farmers have been facing several problems due to unstable political condition and weak governance of Nepal. A long political unrest has seriously affected the agriculture targeted developmental programs and policies (Sharma, 2006). Ethnic and political groups frequently go to strike, embargo and rally with their demand that weakens the market function, which directly hamper the agricultural supply system. The market uncertainty is also increased due to globalized economy that mainly affect supply system of market-oriented farmers. Farmers have to depend on international market for agricultural inputs such as chemical fertilizer, pesticides and energy for agro-machine because there is lack of input producing industries and fuel resource within the country. The higher dependency on international market creates the uncertain input-output system. In addition, being a landlocked country the international trade relation has been restricted to only one or two countries so there are no other options for the international supply system. In these all circumstances, it is essential to understand the farmers' and farming communities' innovative capacity to tackle with multiple challenges and to face the uncertain future.

CONCLUSION: CONCEPTUALIZING INNOVATIVE CAPACITY AS ADAPTIVE ABILITY

The fundamental concern of this thesis is to provide an account to the question of how Himalayan farmers' innovative capacity can be raised and how the innovative capacity can be conceptualized as adaptive ability in the context of global challenges and uncertain future. I have attempted to answer these questions providing empirical evidences and have endeavored to explain the issues in three consecutive chapters. I have used the farming system approach to make descriptive explanation about current farming system of Aahale and Majuwa villages located in the Mid-hills of Arun valley of the Himalayan region. Then I mapped the actual

innovations that have emerged in different components of farming system of both villages which identified the level of innovative capacity. I found several innovative practices and a higher-level innovative capacity in Aahale than in Majuwa. At that point, the concern has been given to the question of why Aahale village has become more innovative than Majuwa and what circumstances promoted to Aahale to be more innovative village. Considering this question at analytical level, I have applied a framework which has integrated the concepts of innovation system and the concept of innovative place. By applying the innovation system framework, I have analyzed the factors and actors influencing innovative capacity. With the support of empirical evidences, I have argued that multiple actors, factors and their interaction enhance the innovative capacity and promote the actual innovations in agriculture. Further, I have argued that it can't be reasonable if we focus on a single factor or actor that influence innovative capacity because farming activities are embedded with complex system of multiple components. The influence of every single factor and actor may not be equally distributed. For instance, in Aahale village the influence of supporting institutions and the sufficiency of water resources were found to be significant than the other factors and actors.

The ultimate concern of this thesis is to conceptualize the innovative capacity as adaptive ability in the context of multiple challenges and uncertain future. Scholars have raised multiple concepts in the way to respond with the global challenges and future uncertainties, for instance 'coping capacity' Turner et al. (2003), 'capacity of response'Gallopín (2006) , 'adaptive ability'(Smit and Wandel, 2006). The core thought of all concepts is how the challenging situation can be adjusted in an appropriate way for both long as well short duration and how local people can effectively cope with various social and environmental challenges and effortlessly face the uncertain future. In the case of Himalayan farmers, the concept of 'flexibility' is also considered as an adaptive capacity (Aase et al., 2010, Holmelin and Aase, 2013). I will present some concluding remarks to make clarity on the question of to what extend innovative capacity can be conceptualized as adaptive ability to face the uncertain future.

It is argued that adoption of innovations in agricultural practice is required for the effective response to growing challenges (Rodima-Taylor et al., 2012). Adoption of innovations in agriculture is commonly advocated strategies to regulate the farmers' multiple problems (Smit and Skinner, 2002). Actors of agriculture, for instance farmers, scientists and policy makers, can innovate the farming practices in several ways to adapt to changing situation. Innovation and improvement can be done in multiple levels and within different components of the

farming system. For instance in farm level, innovative practices can be initiated diversifying crop/animal varieties, introducing new cropping schedule, using new technologies, upgrading effectiveness of market mechanisms etc. (Howden et al., 2007). On social or community level, innovations can be promoted extending institutional space and widening the institutional alliances (Rodima-Taylor et al., 2012). These innovative efforts help farmers and farming communities to adapt with changing situation and to cope with the multiple challenges.

Adaptive ability of a farmer's household, community or country is a process or action to adjust with changing situation (Smit and Wandel, 2006, Brooks and Adger, 2005). Aahale farmers have introduced multiple innovative practices and improved their farming system, which primarily raised their agricultural productivity in various ways. One of the evident instances of innovative practice of this village is introduction of off-season vegetable crops instead of traditional cereals crops. High crop diversification and replacement of traditional cereal crops with new marketable vegetable crops has significantly improved Aahale farmers' living standard. Adoption of high-breed dairy cows has also improved the level of household income. Besides marketable vegetable crops and hybrid dairy cows, Aahale farmers have introduced new fodder grasses and modern agricultural tools. I have argued that these innovations are directly interlinked with the practice of off-season vegetable and hybrid dairy cows, which have also promoted the higher productivity and profitability. All these innovative practices are not direct responses to climatic uncertainties; however, farmers' these actions have considerably raised their well-being and reduced the problem of food insecurity and poverty. It is argued that rising household well-being and reducing poverty is a way to reduce social vulnerability to the global challenges (Adger, 1999).

I have found some other innovative practices that are directly and indirectly associated with the actions and processes of adjustment in climatic and other uncertainties. The practice of raising large cardamom saplings from nursery and planting nursery raised-sapling in Ahale village is one important innovative response to control viral disease infections as well as to recover the large-scale production decline. It has been documented that increasing instances of diseases and pests in large cardamom cultivation of eastern Nepal can be the consequences of climate change (Sharma et al., 2016). Hence, I have argued that the use of nursery-raised saplings that control the viral disease transfer can be an effort of climate change adaptation in Aahale. Moreover, as I have discussed in passage 6.3.1 a recent practice of improved animal shed-management with urine collection system is an important innovative effort of Aahale

farmers. Use of urine as bio-fertilizer and bio-pesticides is one of the sustainable practices that reduce the chemical effect on both food and environment as well as reduce the input dependency on the international market (Bhardwaj et al., 2014). This is one of the important innovative practices, which can directly help farmers to face the uncertain market situation.

Majuwa farmers have been doing subsistence farming and dominantly producing traditional cereal crops that has low profitability and productivity, which is not supportive to raise their living standard. They also keep local breed cows and buffalos for household milk consumption that does not support to increase household income. Regarding to large cardamom production loss, no effort has been made in Majuwa to reduce the problem of diseases in large cardamom production.

However, if we consider the challenge of global market uncertainty, Majuwa farmers may adapt best. This is because, for instance, the durability of cereals is higher than vegetable crops so that farmers can keep it for longer time. Vegetable farmers of Aahale may fail to preserve their harvest if anything happens to the regular market flow. Aahale farmers may also face large-scale loss if the long-distance market flow disturbed. (For instance, blockade the Indian boarder). On the local level, farmers' do not have any cold stores to keep vegetable and do not have access to process their raw milk. In addition, the high breed cows' milk contains low fat, which is difficult to prepare butter in a traditional way. This indicates that in some cases innovative practices cannot necessarily enhance adaptive capacity to uncertainties.

Higher external dependency has been found in Aahale village because farmers use external inputs in agriculture such as hybrid seeds, pesticides and fertilizer. Relying on external support, particularly from NGOs and INGOs, for different agricultural activities was found to be more in Aahale. Therefore, farmers of this village might face a future that is more unpredictable if the external support collapse. Farmers of Majuwa village have been found more self-reliant because of two main reasons. First, they do not use hybrid seeds, chemical fertilizer and pesticides. Next, they have been operating a community seed bank in their own village. This farmers-lead community seed bank preserves the local varieties crops and distributes it to the farmers when they need. This could make farmers of Majuwa more adaptive than Aahale in the uncertain condition.

Interestingly it can be said that innovative practices such as adoption of hybrid crops, animal varieties and use of modern technology tend to increase productivity and profitability of agriculture. It could raise the farmers' well-being and reduce poverty but not all innovative

practices and modification necessarily increase the adaptive capacity to climatic and other uncertainties. It essentially depends on the specific context and circumstances of a farmer' household or farming community.

REFERENCES

AASE, H. T. 2007. Interpretation of categories. *In:* AASE, H. T. & FOSSÅSKARET, E. (eds.) *Skape virkeligheter, Om produksjon og tolkning av kvalitative dada* Bergen: Universitetsforlaget.

AASE, H. T. 2002. Micronutrients and ethnicity of dite in Arun Valley. *In:* CHADHARY, R. P., SUBEDI, B. P., VETAAS, O. R. & AASE, T. H. (eds.) *Vegetation and Society: Their Interaction in the Himalayas.* Tribhuvan University and University of Bergen.

AASE, H. T., CHAPAGAIN, P. S. & TIWARI, C. P. 2013. Innovation as an expression of adaptive capacity to change in Himalayan farming.(Report). *Mountain Research and Development,* 33**,** 4.

AASE, H. T. & FOSSÅSKARET, E. 2007. *Skape virkeligheter, Om produksjon og tolkning av kvalitative dada (translated),* Bergen, Universitetsforlaget.

AASE, T. H., CHAUDHARY, R. P. & VETAAS, O. R. 2010. Farming flexibility and food security under climatic uncertainty: Manang, Nepal Himalaya. *Area,* 42**,** 228-238.

ACHARYA, K. P. 2002. Twenty-four years of community forestry in Nepal. *The International Forestry Review,* 4**,** 149-156.

ADGER, W. N. 1999. Social Vulnerability to Climate Change and Extremes in Coastal Vietnam. *World Development,* 27**,** 249-269.

ADHIKARI, B. & CHAPAGAIN, P. S. 2013. A study on Large cardamom of Nepal. *The Geographic Base,* 5**,** 31-37.

ADHIKARI, T. B. & BASNYAT, R. C. 1998. Effect of crop rotation and cultivar resistance on bacterial wilt of tomato in Nepal. *Canadian journal of plant pathology,* 20**,** 283-287.

AGRAWAL, A. 2010. Local institutions and adaptation to climate change. *Social Dimensions of Climate Change. Equity and Vulnerability in a Warming World. R. Mearns (ed.),* 173-198.

AGRAWAL, A. & GIBSON, C. C. 1999. Enchantment and disenchantment: the role of community in natural resource conservation. *World development,* 27**,** 629-649.

AITKEN, S. C. & VALENTINE, G. 2014. *Approaches to human geography: Philosophies, theories, people and practices,* Sage.

ANANDAJAYASEKERAM, P. The role of agricultural R&D within the agricultural innovation systems framework. Report Prepared for the ASTI/IFPRI-FARA Conference, 2011. Available at: https://www.researchgate.net/links/54471f3f0cf22b3c14e0bf0f.pdf (Accessed in December 8, 2016)

ANDERSEN, P. 2002. Geographical approaches to micronutrient difficiencies in Himalaya. *In:* CHADHARY, R. P., SUBEDI, B. P., VETAAS, O. R. & AASE, T. H. (eds.) *Vegetation and Society: Their Interaction in the Himalayas.* Tribhuvan University and University of Bergen.

ANINDO, D. & POTTER, H. 1994. Seasonal variation in productivity and nutritive value of Napier grass at Muguga, Kenya. *East African Agricultural and Forestry Journal,* 59**,** 177-185.

ARNOLD, E. & BELL, M. 2001. Some new ideas about research for development. *Partnerships at the leading edge: A Danish vision for knowledge, research and development***,** 279-319.

ASFAW, S., MCCARTHY, N., LIPPER, L., ARSLAN, A. & CATTANEO, A. 2016. What determines farmers' adaptive capacity? Empirical evidence from Malawi. *Food Security,* 8**,** 643-664.

ASHBY, J. A. & PACHICO, D. 1987. Agricultural ecology of the mid-hills of Nepal. *In:* TURNER, B. L. & BRUSH, S. B. (eds.) *Comparative Farming Systems.* New York: Guildford Press.

BARNETT, A. 2006. From Research to Poverty Reducing Innovation. Available at http://agris.fao.org/agris-search/search.do?recordID=GB2012100355 (Accessed April 28, 2016)

BASTAKOTI, R. C., SHIVAKOTI, G. P. & LEBEL, L. 2010. Local Irrigation Management Institutions Mediate Changes Driven by External Policy and Market Pressures in Nepal and Thailand. *Environmental Management,* 46**,** 411-423.

BERGER, P. L., LUCKMANN, T. & ZIFONUN, D. 2002. *The social construction of reality*, na. Available at: perflensburg.se/Berger%20social-construction-of-reality.pdf (Accessed January 5, 2017)

BERREMAN, G. D., ROBBEN, A. & SLUKA, J. 2012. Behind many masks: ethnography and impression management. *Ethnographic fieldwork: an anthropological reader***,** 152-174.

BHARDWAJ, D., ANSARI, M. W., SAHOO, R. K. & TUTEJA, N. 2014. Biofertilizers function as key player in sustainable agriculture by improving soil fertility, plant tolerance and crop productivity. *Microbial Cell Factories,* 13**,** 66.

BHATTA, G. D., OJHA, H. R., AGGARWAL, P. K., SULAIMAN, V. R., SULTANA, P., THAPA, D., MITTAL, N., DAHAL, K., THOMSON, P. & GHIMIRE, L. 2015. Agricultural innovation and adaptation to climate change: empirical evidence from diverse agro-ecologies in South Asia. *Environment, Development and Sustainability***,** 1-29.

BISHOP, B. C. 1990. *Karnali under stress: livelihood strategies and seasonal rhythms in a changing Nepal Himalaya,* University of Chicago.

BISTA, D. B. 1967. *People of Nepal*, Department of Publicity, ministry of information and broadcasting, his Majesty's Government of Nepal.

BLAIKIE, P. M., CAMERON, J. & SEDDON, D. 1980. *Nepal in crisis: Growth and stagnation at the periphery*, Clarendon Press Oxford.

BOAHENE, K., SNIJDERS, T. A. & FOLMER, H. 1999. An integrated socioeconomic analysis of innovation adoption: the case of hybrid cocoa in Ghana. *Journal of Policy Modeling,* 21**,** 167-184.

BOOKHAGEN, B. & BURBANK, D. W. 2006. Topography, relief, and TRMM-derived rainfall variations along the Himalaya. *Geophysical Research Letters,* 33.

BOSERUP, E. 1965. *The conditions of agricultural growth: The economics of agrarian change under population pressure*, Transaction Publishers.

BRESCHI, S. & MALERBA, F. 1997. Sectoral innovation systems: technological regimes, Schumpeterian dynamics, and spatial boundaries. *Systems of innovation: Technologies, institutions and organizations***,** 130-156.

BROOKS, N. & ADGER, W. N. 2005. Assessing and enhancing adaptive capacity. *Adaptation policy frameworks for climate change: Developing strategies, policies and measures***,** 165-181.

BROWN, S. & KENNEDY, G. 2005. A case study of cash cropping in Nepal: Poverty alleviation or inequity? *Agriculture and Human Values,* 22**,** 105-116.

BROWN, S. & SHRESTHA, B. 2000. Market-driven land-use dynamics in the middle mountains of Nepal. *Journal of Environmental Management,* 59**,** 217-225.

CHAMBERS, R. & GHILDYAL, B. 1985. Agricultural research for resource-poor farmers: the farmer-first-and-last model. *Agricultural administration,* 20**,** 1-30.

CHAPAGAIN, P. S. 2003a. Involution or evolution? : recent changes in farming system in Ilam, Eastern Nepal. Bergen: P.S.Chapagain.

CHAPAGAIN, P. S. 2003b. Involution or Evolution? Recent Changes in Farming System in Ilam, Eastern Nepal. University of Bergen.

CHAUDHARY, R. & KUNWAR, R. 2002. Vegetation composition of Arun valley, east Nepal. *Vegetation and society: Their interaction in the Himalayas. Kathmandu: Tribhuvan University and Norway: University of Bergen. p***,** 38-55.

CHAUDHARY, R., VISTA, S. P. & CHADHARY, R. 2015. Proceedings of the Stakeholders Consultation Workshop on Large Cardamom Development in Nepal. *In:* CHAUDHARY, R. & VISTA, S. P. (eds.). Khumaltar, Nepal: NARC.

CHHETRI, N., CHAUDHARY, P., TIWARI, P. R. & YADAW, R. B. 2012. Institutional and technological innovation: Understanding agricultural adaptation to climate change in Nepal. *Applied Geography,* 33**,** 142-150.

CHOE, K. & PRADHAN, P. 2015. *Unleashing economic growth: Region-based urban development strategy for Nepal*, Asian Development Bank. Available at: https://www.adb.org/sites/default/files/.../27498/unleashing-economic-growth-nepal.pdf (Accessed October 17, 2016)

CLARK, N. 2002. Innovation Systems, Institutional Change And The New Knowledge Market: Implications For Third World Agricultural Development. *Economics of innovation and new technology,* 11**,** 353-368.

CLARK, N., HALL, A., SULAIMAN, R. & NAIK, G. 2003. Research as Capacity Building: The Case of an NGO Facilitated Post-Harvest Innovation System for the Himalayan Hills. *World Development,* 31**,** 1845-1863.

CLIFFORD, N., FRENCH, S. & VALENTINE, G. 2010. *Key methods in geography,* Sage.

CLINE, W. 2007. *Global warming and agriculture: Impact estimates by country,* Columbia University Press.

COLIN, J.-P. & CRAWFORD, E. W. 2000. *Research on agricultural systems: accomplishments, perspectives and issues,* Nova Science Publishers, Inc.

COUPER, P. 2014. *A student's introduction to geographical thought: theories, philosophies, methodologies,* Sage.

COYNE, I. T. 1997. Sampling in qualitative research. Purposeful and theoretical sampling; merging or clear boundaries? *Journal of advanced nursing,* 26**,** 623-630.

CRESSWELL, T. 2012. *Geographic thought: a critical introduction,* John Wiley & Sons.

CRESWELL, J. W. 2013. *Research design: Qualitative, quantitative, and mixed methods approaches,* Sage publications.

CRONIN, E. W. 1979. *The Arun: A natural history of the world's deepest valley,* Houghton Mifflin.

DAHAL, B. M., NYBORG, I., SITAULA, B. K. & BAJRACHARYA, R. M. 2009. Agricultural intensification: food insecurity to income security in a mid-hill watershed of Nepal. *International Journal of Agricultural Sustainability,* 7**,** 249-260.

DANIGGELIS, E. K. 1998. *The Jangal's Hidden Wealth: A Survival Strategy by Foraging Farmers in the Upper Arun Valley, Eastern Nepal,* UMI Dissertation Services.

DENZIN, N. K. & LINCOLN, Y. S. 2011. *The SAGE handbook of qualitative research,* Sage.

DEVAUX, A., VELASCO, C., LÓPEZ, G., BERNET, T., ORDINOLA, M., PICO, H., THIELE, G. & HORTON, D. 2007. Collective action for innovation and small farmer market access: The Papa Andina experience.

DRUCKER, P. 2014. *Innovation and entrepreneurship,* Routledge.

ECKHOLM, E. 1976. Losing ground. *Environment: Science and Policy for Sustainable Development,* 18**,** 6-11.

ENGEL, P. G. 1995. Facilitating innovation: an action-oriented approach and participatory methodology to improve innovative social practice in agriculture.

ERENSTEIN, O. & THORPE, W. 2010. Crop–livestock interactions along agro-ecological gradients: a meso-level analysis in the Indo-Gangetic Plains, India. *Environment, Development and Sustainability,* 12**,** 669-689.

ERIKSSON, M., JIANCHU, X., SHRESTHA, A. B., VAIDYA, R. A., NEPAL, S. & SANDSTRÖM, K. 2009. *The changing Himalayas: impact of climate change on water resources and livelihoods in the greater Himalayas,* International centre for integrated mountain development (ICIMOD).

EVENSON, R. 1974. International Diffusion of Agrarian Technology. *The Journal of Economic History,* 34**,** 51-73.

EVENSON, R. E. & GOLLIN, D. 2003. Assessing the impact of the Green Revolution, 1960 to 2000. *Science,* 300**,** 758-762.

FAO 2010. Land Use Policy and Plannig. UN Complex, Pulchowk, Nepal: Food and Agriculture Organization of United Nation.

FAO 2014a. Managing climate risks and adapting to climate change in the agriculture sector in Nepal. *In:* SELVARAJU, R. (ed.). Rome, Italy: Climate Energy and Tenure Division, Food and Agriculture Organization of the United Nations.

FAO 2014b. The State of Food and Agriculture : Innovation in Family Farming. Rome: Food and Agricultrural Organization of the United Nation.

FAO 2015. The state of food and agriculture. *Social protection and agriculture: breaking the cycle of rural poverty.* Rome: Food Agriculture Organization Of The United Nations.

FERN, E. F. 2001. *Advanced focus group research,* Sage publications.

FISCHER, R., BYERLEE, D. & EDMEADES, G. 2014. Crop yields and global food security. *ACIAR: Canberra, ACT*.

FNCCI 2012. High Mountain Agribusiness and Livelihood Improvement Project. *Inception Report.* Kathmandu, Nepal: Federation of nepalese Chambers of Commerce and Industry.

GALLOPÍN, G. C. 2006. Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change,* 16**,** 293-303.

GAUTAM, Y. 2011. Food Security in the context of Agricultural Commercialization in Ilam, East Neapal. Bergen, Norway: University of Bergen.

GAUTAM, Y. & ANDERSEN, P. 2017. Multiple stressors, food system vulnerability and food insecurity in Humla, Nepal. *Regional Environmental Change***,** 1-12.

GEBREMEDHIN, B. 2009. *Integrating innovation systems perspective and value chain analysis in agricultural research for development: Implications and challenges*, ILRI (aka ILCA and ILRAD).

GENTA, S., CABRERA, W., HABIB, N., PONS, J., CARILLO, I. M., GRAU, A. & SÁNCHEZ, S. 2009. Yacon syrup: Beneficial effects on obesity and insulin resistance in humans. *Clinical Nutrition,* 28**,** 182-187.

GENTLE, P. & MARASENI, T. N. 2012. Climate change, poverty and livelihoods: adaptation practices by rural mountain communities in Nepal. *Environmental Science & Policy,* 21**,** 24-34.

GERRING, J. 2004. What is a case study and what is it good for? *American political science review,* 98**,** 341-354.

GHOSH, B., DOGRA, P., SHARMA, N. & DADHWAL, K. 2012. Soil erosion-productivity relationship assessment in sloping lands of north-west Himalayas. *Indian J Agric Sci,* 82**,** 1068-1071.

GOBER, P. 2006. Encyclopedia of Human Geography. Thousand Oaks

Thousand Oaks, California: SAGE Publications, Inc.

GOBO, G. 2004. *26 Sampling, Representativeness And Generalizability. Qualitative Research Practice. SAGE Publications Ltd,* London, England, SAGE Publications Ltd.

GODFRAY, H. C. J., BEDDINGTON, J. R., CRUTE, I. R., HADDAD, L., LAWRENCE, D., MUIR, J. F., PRETTY, J., ROBINSON, S., THOMAS, S. M. & TOULMIN, C. 2010. Food security: the challenge of feeding 9 billion people. *science,* 327**,** 812-818.

GODIN, B. 2014. Invention, diffusion and linear models of innovation: the contribution of anthropology to a conceptual framework. *Journal of Innovation Economics & Management***,** 11-37.

GOLAFSHANI, N. 2003. Understanding reliability and validity in qualitative research. *The qualitative report,* 8**,** 597-606.

GUILLEMIN, M. & GILLAM, L. 2004. Ethics, reflexivity, and "ethically important moments" in research. *Qualitative inquiry,* 10**,** 261-280.

GUILLET, D., GODOY, R. A., GUKSCH, C. E., KAWAKITA, J., LOVE, T. F., MATTER, M. & ORLOVE, B. S. 1983. Toward a Cultural Ecology of Mountains: The Central Andes and the Himalayas Compared [and Comments and Reply]. *Current Anthropology***,** 561-574.

GURUNG, H. Physical and cultural patterns in the Himalaya. Ponencia presentada en el International Seminar on Mountains, Katmandú, 2002 Kathmandu, Nepal.

GURUNG, H. B. 1962. Review : Nepal : The Kigdom in the Himalaaya by T. Hagen. *The Geographical Journal,* 128**,** 86-87.

GUTHMAN, J. 1997. Representing Crisis: The Theory of Himalayan Environmental Degradation and the Project of Development in Post-Rana Nepal. *Development and Change,* 28**,** 45-69.

HAGEN, T. 1969. *Report on the Geological Survey of Nepal: Preliminary Reconnaisance*, Fretz [for the] Schweizerische Naturforschende Gesellschaft.

HALL, A., MYTELKA, L. & OYEYINKA, B. 2005. Innovation systems: Implications for agricultural policy and practice.

HALL, A., MYTELKA, L. & OYEYINKA, B. 2006. *Concepts and guidelines for diagnostic assessments of agricultural innovation capacity*, UNU-MERIT, Maastricht Economic and social Research and training centre on Innovation and Technology.

HALL, A., YOGANAND, B., SULAIMAN, R. & CLARK, N. 2003. *Post-Harvest innovations in innovation: reflections on partnership and learning*, Crop post-harvest programme (CPHP), South Asia.

HALL, A., YOGANAND, B., SULAIMAN, R., RAJESWARI RAINA, S., SHAMBU PRASAD, C., NAIK GURU, C. & CLARK, N. 2004. Innovations in innovation: reflections on partnership, institutions and learning. Patancheru 502 324, Andhra Pradesh, India, and Library Avenue, Pusa, New Delhi 110 012, India: Crop Post-Harvest Programme (CPHP). *South Asia, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and National Centre for Agricultural Economics and Policy Research (NCAP).*

HALL, A. A., BOCKETT, G. G., TAYLOR, S. S. & CLARK, S. N. 2001. Why Research Partnerships Really Matter: Innovation Theory, Institutional Arrangements and Implications for Developing New Technology for the Poor. *World Development,* 29**,** 783-797.

HAY, I. 2000. *Qualitative Research Methods in Human Geography*, Oxford University Press.

HAY, I. 2010. Ethical practice in geographical research. *In:* CLIFFORD, N., VALENTINE, G. & FRENCH, S. (eds.). Sage.

HEKKERT, M. P., SUURS, R. A. A., NEGRO, S. O., KUHLMANN, S. & SMITS, R. E. H. M. 2007. Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change,* 74**,** 413-432.

HELVETAS 2014. A handbook of technologies and extension approaches. *In:* BISHWAKARMA, B. K., SHRESTHA, S. K. & ALLEN, R. (eds.) *The sustainable soil management program.* Kathmandu, Nepal: Swiss Intercooperation Nepal.

HODGSON, G. M. 2006. What are institutions? *Journal of economic issues,* 40**,** 1-26.

HOLMELIN, N. N. & AASE, T. T. 2013. Flexibility of Scope, Type and Temporality in Mustang, Nepal. Opportunities for Adaptation in a Farming System Facing Climatic and Market Uncertainty. *Sustainability,* 5**,** 1387-1405.

HOLT-JENSEN, A. 1999. *Geography, History and Concepts: A Student's Guide*, SAGE.

HORRIGAN, L., LAWRENCE, R. S. & WALKER, P. 2002. How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental Health Perspectives,* 110**,** 445-456.

HORTON, D. & MACKAY, R. 2003. Using evaluation to enhance institutional learning and change: recent experiences with agricultural research and development. *Agricultural Systems,* 78**,** 127-142.

HOWDEN, S. M., SOUSSANA, J.-F., TUBIELLO, F. N., CHHETRI, N., DUNLOP, M. & MEINKE, H. 2007. Adapting agriculture to climate change. *Proceedings of the national academy of sciences,* 104**,** 19691-19696.

HUANG, H., WANG, Y., ZHANG, Z., JIANG, Z. & WANG, S. 2004. Actinidia germplasm resources and kiwifruit industry in China. *HortScience,* 39**,** 1165-1172.

ICIMOD. 2013. *Kiwi fruit cultivation.* International Centre for Integrated Mountain Development. Available at: http://www.icimod.org/?q=10415 (Accessed February 17, 2017)

IKERD, J. E. 1993. The need for a system approach to sustainable agriculture. *Agriculture, Ecosystems & Environment,* 46**,** 147-160.

ILIE, V., VAN SLYKE, C., GREEN, G. & HAO, L. 2005. Gender differences in perceptions and use of communication technologies: A diffusion of innovation approach. *Information Resources Management Journal,* 18**,** 13.

IMMERZEEL, W. W., VAN BEEK, L. P. & BIERKENS, M. F. 2010a. Climate change will affect the Asian water towers. *Science,* 328**,** 1382-1385.

IMMERZEEL, W. W., VAN BEEK, L. P. H. & BIERKENS, M. F. P. 2010b. Climate Change Will Affect the Asian Water Towers. *Science,* 328**,** 1382-1385.

IPCC 2007. Climate change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Forth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge Unversity Press.

IPCC 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. *In:* PACHAURI, R. K. & MEYER, L. (eds.).

IVES, J. D. 1987. The Theory of Himalayan Environmental Degradation: Its Validity and Application Challenged by Recent Research. *Mountain Research and Development,* 7**,** 189-199.

JAMISON, D. T. & MOOCK, P. R. 1984. Farmer education and farm efficiency in Nepal: The role of schooling, extension services, and cognitive skills. *World Development,* 12**,** 67-86.

JARRETT, F. G. 1985. Sources and models of agricultural innovation in developed and developing countries. *Agricultural Administration,* 18**,** 217-234.

JICK, T. D. 1979. Mixing qualitative and quantitative methods: Triangulation in action. *Administrative science quarterly***,** 602-611.

JIMI, D., JIMI, M. & SHRESTHA, P. 2015. The community seed bank in Tamaphok. *Community Seed Banks: Origin, Evolution and Prospects,* 2**,** 144-147.

JODHA, N. S. 2000. Globalization and fragile mountain environments: Policy challenges and choices. *Mountain Research and Development,* 20**,** 296-299.

JOHANNESSEN, J.-A., OLSEN, B. & LUMPKIN, G. T. 2001. Innovation as newness: what is new, how new, and new to whom? *European Journal of innovation management,* 4**,** 20-31.

JONES, L. & BOYD, E. 2011. Exploring social barriers to adaptation: Insights from Western Nepal. *Global Environmental Change,* 21**,** 1262-1274.

JOSHI, K., CONROY, C. & WITCOMBE, J. 2012. Agriculture, seed, and innovation in Nepal: Industry and policy issues for the future. *Washington, DC, United States: International Food Policy Research Institute***,** 1-60.

JUMA, C. 2015. *The new harvest: agricultural innovation in Africa*, Oxford University Press.

KAMINSKI, J. 2011. Diffusion of innovation theory. *Canadian Journal of Nursing Informatics,* 6**,** 1-6.

KANTOR, P. 2002. Gender, microenterprise success and cultural context: The case of South Asia. *Entrepreneurship: Theory and Practice,* 26**,** 131-144.

KAPBORG, I. & BERTERÖ, C. 2002. Using an interpreter in qualitative interviews: does it threaten validity? *Nursing inquiry,* 9**,** 52-56.

KAPLINSKY, R. 2000. Globalisation and Unequalisation: What Can Be Learned from Value Chain Analysis? *The Journal of Development Studies,* 37**,** 117-146.

KAPLINSKY, R. & MORRIS, M. 2001. *A handbook for value chain research,* IDRC Ottawa.

KATTELMANN, R. 1990. Hydrology and development of the Arun River, Nepal. *Hydrology in Mountainous Regions I—Hydrological Measurements; the Water Cycle***,** 777-784.

KIRK, J. & MILLER, M. L. 1986. *Reliability and validity in qualitative research*, Sage.

KLERKX, L., HALL, A. & LEEUWIS, C. 2009. Strengthening agricultural innovation capacity: are innovation brokers the answer? *International Journal of Agricultural Resources, Governance and Ecology,* 8**,** 409-438.

KLERKX, L., VAN MIERLO, B. & LEEUWIS, C. 2012. Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. *Farming Systems Research into the 21st century: The new dynamic.* Springer.

KNIGHT, J., WEIR, S. & WOLDEHANNA, T. 2003. The role of education in facilitating risk-taking and innovation in agriculture. *The Journal of Development Studies,* 39**,** 1-22.

KSHATRĪ, L. B. & HUTT, M. J. 2008. *Mountains Painted with Turmeric: A Novel*, Columbia University Press.

LANCKER, E. & NIJKAMP, P. 2000. A policy scenario analysis of sustainable agricultural development options: a case study for Nepal. *Impact Assessment and Project Appraisal,* 18**,** 111-124.

LEACH, M., MEARNS, R. & SCOONES, I. 1999. Environmental entitlements: dynamics and institutions in community-based natural resource management. *World development,* 27**,** 225-247.

LIN, J. Y. 1991. Education and innovation adoption in agriculture: evidence from hybrid rice in China. *American Journal of Agricultural Economics,* 73**,** 713-723.

LINTON, R. 1936. *The study of man: an introduction,* New York.

LOCKE, L. F., SILVERMAN, S. J. & SPIRDUSO, W. W. 2009. *Reading and understanding research,* Sage Publications.

LONG, T. & JOHNSON, M. 2000. Rigour, reliability and validity in qualitative research. *Clinical effectiveness in nursing,* 4**,** 30-37.

LONGHURST, R. 2003. Semi-structured interviews and focus groups. *Key methods in geography***,** 117-132.

MAASDORP, B. V., MUCHENJE, V. & TITTERTON, M. 1999. Palatability and effect on dairy cow milk yield of dried fodder from the forage trees Acacia boliviana, Calliandra calothyrsus and Leucaena leucocephala. *Animal Feed Science and Technology,* 77**,** 49-59.

MANANDHAR, S., PANDEY, V. P. & KAZAMA, F. 2013. Climate change and adaptation: an integrated framework linking social and physical aspects in poorly-gauged regions. *Climatic Change,* 120**,** 727-739.

MANANDHAR, S., VOGT, D. S., PERRET, S. R. & KAZAMA, F. 2011. Adapting cropping systems to climate change in Nepal: a cross-regional study of farmers' perception and practices. *Regional Environmental Change,* 11**,** 335-348.

MARINOVA, D. & PHILLIMORE, J. 2003. Models of innovation. *The international handbook on innovation,* 1.

MASSEY, D. S., AXINN, W. G. & GHIMIRE, D. J. 2010. Environmental change and out-migration: evidence from Nepal. *Population and Environment,* 32**,** 109-136.

MCDOWELL, G., FORD, J. D., LEHNER, B., BERRANG-FORD, L. & SHERPA, A. 2013. Climate-related hydrological change and human vulnerability in remote mountain regions: a case study from Khumbu, Nepal. *Regional Environmental Change,* 13**,** 299-310.

MILLER, J. & BARRY, G. 2010. Qualitative Research. *In:* SILVERMAN, D. (ed.). SAGE Publications.

MILLS, A. 2010. *Encyclopedia of Case Study Research*, SAGE.

MOAC 2013. Agriculture Development Strategy (ADS) 2015 to 2035. Singhdurbar, Kathmandu: Ministy of Agricuture and Coopertative, Government of Nepal.

MOAC 2014. Statistical Information on Nepalese Agriculture. *Kathmandu, Nepal: MoAC*.

MOAC 2015. District Profile of Dhankuta. *In:* UNIT, P. M. (ed.). Singha Darbar, Kathamandu: Ministry of Agricultural Development.

MOFSC 2014. Value change designing of chiraito. Ministry of Forestry and Soil Conservation, Department of Forestry of Nepal.

MORTENSEN, P. S. & BLOCH, C. W. 2005. *Oslo Manual-Guidelines for collecting and interpreting innovation data*, Organisation for Economic Cooporation and Development, OECD.

MULLINGS, B. 1999. Insider or outsider, both or neither: some dilemmas of interviewing in a cross-cultural setting. *Geoforum,* 30**,** 337-350.

MUTENJE, M., KANKWAMBA, H., MANGISONIB, J. & KASSIE, M. 2016. Agricultural innovations and food security in Malawi: Gender dynamics, institutions and market implications. *Technological Forecasting and Social Change,* 103**,** 240-248.

MYTELKA, L. K. 2000. LOCAL SYSTEMS OF INNOVATION IN A GLOBALIZED WORLD ECONOMY. *Industry & Innovation,* 7**,** 15-32.

NARC 2010. NARC's Strategic Vision for Agricultural Research (2011-2013). Kathmandu, Nepal: NARC.

NEUPANE, R. P., SHARMA, K. R. & THAPA, G. B. 2002. Adoption of agroforestry in the hills of Nepal: a logistic regression analysis. *Agricultural Systems,* 72**,** 177-196.

NORMAN, D. The farming systems approach: A historical perspective. Presentation held at the 17th Symposium of the International Farming Systems Association in Lake Buena Vista, Florida, USA, 2002. 17-20.

NOVO, A. M., SLINGERLAND, M., JANSEN, K., KANELLOPOULOS, A. & GILLER, K. E. 2013. Feasibility and competitiveness of intensive smallholder dairy farming in Brazil in comparison with soya and sugarcane: Case study of the Balde Cheio Programme. *Agricultural Systems,* 121**,** 63-72.

NPC 2013. Research into Long Term Impact of Development Interventions in the Koshi Hills of Nepal. Kathmandu Nepal: Nepal Planning Commission, the Government of Nepal.

O'BRIEN, K., QUINLAN, T. & ZIERVOGEL, G. 2009. Vulnerability interventions in the context of multiple stressors: lessons from the Southern Africa Vulnerability Initiative (SAVI). *Environmental science & policy,* 12**,** 23-32.

OECD 2013. *Agricultural Innovation Systems*, OECD Publishing.

OECD 2015. *The Australian Agricultural Innovation System*, Paris, OECD Publishing.

OLEN, S. M., BOOKHAGEN, B., HOFFMANN, B., SACHSE, D., ADHIKARI, D. & STRECKER, M. R. 2015. Understanding erosion rates in the Himalayan orogen: A case study from the Arun Valley. *Journal of Geophysical Research: Earth Surface,* 120**,** 2080-2102.

PARRY, M. L., ROSENZWEIG, C., IGLESIAS, A., LIVERMORE, M. & FISCHER, G. 2004. Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global Environmental Change,* 14**,** 53-67.

PARTAP, U., SHARMA, G., GURUNG, M., CHETTRI, N. & SHARMA, E. 2014. Large cardamom farming in changing climatic and socioeconomic conditions in the Sikkim Himalayas. *ICIMOD Working Paper*.

PEET, R. 1998. *Modern geographic thought*, Wiley-Blackwell.

PINGALI, P., KHWAJA, Y. & MEIJER, M. 2005. Commercializing small farms: Reducing transaction costs. *The future of small farms,* 61.

PORTER, M. E. 1980. Competitive strategy: techniques for analyzing industries and competitors. New York: Free Press.

POWELL, R. A. & SINGLE, H. M. 1996. Focus groups. *International journal for quality in health care,* 8**,** 499-504.

PRASAD, C. S. 2005. Science and Technology in Civil Society: Innovation Trajectory of Spirulina Algal Technology. *Economic and Political Weekly,* 40**,** 4363-4372.

RAUT, N., SITAULA, B. K., AUNE, J. B. & BAJRACHARYA, R. M. 2011. Evolution and future direction of intensified agriculture in the central mid-hills of Nepal. *International Journal of Agricultural Sustainability,* 9**,** 537-550.

RICH, K. M., BAKER, D., NEGASSA, A. & ROSS, R. B. Concepts, applications, and extensions of value chain analysis to livestock systems in developing countries. International Association of Agricultural Economists Conference, August, Beijing, 2009.

RODIMA-TAYLOR, D., OLWIG, M. F. & CHHETRI, N. 2012. Adaptation as innovation, innovation as adaptation: An institutional approach to climate change. *Applied Geography,* 33**,** 107-111.

ROGERS, E. M. 1962. *Diffusion of innovations,* New York, The Free Press.

ROGERS, E. M. 2010. *Diffusion of innovations*, Simon and Schuster.

ROGERS, E. M. 2015. Evolution: Diffusion of Innovations A2 - Wright, James D. *International Encyclopedia of the Social & Behavioral Sciences (Second Edition).* Oxford: Elsevier.

ROGERS, P. P., JALAL, K. F. & BOYD, J. A. 2012. *An introduction to sustainable development*, Earthscan.

SCHROEDER, R. F. 1985. Himalayan Subsistence Systems: Indigenous Agriculture in Rural Nepal. *Mountain Research and Development,* 5**,** 31-44.

SCOONES, I., THOMPSON, J. & CHAMBERS, R. 2009. Farmer first revisited. *Rugby: Practical Action.*

SHANER, W. W., PHILIPP, P. F. & SCHMEHL, W. 1982. *Farming systems research and development: guidelines for developing countries,* Consortium for International Development.

SHARMA, G., PARTAP, U., DAHAL, D., SHARMA, D. P. & SHARMA, E. 2016. Declining Large-Cardamom Production Systems in the Sikkim Himalayas: Climate Change Impacts, Agroeconomic Potential, and Revival Strategies. *Mountain Research and Development,* 36**,** 286-298.

SHARMA, G., SHARMA, E., SHARMA, R. & SINGH, K. 2002. Performance of an age series of Alnus–cardamom plantations in the Sikkim Himalaya: productivity, energetics and efficiencies. *Annals of botany,* 89**,** 261-272.

SHARMA, K. 2006. The political economy of civil war in Nepal. *World Development,* 34**,** 1237-1253.

SHRESTHA, M. L. 2000. Interannual variation of summer monsoon rainfall over Nepal and its relation to Southern Oscillation Index. *Meteorology and Atmospheric Physics,* 75**,** 21-28.

SHRESTHA, T. B. 1989. Dvelopment Ecology of the Arun River Basin in Nepal. Kathmandu, Nepal: ICIMOD.

SILVERMAN, D. 2016. *Qualitative research,* Sage.

SMIT, B. & SKINNER, M. W. 2002. Adaptation options in agriculture to climate change: a typology. *Mitigation and adaptation strategies for global change,* 7**,** 85-114.

SMIT, B. & WANDEL, J. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change,* 16**,** 282-292.

SMITHERS, J. & BLAY-PALMER, A. 2001. Technology innovation as a strategy for climate adaptation in agriculture. *Applied Geography,* 21**,** 175-197.

SPIELMAN, D. J., EKBOIR, J. & DAVIS, K. 2009. The art and science of innovation systems inquiry: Applications to Sub-Saharan African agriculture. *Technology in Society,* 31**,** 399-405.

STEVENS, S. F. 1996. *Claiming the high ground: Sherpas, subsistence, and environmental change in the highest Himalaya,* Motilal Banarsidass Publishe.

SUBEDI, B. P. & AASE, T. H. 2002. Vegetation and society interactions in the Nepal Himalayas: Geographers perspectives in the Arun Valley. *In:* CHADHARY, R. P., SUBEDI, B. P., VETAAS, O. R. & AASE, T. H. (eds.) *Vegetation and Society: Their Interaction in the Himalayas.* Tribhuvan University and University of Bergen.

SUBEDI, B. P. & MANANDHAR, I. N. 2002. Human ecology in Arun area: a study of land use and population dynamics. *In:* CHADHARY, R. P., SUBEDI, B. P., VETAAS, O. R. & AASE, T. H. (eds.) *Vegetation and Society: Their Interaction in the Himalayas.* Tribhuvan University and University of Bergen.

SUBEDI, B. P. & PANDEY, R. 2002. Livelihood strategies of Rai communities in Arun Valley: continuity and change. *Vegetation and Society: Their Interaction in the Himalayas***,** 157-170.

SUBEDI, K. D. 1996. Effect of Leaf Stripping, De-tasselling and Topping of Maize on the Yield of Maize and Relay Intercropped Finger Millet. *Experimental Agriculture,* 32**,** 57-61.

SUGDEN, F. & GURUNG, G. 2012. *Absentee landordism and agrarian stagnation in Nepal: A case from the Eastern Tarai*, Nepal Institute of Development Studies.

SWINTON, S. M. & BLACK, J. R. 2000. Modeling of agricultural systems. *Staff Paper-Department of Agricultural Economics, Michigan State University*.

TEDDLIE, C. & TASHAKKORI, A. 2009. *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences,* Sage Publications Inc.

THOMAS-SLAYTER, B. & BHATT, N. 1994. Land, livestock, and livelihoods: Changing dynamics of gender, caste, and ethnicity in a Nepalese village. *Human Ecology,* 22**,** 467-494.

THORNE, P. J. & TANNER, J. C. 2002. Livestock and nutrient cycling in crop–animal systems in Asia. *Agricultural Systems,* 71**,** 111-126.

TILMAN, D., CASSMAN, K. G., MATSON, P. A., NAYLOR, R. & POLASKY, S. 2002. Agricultural sustainability and intensive production practices. *Nature,* 418**,** 671-677.

TOFFIN, G. 1993. *The anthropology of Nepal: from tradition to modernity,* French Cultural Centre.

TOW, P., COOPER, I., PARTRIDGE, I., BIRCH, C. & HARRINGTON, L. 2011. Principles of a Systems Approach to Agriculture. *Rainfed Farming Systems.* Springer.

TURNER, B. L. & BRUSH, S. B. 1987. *Comparative Farming Systems,* New York, Guilford Press.

TURNER, B. L., KASPERSON, R. E., MATSON, P. A., MCCARTHY, J. J., CORELL, R. W., CHRISTENSEN, L., ECKLEY, N., KASPERSON, J. X., LUERS, A. & MARTELLO, M. L. 2003. A framework for vulnerability analysis in sustainability science. *Proceedings of the national academy of sciences,* 100**,** 8074-8079.

UPRETI, B. N. 2001. The physiography and geology of Nepal and their bearing on the landslide problem. *Landslide Hazard Mitigation in the Hindu Kush-Himalayas***,** 31-49.

USAID 2011. Value chain/market analysis of the off-season vegetable sub-sector in Nepal. Kathmandu, Nepal: United States Agency for International Development.

VAN DER VEEN, M. 2010. Agricultural innovation: invention and adoption or change and adaptation? *World Archaeology,* 42**,** 1-12.

WATSON, A. & TILL, K. E. 2009. The SAGE handbook of qualitative geography. *In:* DELYSER, D., HERBERT, S., AITKEN, S., CRANG, M. & MCDOWELL, L. (eds.). Sage.

WILLOCK, J., DEARY, I. J., MCGREGOR, M. M., SUTHERLAND, A., EDWARDS-JONES, G., MORGAN, O., DENT, B., GRIEVE, R., GIBSON, G. & AUSTIN, E. 1999. Farmers' Attitudes, Objectives, Behaviors, and Personality Traits: The Edinburgh Study of Decision Making on Farms. *Journal of Vocational Behavior,* 54**,** 5-36.

WOLPERT, J. 1964. THE DECISION PROCESS IN SPATIAL CONTEXT 1. *Annals of the Association of American Geographers,* 54**,** 537-558.

WORLD BANK 2006. *Enhancing Agricultural Innovation : How to Go Beyond the Strengthening of Research Systems,* Herndon, VA, USA, World Bank Publications.

WORLD ECONOMIC FORUM 2017. The Global Risk Report 2017. *Insigt Report.* Cologny, Geneva Switzerland: World Economic Forum.

XU, J. & GRUMBINE, R. E. 2014. Integrating local hybrid knowledge and state support for climate change adaptation in the Asian Highlands. *Climatic change,* 124**,** 93-104.

YIN, R. K. 1981. The case study as a serious research strategy. *Science communication,* 3**,** 97-114.

YIN, R. K. 1981a. The Case Study Crisis: Some Answers. *Administrative Science Quarterly,* 26**,** 58-65.

ZURICK, D. & PACHECO, J. 2006. *Illustrated Atlas of the Himalaya,* University Press of Kentucky

Appendix 1: Acronyms and Abbreviations

ADB	Asian Development Bank
AIS	Innovation System Approach
CAA	Commercial Agricultural Alliance
CBS	Central Bureau of Statistics
CEAPREAD	Center for Environmental and Agricultural Policy Research, Extension and Development
DADO	District Agriculture Development Office
DANIDA	Danish International Development Agency
DAP	Diammonium Phosphate
DDC	Dairy Development Cooperation
DFID	Department for International Development
DLSO	District Livestock Service Office
FAO	Food and Agriculture Organization
HIMALI	High Mountain Agribusiness and Livelihood Improvement Project
HVC	High Value Crops
ICIMOD	International Centre for Integrated Mountain Development
ILO	International Labor Organization
IPCC	Intergovernmental Panel on Climate Change
KHADP	Koshi-Hill Area Development Program
LI-BIRD	Local Initiative for Biodiversity, Research and Development
m.a.s.l.	Meters above sea level
MOAC	Ministry of Agriculture and Cooperative of Nepal
NARS	National Agricultural Research System
NPR	Nepali Rupees
SMPC	Sidhuwa Multi-Purpose Cooperative
VDC	Village Development Committee

Appendix 2: Glossary

Aama Samuha	women's group
Aayurvedic Ausadhi	a traditional types of medicine
Amliso	broom grass (*(Thysanolaena maxima)*
Bad	seed bed
Bari	unirrigated land
Bhakaro sudhar	a shed-management and improvement
chok	meeting place
Dale ghas	fodder tree
Dewali	an act of worship scarifying male goat
Doko	bamboo made cone shaped basket
Dugdha Sahakari	milk cooperative
Furkekhar	a kind of grass found in *pakho*
Gramin sadak	rural road
Haat bazaar	periodic market
Khahare khola	rain-fed river
Kharite	mobile merchants
Khoria	slash-and-burn
Khet	irrigated paddy field
Oileni jagga	non-registered land
Pakho	unirrigated slope land
Parampara	tradition
Pasuhat	livestock market
Purma	labour exchange
Tar	considerably flat terrace land
Utis	the Himalayan alder (*Alnus nepalensis)*

Appendix 3: Household survey questionnaires (sample)

(Note: The information will be used for academic purposes and will be kept confidential)

Name of village: ……. Household No:…….. Ethnicity:……

Altitude:…… GPS Point:…….

1. Household Map

2. Land

Land type	Owned (Area in ropani)	Cultivated (Area in ropani)
Khet		
Bari		
Pakho		

3. Cropland change

Crops	Area 1995-2005 (Area in ropani)	2005-2015 (Area in ropani)

4. Livestock
   Buffalo___ Cow____ Ox____ Goat___ Chicken___

5. Chemical fertilizer
   When did you start to use chemical fertilizer_____?

   Chemical fertilizer used in Khet_____ per/ropani

   Chemical fertilizer used in Bari_____ per/ropani

6. Do you have involvement in any agriculture related institutions (co-operatives, local farmers group, NGOs)?

   No ◯ Yes ◯ if yes, which institutions……

7. Have you received any training related to agriculture during last 10 years?

   No ◯ Yes ◯ if yes, what type trainings……

8. What is needed in order to produce more crops on the land you cultivate? Ranking 1-6

More water	
More labor	
More manure	
More chemical fertilizer	
Better seeds	
Better extension services	

9. Have your planted new crops, vegetables or brought new breed of livestock, types of fodder grass, or any other agricultural inputs, or new way of farming during the last ten years? If yes, what are those?

No ◯ Yes ◯ if yes, which crop/vegetable/livestock/types of fodder grass

……

……

10. Why did you introduce those new changes in agriculture? Reasons:

More profit ◯ to diversify ◯ suitable for drought or heavy rain ◯ suitable for marketing ◯ low labor input ◯ quick return ◯ or others……

11. Have you started to use new agricultural utensils during last ten years?

No ◯ Yes ◯ if yes, what kinds? ……

12. Do any children/son in the family want to take over the farm?

No ◯ Yes ◯

13. Have you abandoned arable land during last 10 years? If yes,

Labor shortages ◯ low quality and production ◯ lack of irrigation ◯ damage by pests or animal ◯ or any other reasons…….?

14. Have you experienced any significant negative effect and noticeable loss in your agriculture from climatic or non-climatic events during last decades?

No ◯ Yes ◯ if yes, what kind of events?.....

15. Wealth ranking of household (self-evaluation):

Wealthy ◯ Middle ◯ Poor ◯

16. Other comment and information's