Flexible adaptation in Himalayan small-scale farming

Subsistence production, gender relations, and adaptive capacity under climatic and market uncertainty in Nepal

Nina Bergan Holmelin

Thesis for the degree of Philosophiae Doctor (PhD)
University of Bergen, Norway
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Abstract

Climate change imposes new challenges for small-scale farmers in Nepal by adding climatic uncertainty to the existing natural climate variability, and by disturbing food production systems and food markets. In conjunction with a fluctuating international labour market with low job security for unskilled migrant workers, it is likely that local, subsistence-based food production will continue to be important for household food security in rural Nepal.

This dissertation studies the adaptive capacity of a small-scale farming community through the theoretical lens of flexibility. Building on Gregory Bateson's notion of flexibility as uncommitted potentialities for change, I argue that buffers of unused capacity in factors of production, opportunities for change in crop composition, and the ability to rapidly adjust production give room to manoeuvre. Flexibility in farming gives capacity to adapt to increasingly unpredictable fluctuations in local climatic conditions and international markets for food and labour.

By conducting ethnographic fieldwork and applying qualitative and quantitative fieldwork methods to a case study from the Nepali Middle Hills, I analyse flexibility at the scales of a community farming system and household farm systems. Here, as elsewhere in Nepal, foreign labour migration by young men is prevalent. However, migrants have also started to return and invest their labour in new cash crops, which add to the households' cultivation of traditional staple crops for food. Since land holdings are small and few are fully self-sufficient from own production, additional food is bought by means of some income from cash cropping, remittances, and off-farm work. The expansion of the local range of available cultivars enables farmers to alternate between various food and cash crops, and ensures that if one crop fails, there are others to eat. Diversification, not specialization, preserves the flexibility to rapidly adjust resource utilization, crop compositions, and productive practices. A flexible combination of subsistence production and high-value crops makes an important

contribution to adaptive capacity under uncertain and variable climatic and market conditions.

Migration has contributed to raise household incomes through remittances but has also increased the agricultural work burden for women. Although women already take part in decision-making on the farm, their participation in public, financial and market spheres are more restricted. Local gender roles are currently changing as women have started to enter new social spheres. I find that there are two competing sets of cultural gender norms in Nepal: Modern development ideas of women's empowerment and gender equality challenge traditional gender norms, which constrain women's decision-making power to the household and the farm. In the local community, the ability to negotiate a new role space for women is socially differentiated. Individuals who stand strong in hierarchies of caste and ethnicity, wealth, age, and marital status are in a better position to change local gender roles than less fortunate individuals who rather feel caught in a cultural conflict of competing gender norms. In sum, cultural change in local gender roles opens for greater participation by women in public life, local markets, and microcredit cooperatives.

Although income from cash cropping is an attractive option for returned migrants, the households' production strategy is not primarily driven by a desire to maximise profit. Cash cropping is considered a high-risk option and an alternative to migration, but not an alternative to subsistence food production. I find that people combine two production logics: They apply the profit-motivated market logic on a small share of their land, while keeping most of their land for food production for own consumption. According to the subsistence logic, the main purpose of farming is to ensure a stable access to food for the household by means of own production, to contribute to and benefit from reciprocity-based systems for sharing food and labour in the community, and to maintain social ties and traditions.

The current agricultural development strategy of the Nepali Government regards subsistence production as an impediment to economic growth, and advocates a

transformation of Nepali agriculture into large-scale, mechanized, specialized, and commercial production units. Implementing this strategy may improve the agricultural sector's economic performance and reduce Nepal's dependency on food imports, but it would not ensure stable access to food for rural farming households. The farmers' strategy to balance subsistence and market production, and maintain social security systems in the community, enhances their food security and adaptive capacity.

Theoretically, I distinguish between two levels of abstraction and argue that in a dynamic and uncertain environment, flexible adaptation at one level of abstraction helps ensure the general sustainability of the system at a higher level. Ensuring the sustainability of small-scale farm systems means to maintain their ability to provide people with food and a livelihood, often in combination with off-farm activities. Unless national policies that severely restrict the farmers' flexibility are implemented, or the impacts of climate change turn out to exceed the limits of adaptive capacity in this community, small-scale subsistence farming is likely to persist in Maina Pokhari.

Acknowledgements

As I finalize the work with this dissertation, I wish to thank my supervisor, Tor Halfdan Aase, who inspired me to choose the academic discipline of Geography and who introduced me to Himalaya studies, sixteen years ago. Later, he sent me to the high mountains of Nepal for the very first time as a young Master student and supervised me through the fieldwork and writing process at both Master level and now through a PhD. I am truly grateful for all our theoretical and empirical discussions, his kind help and guidance, his patience, and for believing in me from the very beginning. I am proud to be one of his many academic followers.

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List of publications

1. Holmelin, Nina and Aase, Tor H. (2013)[1]. Flexibility of Scope, Type and Temporality in Mustang, Nepal. Opportunities for Adaptation in a Farming System Facing Climatic and Market Uncertainty. *Sustainability* 2013, *5*(4), 1387-1405. https://doi.org/10.3390/su5041387

2. Holmelin, Nina B. (2017)[2]. Minor crops and major opportunities in Dolakha, Nepal. In T. H. Aase (ed.), *Climate Change and the Future of Himalayan Farming.* Oxford University Press 2017. ISBN 9780199475476. http://doi.org/10.1093/oso/9780199475476.003.0006.

3. Holmelin, Nina B. (2019)[3]. Competing gender norms and social practice in Himalayan farm management. *World Development* 122 (October 2019), 85-95. https://doi.org/10.1016/j.worlddev.2019.05.018

4. Holmelin, Nina B. (submitted 2019). National specialization policy versus farmers' priorities: Balancing subsistence farming and cash cropping in Nepal. (Under review, in *Journal of Rural Studies*)

Co-author contribution

Paper 1: Nina Bergan Holmelin contributed 80%, Tor Halfdan Aase contributed 20%.

A signed co-author declaration is attached in Appendices.

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A view over parts of the study area: Chhetrapa municipality under the twin peak mountain, Gauri Shankar (7134 m).

Contents

PART 1: Framing introduction

List of tables, figures, and map

Acronyms and abbreviations

ADS	Agricultural Development Strategy
APP	Agriculture Perspective Plan
CBS	Central Bureau of Statistics (Nepal)
CICERO	Center for International Climate Research
GDP	Gross domestic product
GoN	Government of Nepal
HICAP	Himalayan Climate Change Adaptation Programme
ICIMOD	International Centre for Integrated Mountain Development
IPCC	Intergovernmental Panel on Climate Change
masl	meters above sea level
NSD	Norwegian Social Science Data Service
PMAMP	Prime Minister Agriculture Modernization Project
RCP	Representative Concentration Pathway
VDC	Village Development Committee

1. Introduction

There is growing concern that ongoing and future climate change will impose great challenges to food production systems and to food security in many regions of the world (Battisti & Naylor, 2009; Lal, 2011; Porter et al., 2014; Myers et al., 2017). Global average crop yields of rice, maize and wheat are projected to decrease by between 3% and 10% per degree of warming above historical levels (Campbell et al., 2016). Greater year-to-year variability in yields is to be expected due to climate change and extreme weather events (Challinor et al., 2014; Porter et al., 2014; Arshad et al., 2017). Higher and more fluctuating food prices are expected, but substantial uncertainty remains in how climate change will influence regional and national food markets (Porter et al., 2014; Myers et al., 2017).

Uncertainty regarding future impacts of climate change and increased variability in global food production challenges the stability of food supply (Myers et al., 2017). Food security is not only dependent on sufficient national or regional availability of food, but also that people have stable access to food and ability to utilize the food nutritionally (Pinstrup-Andersen, 2009). Food security is of particular concern in developing countries such as Nepal, where 24% of the households are chronically food insecure, and especially in the mountain areas where seasonal food insecurity is most prevalent (CBS, 2013c). Two thirds of all Nepali households have subsistence-based agriculture as their main livelihood and even more are partly engaged in agriculture (CBS, 2013a). However, landholdings are generally small and 60% of all households are not self-sufficient in food, thus they rely on markets for covering their remaining food needs (CBS, 2013a). Climate change adds to the problems of underlying food insecurity by increasing the instability in food markets, and by making stable access to food through markets more uncertain (CBS, 2013c). It is therefore likely that local food production will continue to make an important contribution to household food security in Nepal in the future.

Climate change will also influence farming households and communities directly. In Himalaya over the recent decades, the average temperature has already increased by 0.3 °C per decade, which is faster than the global average (Hock et al., 2019). Accelerated melting of ice and snow and greater seasonal variations in river discharge have been observed (You et al., 2017), and loss of snow cover has already led to drying of soils and lower yields of potatoes and fodder in Nepal (Hock et al., 2019). Rainfall variability has increased with more frequent dry spells and greater intensity in wet spells (Singh et al., 2014). Changes in precipitation patterns and in the monsoon are projected for Himalaya this century, but precisely how these changes will affect specific locations remain uncertain (Xu et al., 2009; Immerzeel et al., 2013; Lutz et al., 2014). Considering the very diverse microclimatic conditions in the Himalayan mountains, the future climate to which farming communities in specific localities must adapt is highly uncertain (Aase et al., 2010). Long-term climate change is projected to disrupt the normal weather patterns and thus increase the climatic uncertainty at the local scale.

International labour migration from Nepal has increased dramatically over the last two decades (CBS, 2014b; Gartaula & Niehof, 2018). Seasonal migration for work within Nepal and to India has long been a common livelihood strategy, but recently the out-migration of young men to countries such as Malaysia, Qatar, and Saudi Arabia has surged (Hatlebakk, 2016). During the last national population enumeration, 1.9 million Nepalese resided abroad, among which 88% were men (CBS, 2014b). Remittances from foreign migrants accounted for 32% of GDP in Nepal in 2016 (Fox, 2018). The remittances are spent on daily consumption, land acquisition, loan repayment, education, and health expenses and have, in some cases, contributed to poverty reduction in Nepal (CBS, 2013c; Upreti & Shrestha, 2017).

However, unfavourable inclusion in labour and food markets has also created new forms of poverty (Rigg et al., 2016a; Sunam & McCarthy, 2016). There are considerable economic and personal risks and uncertainties associated with international labour migration. Experiences of forced labour, unfree recruitment and inability to leave the employer have been reported, as well as lacking and delayed

wage payment (Mak et al., 2017). Harsh living and working conditions in extreme heat have led to premature deaths among young labour migrants (Hatlebakk, 2016; Sunam & McCarthy, 2016). The rapidly expanding, oil-based economies of Qatar and Saudi-Arabia offer little job security for unskilled Nepali workers. High risk of migration failure combined with high levels of debt leave the international labour migrants in a situation of precarity (Rigg et al., 2016a). While remittances have contributed positively to household food security, the improvement is highly dependent on the continuation of household remittance income (CBS, 2013c). The migrants are typically absent for 2-3 years at a time, thereby withdrawing their labour from agriculture and leaving women and the elderly with a larger workload on the farm (Sunam & McCarthy, 2016; Gartaula & Niehof, 2018). How rural out-migration influences gendered decision-making on the farm and gender relations in rural communities is not yet satisfactorily illuminated in the literature.

There is thus significant uncertainty in three influential large-scale processes: the state of food availability and increasing volatility in international food markets, how climate change will influence local farming communities, and the role of international labour migration's contribution to household food security and income. The capacity of small-scale farming households to adapt will probably depend on how flexible they are to adjust to uncertain local impacts of a changing climate and to unpredictable fluctuations in markets for food and labour.

1.1 Objective and research questions

The main objective of this dissertation is to study the potentialities for sustaining local agricultural production in the face of uncertain large-scale changes in climate and markets for food and labour. Through a case study from the Nepali Middle Hills, I ask whether, and if so, how this small-scale farming community is sufficiently flexible to adapt to external uncertainties and ensure food security and livelihoods for the households. More specifically, I ask the following research questions:

1. How may the concept of flexibility be operationalised for analyses of adaptive capacity in farming systems facing uncertainty?
2. What are the opportunities for and constraints to adaptive capacity in the studied farming system, and how flexible are the individual farms to adapt to projected impacts of climate change and other large-scale changes?
3. How do local gender roles shape the social spheres in which women and men have decision-making authority, and how are these spheres changing in the light of changing gender norms and in the context of men's out-migration?
4. Why do farmers reserve of most of their land for subsistence production instead of specializing in profitable high-value cash crops?

1.2 Structure of the dissertation

The dissertation is structured in the following way: The first part is a framing introduction which explains the coherence of the dissertation. Chapter 1 introduces the research topic and objective of the study, presents summaries of the four papers and shows how they contribute to a larger research programme on climate change adaptation in Himalaya. Chapter 2 introduces the study area and gives a thorough discussion of research design and applied methods. Chapter 3 presents the theoretical and philosophy of science foundations of the dissertation, discusses core analytical concepts, and relates the contributions of the papers to existing literature in the field. Chapter 4 answers the research questions and draws some main conclusions from the dissertation as a whole. The second part of the dissertation consists of the four papers in full, in their published and submitted states. The papers 1 to 4 address the respective research questions 1 to 4. The questionnaire form and a co-author declaration for paper 1 are attached in Appendices.

1.3 Summaries of the papers

Paper 1 outlines a theoretical approach to study adaptive capacity in farming systems by operationalizing the concept of flexibility. Building on the theoretical literature on flexibility in complex systems, the paper discusses how flexibility theoretically relates to diversification, innovation, resilience, adaptive capacity, and the general sustainability of small-scale food production systems. Understanding flexibility as uncommitted potentiality for change, the term flexibility is operationalized by distinguishing three dimensions: Firstly, *flexibility of scope* is the presence of buffers of unused capacity in factors of production, thereby allowing the degree of resource utilization to be kept within the upper and lower tolerance thresholds. Secondly, *flexibility of type* is the ability to change crop composition, selecting from the range of possible crops and productive practices (e.g. non-timber forest products) in the system, here characterized as the local opportunity situation. Lastly, *temporal flexibility* is the capacity to rapidly adjust the system in the short-term by reallocating productive resources and alternating between crops, and to prepare for an uncertain future in a long-term perspective by keeping several options open. The analysed community farming system possesses flexibility to adapt in several respects, but only within the system's thresholds of tolerance. The paper identifies the main constraints to flexibility and discusses to what extent it is possible to relieve some of those constraints. In this case, construction of a new collective water pipe will improve local water access temporarily, but since the underlying problem of gradual warming and melting ice and snow is not resolved, the system will still face constraints from seasonal water scarcity under expected future impacts of climate change. The main contribution of this paper to the dissertation is the development of a theoretical approach for studying and analysing farming flexibility as an expression of adaptive capacity under uncertain conditions of production.

Paper 2 gives an in-depth empirical analysis of the farming system in the study area, Maina Pokhari in Dolakha, and applies the flexibility theory at the scale of single household farm systems. The paper identifies the current room to manoeuvre and the main constraints to flexibility of scope and maps the current opportunity situation. By

applying downscaled climate projections that are adjusted to the study area, an estimation is made of how the local opportunity situation and the conditions for cultivation are likely to be affected, should the projected changes occur.

Like many rural communities in Nepal, Maina Pokhari experiences extensive labour migration to Kathmandu and abroad, especially by young men. However, migrants have also started to return and invest their labour in the family farm. Local innovation in cultivation of new vegetables, forest products, fruits, and spices with high market values has increased the local range of available cultivars. By using the flexibility of scope, type and temporality in their farm systems, farmers combine subsistence and market production in ways that enhance household food security. For the migrating youth, a return to farming is regarded as a safety net and backup plan, but the opportunity to generate some income from farming makes returning a more attractive option and reduces the households' dependency on remittances. The paper concludes that diversification, not specialization, preserves the flexibility to rapidly adjust resource utilization, crop compositions and productive practices. Furthermore, a balanced market integration with a flexible combination of subsistence production and high-value crops makes an important contribution to adaptive capacity in the face of uncertain and variable climatic and market conditions.

Social differentiation between households, and between women and men, are not well captured analytically by the farming systems approach and the flexibility theory. **Paper 3** therefore focuses on gender relations and social differentiation in caste and ethnicity, wealth, age, and marital status. The paper identifies two competing sets of cultural gender norms in Nepal and discusses how people, through their social practices, relate to these abstract sets of gender norms. Modern development ideas of women's empowerment and gender equality, promoted by international development organizations and the Nepali Government, currently challenge traditional gender norms, which favour men in land ownership and inheritance, leave women with limited economic independence, and confine women to household chores with little participation in community decision-making processes and market activities.

By mapping the gendered division of labour and intra-household decision-making in the context of men's out-migration, I find that women have a say in matters related to the household and farm management, but not in spheres lying outside the household and the farm. The ability to negotiate between competing sets of gender norms and alter what is considered socially acceptable practice in the community is socially differentiated. I conclude that those who are best positioned to challenge traditional gender norms are individuals who stand strong in hierarchies of wealth, caste, age, and marital status. Interactions between modern development norms and traditional gender norms inspire local cultural change which has implications for women's participation in political, financial and market spheres.

The first two papers give much attention to emerging opportunities and introduction of new high-value crops. However, paper 2 shows that only a minority of the households in Maina Pokhari choose to deliberately cultivate crops for the market, and that those who do, dedicate only a fifth of their land to cash crops. **Paper 4** therefore explores the production strategies of farming households, asking why people prioritize the reservation of most of their land for subsistence production and avoid specialization in high-value crops, even after having experienced the income-bringing potentials of cash cropping. Drawing on classical theories of peasant behaviour and motivation, I identify several reasons and priorities that guide the production strategies. I find that farming households balance several different objectives when choosing their crop compositions, which can be distinguished as two production logics: Firstly, a market logic where the exchange value of the crops matters and where spices, vegetables, and fruits are preferred because they give higher economic returns than staple crops. Secondly, a subsistence logic where crops are selected based on their use value as the purpose of cultivation, according to this logic, is to ensure a stable fulfilment of household and community needs.

The farming households follow the subsistence logic for most of their plots for three main reasons: Firstly, they aim to ensure a stable supply of food through choosing a diversity of reliable crops with low yield variability, to reduce the risk of food insecurity for the household and in the community. Secondly, subsistence production

is embedded in and helps to reinforce social networks of loyalty and reciprocity. Social obligations for reciprocal sharing of food, and systems for casual labour in exchange for food, reduce the risk of anyone experiencing periods of severe food scarcity. Lastly, traditional subsistence production is experienced as a meaningful activity that is well adapted to the local environment, is based on embodied knowledge, and is embedded in culture and traditions. Some independence from markets gives autonomy, and the family farm represents a safe base to which young migrants can return. While subsistence crops are only sold in case of a surplus, investments are made, and higher risk is taken on dedicated cash crops. Cultivation for profit is evaluated against migration and other livelihoods, not against subsistence production. The households are fully capable of combining the subsistence logic on most of their land with some cash cropping, but they find it too risky and unwise to convert completely to commercial production.

The current agricultural development strategy of Nepal regards subsistence production as an impediment to economic growth and advocates a transformation of Nepali agriculture into large-scale, mechanized, specialized, and commercial production units. The implementation of this strategy may improve the agricultural sector's economic performance and reduce Nepal's dependency on food imports, but it would not ensure a stable access to food for rural farming households. The farmers' strategy to balance subsistence and market production and maintain social security networks in the community enhances their food security and adaptive capacity.

The first and second papers apply a farming systems approach to analyse farming flexibility: Paper 1 at the scale of a community farming system, and paper 2 at the scale of household farm systems. The third and fourth papers focus on farm management and decision-making: paper 3 between husband and wife at the intra-household scale, and paper 4 at the scale of the household as one economic unit. Table 1 presents an overview of the papers and shows how they are related.

Table 1: Paper overview and coherence

Papers	**Topic**	**Unit of analysis**	**Theoretical contributions**	**Empirical findings**
1. Flexibility of scope, type, and temporality in Mustang, Nepal. Opportunities for adaptation in a farming system facing climatic and market uncertainty	Farming flexibility as adaptive capacity under climatic and market uncertainty	Community farming system	Flexibility consists of buffers of unused capacity, a variety of possible crops/products and ability to rapidly adjust production	The system has significant flexibility to adapt, but is constrained by little meltwater in spring which could worsen with climate change
2. Minor crops and major opportunities in Dolakha, Nepal	Farming flexibility as adaptive capacity under climatic and market uncertainty	Household farm systems	How the local opportunity situation may change under locally adjusted climate projections	High-value crops give new income opportunities and improved adaptive capacity if traditional crop diversity is kept
3. Competing gender norms and social practice in Himalayan farm management	Farm management and decision making	Individual men and women	Two competing sets of cultural gender norms create new opportunities for change in women's and men's social practices	Women take active part in decisions on the farm. Social differentiation influences who can alter local gender norms and establish new practices
4. National specialization policy versus farmers' priorities: Balancing subsistence farming and cash cropping in Nepal	Farm management and decision making	Households	Subsistence logic and market logic are distinct, but can be successfully combined	Farmers prioritise reliable subsistence crops and see cash crops only as a high-risk supplement

1.4 Scientific environment and funding

This PhD project is part of and funded by a larger research programme named Himalayan Climate Change Adaptation Programme, HICAP (2012–2017), which was jointly implemented by the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, CICERO Center for International Climate Research in Oslo, and GRID in Arendal, in collaboration with 28 regional partner institutions in nine countries. HICAP was funded by the Norwegian Ministry of Foreign Affairs and the Swedish International Development Agency (SIDA).

HICAP was carried out in five river basins in the Hindu-Kush Himalayan region: The Upper Indus in Pakistan, the Koshi sub-basin in Nepal, the Eastern Brahmaputra in India, the Upper Brahmaputra in the Tibetan Autonomous Region and the Upper Salween-Mekong in China. The work was organized in seven interrelated work packages (Figure 1) which covered regional and downscaled climate scenarios, water availability and demand scenarios, ecosystem services, food security, vulnerability and adaptation, women and gender in adaptation, and communication and outreach.

This study is related to three of the work packages: Vulnerability and adaptation, women and gender in adaptation, and food security. Papers 1 and 2 relate to adaptation and vulnerability by analysing the flexibility of farming and farm systems, including the constraints to flexibility, and discussing how the opportunity situation of farming households is likely to change under future climatic conditions. Paper 2 includes analyses based on downscaled climate scenarios from the first HICAP work package. Paper 3 concerns gender relations by discussing how people negotiate what are considered socially accepted practices by relating to two competing sets of gender norms. Lastly, paper 4 addresses food security issues through exploring farmers' motivations for retaining subsistence production and finds that ensuring household and community food security was an important factor.

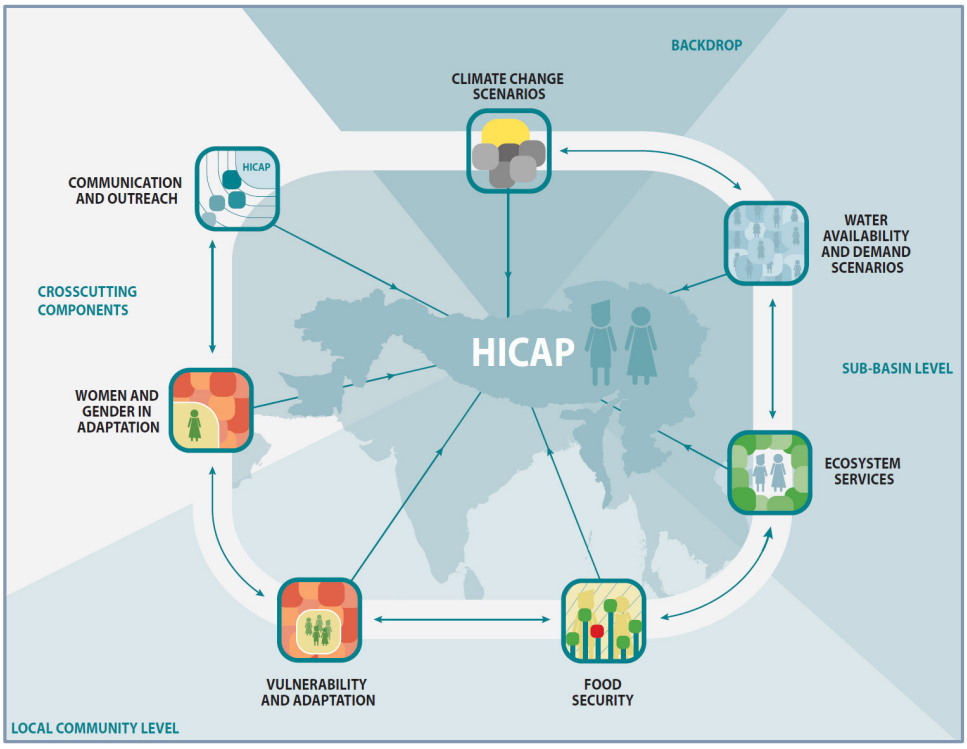


Figure 1: Overview of HICAP work packages (ICIMOD 2013).

Throughout the project period I have been affiliated to the Department of Geography and the PhD programme at the Faculty of Social Sciences at the University of Bergen. I have been part of the research school at the Center for Development and the Environment (SUM), University of Oslo, and have completed PhD courses at the University of Bergen, University of Stavanger, University of Oslo and the Western Norway Research Institute. The papers have been presented at five international and Nordic conferences in Nepal, USA, and Norway and communicated through various popular science presentations, lectures, radio interviews, op eds (including in *Nepali Times*) and magazine articles. Three of the papers are published in international peer-reviewed journals and publishers, among which two papers are published at Level 2. The fourth paper is under review for a Level 2 journal.

Doing a PhD as part of a larger research programme implies that my choices regarding thematic focus have, to some extent, been conditioned by the strategic priorities of the HICAP programme, to which the papers have been reported as outputs. Topics such as national adaptation policy and institutional capacity for adaptation, changing ecosystem services, and changing regional water availability and demand have been addressed in other work packages of the programme. A large hydropower project, Tamakoshi III, involves the construction of a dam nearby the study area, but this is not a topic in the dissertation as the downstream areas will face the greatest consequences. Two great earthquakes and numerous smaller quakes caused extensive and severe damage to Nepal in the spring of 2015, including the study area, but disaster risk and natural hazards are not within the scope of this project. Historical accounts of the Maoist insurgencies which lasted from 1996 to 2006 are also excluded from the dissertation.

2. Research design and methodology

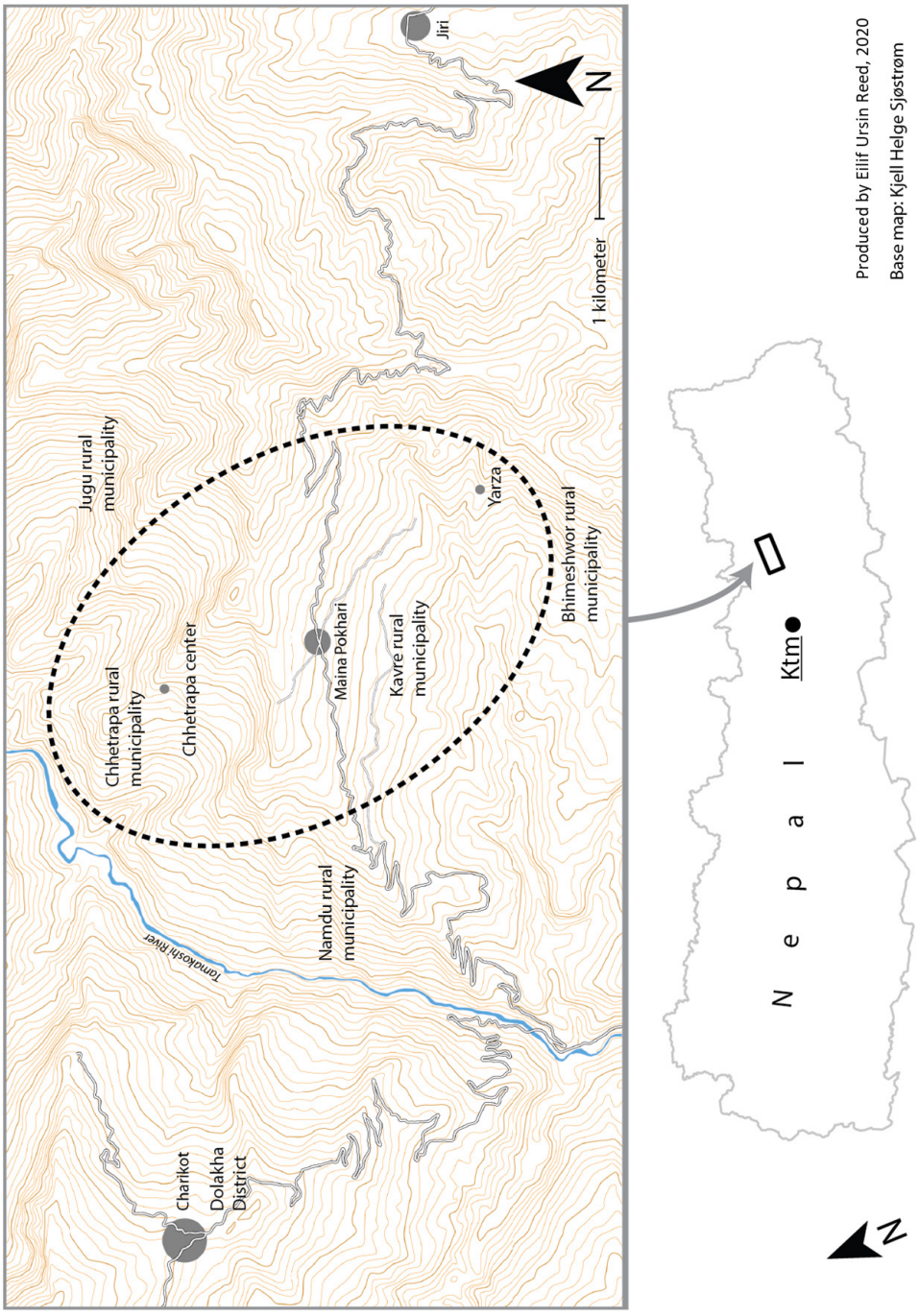
2.1 Selection of study area

The study area was selected based on the following criteria: 1. It must lie in a sub-basin of the Koshi river system of Nepal due to coordinated strategic choices of HICAP focus areas; 2. It should comprise a Middle Hill agro-forestry farming system in order to ensure comparability to five other case study areas for a joint publication by co-authors and I (Aase et al., 2017)[4]; 3. Small-scale farming should be the dominant economic activity and livelihood in the area, preferably including both traditional and innovative farming practices; 4. The altitude span of the hillsides should cover the current altitude limit for rice cultivation which is likely to be affected by current and future climate change; 5. The caste and ethnicity composition should be mixed and levels of wealth and land holdings vary; and 6. Longer periods of ethnographic fieldwork must be feasible, meaning that a local hotel or lodge had to be available and walking distance to the studied settlements was preferred.

A scoping trip for locating a suitable study area was conducted in October 2012. My supervisor and I visited and evaluated four potential sites. The area that best met all the above-mentioned criteria was Kavre and Chhetrapa Rural Municipalities in Dolakha[5], a mountain district in Province 3 of Nepal (see Map 1). The two municipalities lie in the Middle Hill zone and are separated by a forest-covered ridge peaking at 2419 meters above sea level (masl). The Tamakoshi river, a tributary to the greater Koshi river, runs by below at approximately 880 masl. Individual farms and small settlements are scattered along the slope of the hillside between approximately 1400 and 2100 masl, on both sides of the ridge.

[4] Aase, T. H., **Holmelin, N. B.**, van Oort, B., Agrawal, Nischalke, S., Wang, W., Ahmed, S., Chapagain, P. S., and Bisht, S. (2017). Current adaptations and future prospects of Himalayan farming. In: *Climate Change and the Future of Himalayan Farming*. T. H. Aase (ed.). India: Oxford University Press.

[5] Dolakha belonged to the Janakpur Zone of Central Nepal until 2017 when a new administrative structure was implemented in Nepal. Municipalities were formerly called Village Development Committees, VDCs.



Map 1: The study area

The village Maina Pokhari (1970 masl) is the centre of the study area. It is a transport hub, marketplace and meeting point for people living in adjacent settlements. The village lies along a road which links the road head Jiri to the district headquarters Charikot and leads further on to Kathmandu, seven hours drive from Maina Pokhari. I define the study area as a functional region, meaning that it comprises all households using the village Maina Pokhari as their primary market and transport nexus. The concept 'functional region' is further elaborated in section 3.3.3. Most households in Kavre and Chhetrapa municipalities and a small Sherpa settlement, Yarza, in Bhimeshwor (former Mirge) municipality are included. Households located more than a 2.5 hours' walk away from Maina Pokhari prefer to visit other, smaller marketplaces. The boundaries of the study area are thus defined in terms of relative space, the walking distance to the village. A thorough general description and a farming system analysis of the study area is included in paper 2 and is not repeated here.

2.2 Mixed methods research design

The publications are based on primary data obtained and produced during fieldwork. After the initial scoping trip in 2012, I conducted fieldwork during two periods in Maina Pokhari in 2013, spring and autumn. Each fieldwork lasted approximately two months. In addition, I had two visits to Nepal in 2014, and in the autumn 2015, I spent another two weeks in Nepal and went back to Maina Pokhari for a short follow-up fieldwork. The papers 2, 3 and 4 constitute the empirical core of the project while paper 1 is included mainly due to its theoretical contribution on the concept farming flexibility. Paper 1 draws on empirical data from my earlier work in Lower Mustang, Nepal. Reflections over fieldwork and applied methods for paper 1 are described and discussed briefly in the paper and in detail in Holmelin (2010).

I developed a mixed methods research design (Cresswell et al., 2003; Johnson & Onwuegbuzie, 2004) that involves a combination of selected qualitative and

quantitative methods for data production. Qualitative and quantitative oriented research methods are not mutually exclusive, but rather focus on different aspects of social phenomena (Agar, 1986; Aase & Fossåskaret, 2014; Wadel, 2014). While quantitative methods are focused on investigating the extent and magnitude of the research topic and are suitable for answering questions of the dispersion, prevalence and quantitative trends of change, qualitative methods instead focus on the content of the phenomenon resulting in knowledge of for instance how and why a certain event or process occurred, or which factors contribute to social change (Aase & Fossåskaret, 2014). Qualitative methods are suitable for obtaining insight and a deeper understanding of social phenomena and are particularly useful for studying relations, processes and social interactions (Aase & Fossåskaret, 2014; Wadel, 2014). Qualitative work is inherently interpretative, focusing on meanings rather than frequencies (Agar, 1986). Qualitative and quantitative oriented methods build on different principles for ensuring reliability and must not be mixed into hybrids, but a research design that rigorously draws on both qualitative and quantitative methods can produce results that complement each other which in sum gives a more comprehensive picture of the research topic. Different kinds of methods are necessary in order to understand the complexity of social phenomena (Cresswell et al., 2003).

Both quantitative and qualitative methods vary with respect to researcher involvement and number of units included in the sample (Aase & Fossåskaret, 2014). Some quantitatively oriented methods involve a large number of units and a low level of researcher engagement, for instance a structured survey with a predefined set of possible answers. At the other extreme are qualitative methods such as participant observation where the researcher is intensively involved, establishing social relations with a smaller number of informants. However, many research methods can be placed along a continuum between these two poles (Johnson & Onwuegbuzie, 2004; Aase & Fossåskaret, 2014). Semi-structured interviews and field conversations are examples of methods lying along the continuum between the two extremes, although tending towards the qualitative end. The purpose of mixed methods research is to move beyond the purist position that qualitative and quantitative methods are incompatible,

instead recognizing that both of them are useful and important in producing different kinds of knowledge (Johnson & Onwuegbuzie, 2004). The relative priority of qualitative and quantitative methods will vary with the objective of the study (Cresswell et al., 2003). As my research questions focus on the content more than the extent of the topics in question, I let the qualitatively oriented methods take priority accordingly.

In the following sections, I describe the applied methods ranging from the most intensive method, participant observation, to the most extensive, a household survey. Since all data production had to be completed within the time I had in the field, I did not conduct the quantitative and qualitative methods in sequence, but rather chose a simultaneous design (Cresswell et al., 2003), also called a *mixed-model* design (Johnson & Onwuegbuzie, 2004), of applying the different methods within the same stage of the research process, in my case, the fieldwork.

2.2.1 Ethnography

Ethnographic research is done in a variety of ways and there is no single definition of ethnography that is universally adopted (Stewart, 1998), but one important objective is to study social life as it unfolds in the practices of everyday life (Donge, 2006). The researcher aims to observe events, practices and social processes in their natural context and then discuss these observations with the informants, seeking to reveal people's own interpretations, their concepts and cultural categories (Aase & Fossåskaret, 2014).

Stewart (1998) lists four core characteristics of ethnographic research: The first is participant observation. In contrast to research methods that establish artificial situations, such as controlled experiments, the ethnographic ideal is to be accepted as a participant in social life (Donge, 2006). The goal is to obtain sufficient access to take part in and observe social processes as they occur "backstage" (Aase & Fossåskaret, 2014), through taking an active, participative role in everyday life (Stewart, 1998). Reflections on how I participated in social life through acquiring

local and semi-local statuses and what kinds of access I obtained are discussed in detail later in this chapter.

The second characteristic is holism, to synthesize disparate observations into an integrated whole. In earlier anthropological traditions, attempts at holistic analyses of a society and its culture have been made (Howell & Melhuus, 2001). However, the journal article format does not allow for the level and amount of detail needed to fulfil the ambition of holism. In practice, comprehensiveness is always limited and most ethnographic analyses today are not and cannot be all-embracing, but instead choose a narrower focus (Stewart, 1998). Within Geography, there is general acceptance for a focussed analysis in accordance with the defined objective of the study.

The third characteristic is context sensitivity, meaning that the researcher explains one set of observations in terms of their connections with others. In my papers this is achieved through analysing quotes from informants in the light of characteristics of the household (family situation, property, wealth level, altitude of the farm, distance to the market, etc.) and with reference to the broader context of agricultural opportunities, what I in papers 1 and 2 call 'the opportunity situation', climatic conditions and cultural gender norms. Since I interviewed the same households quantitatively by means of the household survey and qualitatively through in-depth interviews, the different types of household data are coupled.

Stewart's last characteristic of ethnography is sociocultural description. Ethnographers agree that the subjective views of people should be recorded and interpreted (Stewart, 1998). Observations become data when they are conceptualized, and in the process of categorization and interpretation, different meanings can be revealed (Aase & Fossåskaret, 2014). To identify diverging interpretations of a phenomenon can contribute to building understanding and insight into social processes, human—environment relations, and cultural norms. I show the latter in Paper 3 where I present people's own concepts, categories, and interpretations of how decision-making is gendered and use this as a basis and supplement to my analysis

based on scientific concepts. In paper 2, the informant's own concept of 'the five J's' is remarkably consistent with the scientific concept of a farming system: The five J's refer to the Nepali words for water (*jal*), forest (*jangal*), livestock (*janawar*), labour (*janashakti*) and land (*jamin*) and the farmer must manage these five resources well in order to be successful. A large part of the empirical material included in paper 4 consists of people's own interpretations and views of the importance of subsistence production, its multiple functions, and its low-risk qualities, expressed as direct quotes. In paper 1, people's own interpretations of their economic prospects and their preferred strategies for preparing for the future are included.

2.2.2 Participant observation: Positionality and status

Feminist social scientists have since the late 1980s questioned claims to objective and value-free research, arguing that all knowledge is produced in specific circumstances which shape it in some way (Rose, 1997) and that power relations between researcher and informant influence how knowledge is represented (Mullings, 1999). The terms positionality and situated knowledges redirect the focus from the researched to the researcher as an embodied person with a background, history and identity, not as an objective and neutral observer (Haraway, 1988; Rose, 1997; Mullings, 1999). Instead of denying or ignoring that the researcher's personal identifiers influence the research process, feminist social scientists instead called for reflexivity, to critically reflect on one's own positionality and how it shapes interpretations of data and representations of 'the other' (Rose, 1997; Nagar & Geiger, 2007). This feminist critique is relevant for ethnographic fieldwork in calling for critical reflections of how the gender, age, nationality, class and other social markers of the researcher influence how he or she is perceived by the informants, how social interaction in the field occurs and how the researcher views and interprets the data (Mullings, 1999). However, while critically reflecting over one's own positionality, one must cautiously avoid going to the other extreme of essentialising social categories (Nagar & Geiger, 2007).

While positionality refers to personal identifiers such as gender, age and class, the concepts status and role point to the related topic of a person's position in a social system. A status is a social position with a connected set of rights and duties (Linton, 1936; Aase & Fossåskaret, 2007; Wadel & Wadel, 2007). Social relations are established between symmetrical statuses, for instance two friends, or complementary statuses such as student and teacher, which enable each party to have specific role expectations of the other. By performing the role according to the rights and duties of a particular status, for instance 'teacher', the status is activated and confirmed. Any social person occupies a number of statuses simultaneously (Wadel & Wadel, 2007). An important task for the researcher doing participant observation is to critically reflect over which statuses she is ascribed, how she can perform and shape the role or perhaps even achieve some new statuses, and what kind of access that gives her (Aase & Fossåskaret, 2007). My positionality as a white, European woman of 29 years influenced which statuses I was ascribed and could take on. Being a woman opens some doors and closes others, just as being Western and not Nepali does.

During fieldwork I was accompanied by a Nepali research assistant. I ensured that the research assistant was a woman and not older than me to avoid problems of being perceived as subordinate to my research assistant due to cultural perceptions of social rank related to gender and age. Having a Nepali friend who I could walk with and talk to was also beneficial for obtaining access. People we met on the paths would often stop and ask my assistant who I was and where we were going. When I on occasion walked alone people would be puzzled, asking where my friend was. I also needed translation for the interviews as I only knew a little Nepali, and most people knew no or very little English. My Nepali improved during the time in the field, but I still required translation to get the answers and quotes correctly recorded.

In the following I will elaborate on how my statuses in the local status inventory developed and progressed during fieldwork, and to what extent I was unable to achieve certain statuses due to my specific positionality in terms of age, gender and nationality.

The foreigner. The very first day of the first fieldwork there was a wedding in the village. Lots of people were gathering, the bride was dressed in red and they were all dancing, waiting for a bus load of the groom and his friends to come and take the bride with them. The ritual is a symbolic re-enactment of capture marriage, a tradition which is now abandoned (Bista, 1991). The wedding lasted all day, and my assistant and I were invited to join in. The event opened for many informal conversations where I could introduce myself. I received some invitations from people who wanted to show me around, younger people who knew some English, which I followed up the next day. I let my new acquaintances take me to various parts of the field area, introducing me to their friends and relatives. They were proud to show that they knew a Western person, a foreigner, and glad to demonstrate their English skills. Accepting invitations and letting myself be introduced was a very good way to obtain initial access to the farming areas surrounding Maina Pokhari village. When first I was introduced to a new area and some of the people living there, I experienced that I had the necessary access to come back another day, walk onto a farm and ask for an interview. People would generally accept and invite me into their courtyards.

The PhD student. Knowing that my initial household interviews were very important for future access, and that people would probably discuss them afterwards, which they did, I was cautious to ask only about farming practices and to avoid any questions that could appear intrusive or inappropriate. I introduced myself as a PhD student doing my dissertation on the broad term "farming," as I rapidly discovered that students were generally accepted, few people would relate to "research" or to "climate change" and that any attempt to explain my research agenda more in depth was rather futile. "Student" was a known status in the local status inventory (Linton, 1936; Aase & Fossåskaret, 2007) with a connected set of rights and obligations. Nepali students doing their thesis work would occasionally come to the village, which meant that people knew roughly what to expect. They did not know what to expect from a "researcher", however. It was not a well-known local status and I found that introducing myself as a researcher could easily alienate people. Taking on the status of a PhD student and performing my role accordingly also ensured that I could avoid any impressions of being an NGO worker coming with projects, money, or

contacts for new business opportunities. Being honest about my work and intentions was important for gaining trust.

A benefit of conducting a structured quantitative household survey was that it corresponded to my informants' expectations to what "students" would do. The survey was thus useful not only for data collection purposes, but also for confirming my status as a PhD student doing research. People's previous experience with researchers had largely been the conducting of household surveys and governmental population censuses. By opening a household interview with the survey, I established the situation as a research interview, which next opened for open-ended questions and informal conversations about any subject of interest.

The "Swiss". The household survey also clearly distinguished me from a tourist or trekker. Maina Pokhari is rarely visited by tourists and trekkers, as they either drive directly to the road head Jiri or fly to Lukla in Solukhumbu district for trekking in the popular Mount Everest area. However, Swiss development agents have been working in the area for more than thirty years and have through continued and long-term efforts managed to build roads, introduce new crops, invest in irrigation, and improve health services. A few Swiss researchers have also been working in the area and have apparently left a good impression. When I explained what I was doing there, people often referred to "the Swiss". They also found that I looked much like them. To me the association to the Swiss was favourable, I was met with the attitude that I, like the Swiss people, contribute to long-term benefits and progress (*bikas*).

The Western woman. Since one of my research topics was gender relations, it was important for the study that I could interact with women without the company of a man. During the course of fieldwork, we gradually obtained access to interview women in their kitchens, courtyards, and fields and to engage in semi-structured group discussions with women. One-on-one interviews and group discussions were also conducted with men and with groups of men and women. Semi-structured interviews that from the outset concerned agriculture often turned into conversations about relations between men and women, marriage practices, and social expectations

connected to the role as a housewife. The great interest that young women in particular took in marriage norms and practices in what they call ‘outside’, here meaning the West, laid the ground for comparisons and distinctions between local ‘inside’ norms and practices and those of ‘outside’.

In accordance with an interactionist view on interviewing (Aase & Fossåskaret, 2007), the interviewer takes an active part in creating dialogue during the interview. Meaning is constructed through a conversation between two or more active parties and the researcher must actively engage in the conversation. The methodological challenge is not to attempt to be a passive or objective listener, but rather to reflect thoroughly on the ways in which the researcher influences the situation and how the rights and duties connected to the researcher’s status (Linton, 1936) in the situation influence the type of information that is obtained. Interview data is thus not revealed, but rather produced during the interaction between researcher and informants (Aase & Fossåskaret, 2007).

With that in mind, I engaged in the discussions of gender norms and marriage practices by explaining my own civil status, talking about Norwegian culture and gender relations, and showing some photos. Sharing something about myself as well contributed to balancing the interview situation as I was not the only one asking all the questions, draining them for information, and it helped establish an image of myself as a whole social person, with my own background, family, and social relations. I found that this helped building trust and confidence, that both parties had something to learn from each other, and that once people had heard how we “in the West” found a boyfriend and entered marriage, the relevance of talking about how this worked locally and in Nepal increased. Discussions of cultural differences revealed patterns, norms and practices that are often taken for granted when not contrasted by something very different.

Since gender relations was one of my research topics, I made sure to include both men and women as informants, striving for a rough balance. While my status as a woman gave me access to conversations and social interaction with other women, my

status as a Westerner gave me access to talk to men, to a certain extent. The dynamics of the conversations differed accordingly. Men often perceived the interview situation as more formal than women did. Initially, men tended to focus more on quantitative information about crops and farming practices, which were more in line with their perception of what researchers did and surveys were for. They were less inclined to present their own views and experiences during the first meeting. After repeated visits and several informal field conversations, some men changed their perception of what I did and increasingly elaborated on their own views, opinions and perceptions regarding farming and livelihood priorities, their families, local affairs and trends of change in the community.

However, I did not have access to arenas for local politics and the various committees (*samitis*) making collective decisions, which were dominated by men. Neither did I have access to ask men older than me about their personal experiences of marriage, health issues, or their positions in local hierarchies of power. These were topics I could occasionally discuss with women, who would also introduce me to the symbolism of impurity related to menstruation and childbirth and the established practices for separation during women's periods and for restoring symbolic purity afterwards (*chhaupadi*). This level of intimacy in the conversations was only possible to achieve with women. Certain young men, who would address me as '*didi',* 'older sister' would share their aspirations for the future, their worries about the perceived pressure to "be successful" in terms of income generation, and some would tell me about great challenges and even traumatic experiences of abuse and imprisonment during international labour migration.

During my fieldwork in Jharkot, Mustang, which laid the empirical basis for paper 1, I was invited by a friend to be present and observe the election of a new village leader and his assistants. Both women and men were present at the roof-top meeting, but only men spoke, and only men could be elected. In Jharkot, I had the status as a volunteer teacher in the local Buddhist monastery (*gompa*), where I gave classes in English and mathematics every afternoon. The children lived in the monastery and spent much time in the inner courtyard and in the kitchen, places where I had access

due to my status as a teacher. My relation to the children was also a way into participating in other social arenas and events in the village such as festivals, celebrations, ceremonies, and funerals. Being a teacher gave me a local status that justified why I spent six weeks in this small village, unlike all the trekkers who would spend a maximum of two nights there. It also improved my access to social arenas and to interview people, beyond what I could have achieved from merely being a student and a paying guest at the lodge. Although I did not have a local status in Dolakha, my access improved over the course of the fieldwork as I achieved other, semi-local statuses.

Guest and "bonus daughter". I rented rooms in a lodge in Maina Pokhari, and the hosts rapidly considered me as their guest and "their" foreigner. People would often ask where I was staying and when I referred to my hosts, they would nod approvingly. Being associated with my hosts proved to be a great social benefit. They were a respected family in the community and their ground floor restaurant was a hub for small trade, informal meetings, and other forms of daily social contact in the village. Much social interaction happened in the mornings and after a while I found that people sometimes came looking for me and were already waiting for me when I came down in the morning. Many valuable observations, long field conversations and invitations to visit their farms and interview them occurred in the mornings in the restaurant. After repeated invitations and visits to certain households and participation in festival celebrations, forms of acquaintances and friendships were established through which I was informed about events, rituals, norms and gossip stories that I otherwise would have been completely unaware of.

My host mother would often say how much I reminded her of her fourth daughter. She had both adult, married daughters and adolescent daughters staying at home. My interpreter and I were more and more treated like guests of the family, their temporary "bonus daughters" and "bonus sisters", who they included in festival celebrations and ceremonies. We spent much time with them in the mornings and evenings, where they taught me Nepali, let me help with small household chores and after a while they started to test their English skills as well. When the main festival

period, Dasain – Tihar was coming up, we took part in the preparations and in ceremonies. We all dressed up in saris, we celebrated *bhai tikka*, and I was invited in to do *puja* (a ceremony) in the sacred ancestor room during *Laxmi puja*, which I interpreted as a sign that I was – for some time – considered to a degree an insider.


Festival celebrations during Dasain – Tihar

Fieldwork also has its challenging sides. Sometimes I would ask myself who was really observing whom. Male drivers who stayed at the hotel would often stare at me for hours in the evenings and discuss my presence in an obvious manner. Some would stand less than 20 centimetres away from me, staring, throughout a whole interview with an informant. They obviously found me out of place. It made me feel much like an animal in a zoo, and I found that I was an object of observation just as much as I was the observer.

In the farming areas surrounding Maina Pokhari, however, I was greeted on the path and welcomed into the farms. When I asked for an interview, I could hear that they "had been waiting for you to come visit us too" while rolling out a straw mat for us to sit on. The great difference in how I was approached by different groups of people invoked reflections on power relations between the researcher and the researched. The feminist geography literature has often highlighted the dimensions of power inherent in all knowledge production and how white, Western academic researchers

are in a privileged position to the people they study when the research is done in a cross-cultural context (Rose, 1997). I fully acknowledge the power and responsibility that is inherently tied to producing academic knowledge in the shape of published, peer-reviewed articles, where my choices of perspective and use of quotes and other empirical data will influence whose voices are heard. However, I am less convinced of my having a privileged position in relation to my informants during the fieldwork as such. As the above discussion shows, my position(s) in the local status inventory was far from the top of the local status hierarchies. My social background and higher education did not count in this context, and I had no access to the inner circles of powerful men in the local community. In some situations, I became partly an insider while in other situations I was still considered a stranger. My privilege and power as a researcher rather lie in deciding which questions I ask, how I interpret the answers and in what form I choose to present the results (McLafferty, 1995). Ethical considerations and responsible handling of data are discussed in section 2.3.

2.2.3 Observation

A priority during fieldwork was to obtain relevant data for conducting a comprehensive farming system analysis (Turner & Brush, 1987), the result of which is presented in paper 2. While interviews are suitable for studying human and social aspects, a farming system is a type of social-ecological system which also demands analytical inclusion of natural components. Observations of fields and crops, forests, livestock, water resources, altitude and climatic conditions were important for mapping the opportunity situation in the field area (see paper 2), the constraints to cultivation from altitude, steepness of the slope or lack of water, and unrealized potentials for cultivation. To directly observe the landscape laid the basis for discussing these observations with the farmers themselves, such as why they prioritized certain crops and chose not to grow other crops even though they had suitable land for them. Such observations of the farm and its natural environment enabled numerous discussions over resource utilization, production strategies, water rights and market opportunities and constraints that would not have been attainable

based on interviews alone. The research question for paper 4 arose from observations of the pervasive priority of maize and millet for subsistence over other crops with a higher market value.

Using a GPS, I noted the altitude of the main fields for each interviewed household. I also walked transects down the slopes in Kavre and in Chhetrapa and marked the highest altitude where rice was cultivated. This marked the altitude limit for rice cultivation under the current local climate. Irrigated land (*khet*) existed also above this limit, but the farmers did not cultivate rice there. The farmers referred to it as *lekh*, the higher-altitude summer pastures. I also asked people to draw local maps for distribution of irrigation water and for community forest rights, and to draw their agricultural calendar. Observing newly introduced crops, fruit trees, herbs and so on gave me an opportunity to ask about these plants in detail. Random observations resulted in my discovery of several local innovations.

2.2.4 Semi-structured interviews and group interviews

A large part of the qualitative data was obtained through semi-structured interviews in the surveyed households. The interviews covered a range of issues regarding farming, cropping patterns and weather-related challenges, but also people's priorities and strategies for the future, experiences of social norms and expectations, and perceptions of opportunities and constraints in the community. The initial quantitative household survey then developed into a semi-structured interview partly led by the informants themselves. A combination of quantitative and qualitative methods was thus applied even within one interview situation.

Semi-structured interviews were also conducted with key informants and representatives for local NGOs, local and district governmental officers, lending and saving cooperative members, interest group committees (*samitis*), the district research centre, and others. Secondary data included local statistical and census reports on population and agriculture and were obtained from District and Municipal offices and translated from Nepali.

I did ten group interviews, out of which four were all men, three were all women and three was both women and men. The groups consisted of three to ten people and the interview situations arose spontaneously (Yin, 2011). I did not sample participants according to some predefined characteristic (i.e., focus groups), or as a random sample. The purpose of the group interviews was to observe social interaction between informants who already had established relations to each other (Wadel, 2014), and invite them to discuss and reflect upon a topic that I introduced. The groups therefore consisted of people who were already gathered: Elderly men sitting outside a tea shop, women in the lending saving cooperative, young men home for the holidays, women of mixed ages having a break from harvesting rice, and so on. My role in these interviews was less active than in one-on-one interviews, as I wanted the informants to respond to each other and discuss among themselves. The sessions resulted in reflections and perceptions on opportunities and constraints in the community, historical and recent developments, and prospects for the future.

2.2.5 Intensive household cases studies

In some households I obtained good contact and was invited back. Ten of the interviewed households were developed into intensive household case studies, with repeated contact over weeks and extended interviews on a number of issues, including a full guided tour of their farm and fields. On five of these farms I mapped all their plots and noted, for each plot, the currently cultivated crops and what they cultivated in the same plots ten years before, as an indicator of temporal changes in cropping patterns in these farm systems. The informants described their agricultural calendars and their strategies for coping with crop failure. I also asked them to reflect on their choice of crops and the benefits and disadvantages of different crops. Altogether, these in-depth interviews and conversations provided data that enabled me to analyse farm-system flexibility. Questions regarding current and past crop choices and strategies following crop failure were also included in the household survey (see the questionnaire form in Appendices). The range of varying and similar

answers to these questions contributed data for analysing farming system flexibility and the opportunity situation in the community, as presented in paper 2.

The intensively studied households enabled deeper insight into how single farms were run, how the family made farm-management decisions and their life situation in general. For each time we met, a fuller picture was painted, and more personal details were included. Not until the fifth time I talked to one married couple did they let me know that they had crossed caste boundaries and married out of love, which had led to social stigma and many struggles. The challenges of labour migration, with indebtedness, mistreatment, and imprisonment by employers abroad, were also first revealed after many meetings when a certain level of trust had been established. Paper 3 discusses these issues in depth.

2.2.6 Household survey: Sampling and representativity

The household survey covered 114 households in all parts of my field area. The aim of the survey was threefold: Firstly, to obtain quantitative data on land holdings, resource utilization, cropping patterns, decision-making and background characteristics that complement qualitative information from the households I interviewed, which enabled formulation of cases of single household farm systems combining qualitative and quantitative data; secondly, to produce structured, quantitative data on selected topics that were comparable to data produced in other case studies for a joint publication (Aase et al., 2017); and lastly, to confirm my status as a PhD student by performing the role in line with my informants' expectations, which helped me obtain access to ask more open-ended, qualitative questions.

The sample was selected purposively and non-probabilistically (Gobo, 2004; Teddlie & Yu, 2007). Since the study area covers all households using Maina Pokhari as their primary market, I purposively selected households in all settlements and clusters of houses located within 2.5 hours' walk from Maina Pokhari: 54 households in Chhetrapa, 52 in Kavre and 8 in the small Sherpa settlement, Yarza. Households lying further away preferred to visit other local markets and were therefore excluded

from the sample. The geographical distribution of households was the main criteria for sampling. I hypothesised that walking distance to the market in Maina Pokhari would influence level of market integration, especially the choice of growing cash crops; how and to what extent is discussed in paper 4. The sample is non-probabilistic as instead of selecting households randomly, I ensured that the variance of variables of particular interest to my study was covered, which is a suitable procedure for obtaining representativity in purposive samples (Gobo, 2004). The final sample covered farm altitudes from 1500 to 2100 meters, all castes and ethnic groups in the area, land holdings from small to large, distance to the market, wealthy to poor households, and local differences in education, migration, and crop diversity. The data were coded and analysed in SPSS by means of descriptive statistics and, to a lesser degree, linear regression and crosstabulation (Chi^2). Gendered distribution of respondents, procedures for data analysis and results are presented in papers 2 and 3. Survey results were also used for a comparative analysis in a joint publication (Aase et al., 2017) which is not included in this dissertation. The questionnaire form is attached as an appendix.

Table 2: Comparison of survey variables to district and national census data

Variable	Maina Pokhari survey (2013) n=114	Dolakha (2011/2012) N=40718	Nepal (2011/2012) N=5423297	Sources
Vegetables, spices, fruits, share of all cultivated land	6.5%	6.1%	6.3%	(CBS, 2013b, 2013a)
Cereals, legumes, tubers, oilseeds, share of all cultivated land	93.5%	93.8%	93.9%	(CBS, 2013b, 2013a)
Average land holdings (ha)[6]	0.54	0.66	0.66	(CBS, 2013b, 2013a)
Share of households renting land	6.1%	19.6%	15%	(CBS, 2013b, 2013a)
Average area rented (ha) [7]	0.18	0.28	0.50	(CBS, 2013b, 2013a)
Average household size excluding migrants	4.4	4.1	4.9	(CBS, 2016)
Migrants abroad, share of total population	5.3%	5.1%	6.8%	(CBS, 2014a)
One or more migrants abroad, share of households	24%	*	25%	(CBS, 2014c)
Out-migrants domestically and abroad, share of total population	27%	29%	20%	(CBS, 2014b)
Men as share of migrants abroad	95%	*	88%	(CBS, 2014b)
Woman as head of household, share of households		34%	26%	(CBS, 2012)
Husband absent or deceased: Share of households	24%			
Woman managing the farm: share of households	45%			
Religion: Hinduism	68%	68%	81%	
Buddhism	31%	22%	9%	(CBS, 2014a)
Other	2%	10%	10%	
* Data for Dolakha not available, see national figure				

[6] Paper 2 refers to district level statistics when citing the average land holding to 0.7 ha (CBS, 2013b), while papers 3 and 4 refer to my household survey, where average land holdings is 0.5 ha.

[7] An error occurs in paper 2, page 178: "Currently, 6 percent of the surveyed households rent and sharecrop plots, on average 1.3 ha per sharecropper." The correct figure is an average of 0.18 ha per sharecropper. The correct figures are comparable to data from Dolakha district, where 5.3 percent of the household rent land, on average 0.11 ha, for sharecropping (CBS, 2013b).

In terms of representativity of the sample, Table 2 compares the distribution of key variables from my household survey (Maina Pokhari survey 2013) to population census data (2011/2012) from Dolakha District and from Nepal. The census is part of the most recent full population enumeration, which is conducted every tenth year in Nepal. The comparison shows that the Maina Pokhari survey has a high degree of representativity when compared to Dolakha District:

The variables selected for comparison in the table are based on the quantitative data I have used in analysis in the published and submitted papers, as representativity should ideally and as far as possible be checked for all variables of interest in the analysis (Gobo, 2004). In paper 2 I highlight the small share of cultivated land used for cash cropping among those who diversify into market production, a figure which is part of the empirical basis for paper 4. Table 2 shows that the share of land dedicated to cultivation of vegetables, spices, and fruits in my sample, 6.5%, is representative for Dolakha and for Nepal: 6.1% and 6.3% respectively. Average land holdings in my sample is slightly lower than the district average, which in turn mirrors the national average. The variance of landholdings was modest in my sample because there were not any exceptionally large landowners, which there are in other areas of Dolakha and elsewhere in Nepal. The share of households renting land is thus also smaller in my sample than the district and national figures.

In paper 3, I analyse gendered decision-making and gendered division of labour. Comparable data are not available through the national population census of 2011/2012 or other statistical reports from the Central Bureau of Statistic (CBS) of Nepal. Related variables must therefore be used as proxies for checking representativity. Since paper 3 discusses the large impact of men's out-migration on gendered decision-making, Table 2 compares average household size, number of migrants domestically and abroad as share of total population, share of households with migrants abroad, and the share of men among all foreign migrants. The sample largely reflects the general picture of migration patterns in Dolakha and in Nepal.

For gendered decision-making, no directly comparable data were available in any of the census reports. However, women are reported as “head of the household” in 34% of the households in Dolakha (Table 2). The applied definition of a household head is the person “being mainly responsible for the maintenance and management of the household. The person should be usual resident of the household and should be aged 10 years and above” (CBS, 2014b, p. 322). The CBS’ definition does not distinguish between different types of household decisions, nor whether the household head is in fact present at the time of the census enumeration. The CBS has been criticized for not accounting sufficiently for the great prevalence of multiple settlements within one nuclear family in Nepal (Aase et al., 2019). As I discuss thoroughly in paper 3, women in my study area are in charge of farm-related decisions in 45% of the surveyed households, but men have a stronger say in household decisions regarding spheres that are considered as ‘outside’, such as financial matters. It is then unclear how the CBS in the quote above determines who are “mainly responsible for the maintenance and management of the household”. In Maina Pokhari, when the husband is migrated or deceased (24% of the surveyed households), women take over all farm-related decisions. The CBS definition does not specify how long a person must be absent to no longer be considered a “usual resident”. Considering these ambiguities in the CBS definition of household head, I present the figures from Maina Pokhari separately from those of Dolakha and Nepal. The district-level figure for women as household head lies between the two figures from Maina Pokhari on farm management and absent or deceased husband. Lastly, Table 2 shows the shares of Hindus, Buddhists and other religions, which in my sample is quite similar to the respective figures from Dolakha. The national share of Hindus is somewhat higher as the CBS includes many smaller religious systems elsewhere in Nepal into the broader category Hinduism (Bista, 1991).

The distribution of households according to caste groups and ethnic groups is shown in Table 3. Since geographical distribution of the households was the principal criterion during sampling, I strategically chose to balance the number of households in Chhetrapa and Kavre municipalities. The caste and ethnicity distribution in my

survey therefore does not fully reflect the distribution in the three municipalities altogether (referred to as 'Local censuses' in the table). Compared to my sample, Kavre has a larger proportion of high-caste Bahuns and Chhetris, while Chhetrapa and Yarza have larger proportions of ethnic groups (Jirel, Sherpa, Newar and Tamang). Since the total population of Kavre municipality is almost twice as large as that of Chhetrapa municipality and much larger than the population of Yarza ward, the caste distribution in the column 'Local censuses' is biased compared to my actual study area, the functional region. The distribution in Chhetrapa municipality, however, is comparable to that of Dolakha district, and to the distribution in the middle hill and mountain districts of Nepal. Since the caste and ethnicity distribution in my sample is not representative for Dolakha, I have not generalized any empirical results based on differences among caste and ethnic groups.

Table 3: Distribution of population among caste groups and ethnic groups

Caste groups/ ethnic groups	Maina Pokhari	Local censuses[1]	Kavre VDC[2]	Chhetrapa VDC[3]	Yarza ward[4]	Dolakha[4]	Nepal (Hill)[5]
High caste	54%	68%	82%	48%	4%	48%	47%
Ethnic groups	31%	21%	3%	46%	96%	45%	41%
Low caste	16%	11%	15%	6%	0%	7%	12%
Sum	100%	100%	100%	100%	100%	100%	100%

[1] Local censuses: The sum of the populations in Kavre, Chhetrapa and Yarza.

[2] (Kavre VDC, 2008)

[3] (Chhetrapa VDC, 2010)

[4] (Dolakha District Development Office, 2005)

[5] (CBS, 2014c) Note: Here, 'hill' includes middle hill and mountain districts, but not Terai.

The caste system in Nepal differs from that of India with its four *varnas* Brahman, Khastriya, Vaishya, Shudra, and the untouchables, which was already described in the ancient Manusmriti (Bista, 1991). Hinduism has been practiced for centuries in Nepal but the caste system was first codified in the Mulukhi Ain, the national legal

code of 1854 (Gellner, 2007). The caste system had to be adapted to Shamanism, Shaivism and Buddhism and to the numerous ethnic groups of Nepal (Bista, 1991). The term 'caste' in Nepal refers to those groups whose social structure is hierarchical and strongly embedded in Hindu ideas of purity and impurity (Dahal, 2014). High-caste groups such as Bahun, Chhetri and some others are the wearers of the sacred thread and are considered "pure", while low-caste groups such as the Dalit groups are categorized as "untouchable" or *pani nachalne*, "water unacceptable" (Bista, 1991; Gellner, 2007). The high- and low-caste groups are called *Jat*, while the ethnic groups or Matwalis (literally meaning 'alcohol drinking') are *Janajati*, not caste groups, and are placed in the middle of the hierarchy. The *Janajati* category also includes the many smaller ethnic groups of Tibetan origin (Gellner, 2007). Discrimination based on caste was legally abolished in 1963 (Bista, 1991) and the constitution of 1990 defined Nepal as a multi-ethnic country (Gellner, 2007).

2.3 Ethical considerations

Prior to the first round of fieldwork, I developed a detailed plan for data production which was approved by the Norwegian Social Science Data Service (NSD). According to the regulations for recording personal data, I anonymized my data and did not record any names or other personally identifiable data. Photos from fieldwork were taken for illustrative purposes and were not linked to the written data material. After all data collection was completed, the project and details regarding all data material were again reported to and approved by the NSD.

Voluntary informed consent is usually obtained by asking participants to sign a written statement (Yin, 2011). However, I chose to ask for voluntary informed consent from participants orally due to the low level of literacy among the adult population, especially women: Less than 25% of women aged 45 years or more are literate (CBS, 2014c). I was open about why I was staying in the village and about the purpose of my work and explained that the informants had the right to end or

withdraw from the interview. Given that most participants had little or no knowledge of what a research project entails, I took extra measures to avoid any threat of harm from participating in the project and to assure confidentiality of their identities (Yin, 2011; Wadel, 2014). I critically evaluated whether I should record sensitive personal information such as health problems, disabilities, sexual orientation, alcoholism, stigmatizing life situations and difficult life events. Although such personal information gave me a deeper understanding of people's priorities, predicaments, and life situations in general, I made sure to exclude sensitive details in publications and other written work. When performing participant observation, I also witnessed certain situations that would not be ethically right of me to record as data. Making ethical considerations in research involves reflecting over which status I had when gaining access to this information (Wadel, 2014), which was not always the status as a researcher, and to be considerate in protecting the confidentiality and trust of my informants.

2.4 Reliability and validity

Reliability in qualitative research is the extent to which a finding is independent of accidental circumstances, while validity is the degree to which the finding is interpreted in a correct or sound way (Kirk & Miller, 1986). To ensure validity involves that the researcher's descriptions and interpretations of a studied social phenomenon reflects the informants' own understanding of the situation (Schutz, 1962, in Harrington, 2000), although they do not have to agree with the final conclusions. The goal is to realize as much reliability and validity as possible, even though perfect validity is not attainable (Kirk & Miller, 1986; Yin, 2011).

Concept validity is ensured by formulating precise definitions and being consistent in application of analytical concepts. In section 3.3 I discuss and define some of the most important concepts used in the analyses, which add to the definitions presented in the papers as such. I have sought to apply the same definitions across the papers.

Using a diverse set of methods helps ensure theoretical validity as the hypotheses or interpretations in question are approached and tested in different ways (Kirk & Miller, 1986). As described above, I used a combination of qualitative and quantitative methods, which resulted in different types of data from the same households. As I conducted all the household interviews for the survey and all the qualitative interviews myself, I could control how the questions were formulated and how the answers were interpreted and categorized, which ensures consistency and raises the reliability of the survey results. Although I could not control how the research assistant formulated and translated our conversation, the simultaneous translation allowed for follow-up questions and clarifications.

The combination of interviews and direct observations on the farms and in the surrounding area further strengthened the reliability of the data. Reflections on how my status and positionality during fieldwork influenced the data production process is discussed in section 2.2.2 above. During fieldwork, interpretations are continuously tested through daily face-to-face contact with the informants (Kirk & Miller, 1986). Intensive long-term fieldwork that results in rich data, with repeated observations and many interviews, strengthens validity (Maxwell, 2009, in Yin, 2011). Asking the same questions to many households and having several conversations with a smaller number of households assisted in the testing, adjusting, and confirmation of my interpretations during fieldwork. For instance, during fieldwork my initial focus was directed towards agricultural innovation and the benefits of new high-value crops, but after many conversations and observations my understanding improved of how people appreciated and saw many benefits from cultivating maize, millet and other traditional crops for subsistence, interpretations which are included in paper 4. In paper 3 I present the informant's own reasons for and interpretations of their practices regarding gender relations in farm management, in accordance with Schutz' validity criteria (Harrington, 2000). The validity of my interpretations and conclusions was further checked by comparing my findings to other empirical studies from the region and to the conclusions from the existing literature on the field, as I have done in the papers.

3. Theoretical basis for the analyses

3.1 Theory of science foundations

Interdisciplinary approaches to human-nature systems or socio-ecological systems have challenged the conventional dichotomy between natural and social sciences by studying interrelated systems consisting of both social and natural components. Farming system analyses exemplify such an approach by studying how farmers manage and engage land, labour, water, livestock, forests or pastures and capital in producing food and other agricultural outputs, and by relating the farming system to its social, economic, political and climatic context (Turner & Brush, 1987; Dixon & Gulliver, 2001; Aase, 2017). It is hardly possible to study social-ecological systems without ontologically assuming the existence of a nature prior to human perception and knowledge of it. Critical realism is one among several theories of science that assumes the existence of an intransitive world of objects, while epistemologically regarding any human knowledge of the external world as partial, constructed and fallible (Sayer, 2000).

3.1.1 Critical realist ontology

The theory of science foundation of this PhD project is based on critical realism (Bhaskar, 1978, 2010), a well-recognized theory of science which has been given much attention in geographic literature. As Bhaskar's formulation of a philosophy lacks clear implications for how to develop a consistent research method (Yeung, 1997), Andrew Sayer and others have elaborated on and further developed critical realism for application within geographic research (Sayer, 2000; Sayer, 2006). The ontological assumption of critical realism is that the world exists independent of human perception and knowledge of it. Critical realism thus rejects the ontological idealist position that the world is a product of our knowledge (Sayer, 2006).

Bhaskar presents a stratified ontology consisting of three levels of reality: the real, the actual and the empirical level (Sayer, 2000; Hansen & Simonsen, 2004; Bhaskar, 2010). At the real level, objects, structures, and causal powers exist, which also includes social structures. These objects and structures have causal powers which may or may not set mechanisms in motion to produce actual unfolding events. They represent the range of causal potentials. With a few exceptions the world is constituted by open systems (Bhaskar, 2010), which implies that the relations between the structures and mechanisms are contingent: they are neither necessary nor impossible. The existence of a structure with certain causal powers does not imply that an actual effect is determined to unfold, as this will depend on other intervening mechanisms. One example is the causal power or potential of a seed to sprout, at the real level. Whether the seed sprouts and flourishes or not depends on the contingent conditions of other factors such as availability of water, fertile soil and micronutrients, appropriate temperature, and sunlight. If the seed flourishes, Bhaskar calls this an unfolding event at the actual level of reality. As the seed may be located deep in a forest and far away from any human observer, the third question is to what extent and how humans are aware of the unfolding event. Our experience of actual events, including our perceptions and the knowledge we produce about what we experience, is the third, empirical level of reality. Bhaskar argues that we can experience and observe unfolding events, but our *knowledge* of these events is not an objective reflection of the world, it is produced and conditioned by our senses and cognitive abilities (Bhaskar, 1978). Science is a social process aimed at production of knowledge, which allows us to have changing knowledge of unchanging objects (Bhaskar, 1998).

3.1.2 Epistemology

The epistemological stand of critical realism is that humans only have direct access to the empirical level of reality which consists of perceptions and interpretations of observed actual events (Sayer, 2000). Bhaskar dismisses the idea that humans can achieve direct access to the truth and can see the world truly objectively, as it really

is. He finds that any neutral, and objectively true description of what Kant calls the 'Ding an sich' is unattainable, or at least inaccessible to humans. He thereby refutes the extremes of both positivist and constructivist positions (Sayer, 2000). Positivism contends that objective, neutral and true scientific knowledge which corresponds to the external world is obtainable through empirical observation (Holt-Jensen, 1999; Aase & Fossåskaret, 2007). Constructivism assumes that no independent reality exists outside human minds, reality is instead created through the diversity of human concepts and practices (Hansen & Simonsen, 2004). Constructivism thus asserts that through creation of concepts and active engagement in the world, subjects create what they perceive as reality, and no other reality can be known to exist. In contrast, critical realism combines ontological realism, assuming the existence of an intransitive world, with epistemological relativism, that our knowledge about this world is produced and fallible (Bhaskar 2010) and acknowledges that social structures also exist at the real level. They are pre-existing to any individual being born, but individuals can engage in reproducing and transforming such structures (Bhaskar, 1998; Sayer, 2006). One example is the caste system. Although it has been socially constructed over time, it is real in the sense that new generations are born into it, acting in some ways and not in others because of caste divisions. Since ideas and discourses are influential in shaping societies and motivating people's actions (Sayer, 2006), critical realism ascribes causal powers to human reasons and intentions (Yeung, 1997). Social structures and actual social events must be interpreted and understood; their meaning cannot be measured objectively (Sayer, 2000).

All four papers implicitly rest on this epistemological position. Papers 1 and 2 map out the present range of *potential* production choices within certain thresholds, emphasizing uncommitted potentialities for change in the system. To do so implies an assumption about the existence of real level structures for what is possible and not possible to cultivate in these farming systems. For instance, there are altitudinal and climatic limits for cultivation of rice and maize, and seasonal water scarcity puts constraints on the amount and composition of crops. Still, while analyses of flexibility in terms of "uncommitted potentialities for change" (Bateson, 1972, p. 497) emphasize the range and constraints of structural possibilities, the observable,

actual outcome of farming depends on the farmers' choices and efforts, given the resources and opportunities available to them. Papers 1 and 2 therefore acknowledge that existing potentials are not necessarily realized and that the farmers themselves are the managers of their farm systems. The adaptive capacity lies in the ability to utilize the existing opportunities for change when needed, by making use of available capacity to rearrange productive factors, and by employing the options that are available, but currently not in use. The range of cropping options available to the farmers, which I call the opportunity situation, differs from the actual, observable practices that are employed at any given point in time.

Papers 3 and 4 follow up on farm management by going further into investigating people's intentions and reasons for the choices they make and the practices they sustain. These two papers seek a deeper understanding of the decision-making process in farming households, both between husband and wife in paper 3 and for the household as one economic unit in paper 4. I show how household decision-making is a socially intertwined process. It is to a large extent related to cultural norms for what is considered socially appropriate behaviour for women and men, and the choice of cultivating for subsistence or for the market has consequences not only for the households themselves, but also for the functioning of reciprocity-based social security systems in the community. Social and cultural structures thus play a role in household decision-making regarding farm management. I seek to investigate this relation and explain how farm management is related to cultural norms in paper 3, and to two production logics, for subsistence and for the market, in paper 4.

The phenomenology of Berger and Luckmann (1966) emphasizes how we perceive things as they appear to us. Berger and Luckmann argue that social structures such as the caste system, feudalism or capitalism are constructed by humans, but once the social structures are institutionalized and habitualized, they become real, objective and hard to escape or ignore for new individuals in that society. Although social structures are originally constructed, once they are established, they become parts of an objective reality for each person who must accept their existence in society.

It is not obvious on which level of reality, in Bhaskar's terms, Berger and Luckmann consider the social structures to exist. On the one hand, their main interest is how the social world becomes real *to the individual*, in his/her perceived world of phenomena, which in Bhaskar's model is the empirical level of reality. In that case, their attempt is not to search for conditions and causality in the intransitive sphere, at the real level of reality. On the other hand, Berger and Luckmann discuss how socially constructed norms, rules and institutions *become real* social structures, which an individual is born into and must relate to. In that sense social structures may be interpreted as real level structures (thus equally structural as physical or biological ones) with contingent outcomes at the actual level, that we can observe empirically. Some, but not all critical realists consider social structures as no less real than, for instance, the biological growth potential of seeds (Sayer, 2000).

Bhaskar (1998) criticises Berger and Luckmann's model of human/society interaction for repeating the errors they try to avoid. The critique is comprehensive and will not be repeated in full here, but of relevance for the present discussion is the following: Even though society is there *prior to* the individuals being born, this is not the same as saying that society exists independently from them, as society would not exist without human activity and interaction. Furthermore, individuals do not create society, they reproduce or transform it, through conscious and unconscious practices. Bhaskar argues that people and society are not related dialectically, they do not constitute two parts of the same process because they refer to two radically different kinds of thing. While humans act with purpose, intentions and self-consciousness, their actions often have the unintended consequence of reproducing many of the social structures that govern their behaviour. Bhaskar thus distinguishes clearly between human actions, which are motivated by people's intentions, purposes and reasons, and the structures governing the reproduction and transformation of social activities.

In paper 3, I follow this line of thought in arguing that cultural norms are social constructions, but they become a social reality for any one individual living in that society. Culture is defined as an historically transmitted pattern of meanings that are

symbolically expressed, an abstract set of control mechanisms for the governing of behaviour (Geertz, 1973). I interpret Ortner's (1990) concept of a gender hegemony as referring to norms for behaviour, the relative dominance of some cultural logics, meanings and practices related to gender, over others. Analytically, I identify the abstract set of norms and rules that regulate gendered social behaviour in a society and analyse how people relate to these norms through social practices. The analytical approach builds on a distinction between different levels of abstraction and a critical realism position on the role of abstract theories in understanding the non-observable structure of causal mechanisms, including people's intentions and reasons for their action.

3.2 Abstraction

Since we only have direct access to the empirical realm of reality (Bhaskar, 2010), any human knowledge of the underlying causal powers, contingent conditions and mechanisms, as well as their actual unfolding events are therefore confined to abstract theories (Hansen & Simonsen, 2004). The main purpose of abstraction in critical realism is to construct theories that can explain structures and mechanisms at the real and actual levels, through building theoretical models and using the logic of metaphor and analogy (Bhaskar, 1998). To do so requires repeated alternations between the concrete, empirical world and the world of abstract theories, while making sure not to lose touch with the reference to the empirical world when constructing abstract explanatory theories (Solheim & Sørhaug, 2005).

The contingency in open systems makes empirical outcomes of causal structures indeterminable: a specific observable event can be the result of many different causal structures, and one causal power can cause a variety of different observable outcomes (Hansen & Simonsen, 2004). Since complex social-ecological systems are open, contingent and contextually variable (Sayer, 2000), the actual outcomes are not predetermined, but after an event has occurred, we can use logical reasoning and

abstractly seek to understand which mechanisms and contextual factors that were in play. The search for necessary and contingent conditions that enable a certain event to happen is an important part of knowledge production.

Applying an analytical farming system model (Turner & Brush, 1987) as I have done in papers 1 and 2, involves defining a set of crucial variables which are causally interlinked in such a way that changes in one variable leads to changes in the others. The system variables are often structured in terms of 'factors of production', which in farming mainly consist of cultivated land, water, forests, pastures, livestock, and farmers/household. External parameters that influence the system (Norman, 2002) are for instance seeds, fertilizers, money, markets and roads, as well as political and economic conditions. Important causal links in the system are identified: for instance that the farmer invests her labour in cultivation and obtains good yields in return; she gives the crop residues to the livestock, collects fodder in the forest or lets the livestock graze in the pastures, while they provide manure which in turn maintains soil fertility. Or, crops are sold, and fertilizers are bought, which reduces the need for animal manure and thus for fodder.

The abstract and simplified though contextually adjusted model presents the variables in the format of a system that is managed by the farmer(s) with the intention of producing agricultural outputs. The relations between the system variables are theoretical assumptions of contingent causal relations, while the resulting observable events occur, in Bhaskar's terms, at the actual level of reality. The farming system possesses potentials for producing food, but as the system is open and contingent, unexpected intervening mechanisms such as a severe pest outbreak or drought can result in an actual outcome of little or no edible yields. By means of our senses we can observe and interpret one actual event (e.g., sowing of seeds) and another (yields) as being correlated, but we can only theorize – with basis in logic and previous experience – about the real level causality leading from the first event to the second. In other words, causality as such cannot be observed empirically.

A different view is presented by Vayda (1983; 1996) who proposes the progressive contextualization of empirical events by following threads of causality outwards in

space and backwards in time. In studying events, activities and people—environment interactions instead of systems, he avoids making a priori definitions of the boundary of the complex under study, and any stable, causal relations between system variables (Vayda, 1983). Vayda seeks to trace the causes rather than the effects of observed events. He argues that it is possible to follow threads of causation empirically in space and time (Vayda, 1996). His view deviates from critical realism, which asserts that our knowledge of structures and causal mechanisms are only accessible to us through abstraction, on a higher[8] level of logical abstraction than that of empirically observable events. On an abstract level, it might be possible to search for both the causes and the effects of an observed event, but not at the empirical level of reality. However, Vayda is in accordance with critical realism regarding possibilism: he recommends pursuing rather than analytically neglecting surprising elements and turns of events. Possibilism in critical realism means that the empirically observable outcomes of causal structures depend on contingent conditions and are not predetermined, but once an event has occurred, we may seek to understand which causal structures and mechanisms were at play and which context-specific conditions that enabled this particular event to unfold. This type of knowledge is transferrable from one specific event to the next, and to acquire such understanding demands a shift to a higher level of abstract reasoning.

I therefore follow Gobo's (2004) methodological recommendation to search for transferability of general structural features, which allows one to not always being concerned with the empirical representativeness of the studied sample and the empirical generalizability of the results to a larger population. Gobo suggests that we seek general knowledge of the nature of a process by searching for similarities across empirical variations, by means of abstract concepts and categories.

[8] Bhaskar occasionally describes the real level as 'deeper' than the actual and empirical levels, thereby structuring his theory by means of a vertical metaphor where abstraction is to reach deeper down, under the surface. Bateson and Solheim, however, use the opposite vertical metaphor, where abstract thinking occurs at a *higher* level than the empirically observable world. To avoid confusion, I here follow Bateson and Solheim in representing the abstract level as higher than the empirical level.

To see similarities and patterns across empirical variations requires thinking at multiple levels of abstraction (Bateson, 2002). According to Solheim,

> "The fundamental property of similarity consists of being an *abstraction* from the bodily and concrete. To present something as "similar" to something else is to ignore the substantial physical properties and differences – the concrete forms of appearance of things. The differences do not disappear (…) but are suspended in favour of another level of meaning – a *meta-level* where similarity is precisely established "in abstracto". Thus, similarity exists in principle only as similarity *between* something, presupposing that difference prevails – on another level." (Solheim, 1998, p. 86, my translation)

Solheim draws on Bateson's (1972, 2002) distinction of a hierarchy of logical types, for instance the distinction between the map and the terrain or the difference between a class and its members. Bateson encourages us to think abstractly about observable world phenomena and look for the patterns which connect them, to look for similar shapes, forms and relations between parts (Bateson, 2002). Similarity and difference exist simultaneously, at different levels of abstraction. That something is similar to – as contrasted to identical with – something else requires that differences continue to exist at another level. To see similarities and patterns across differences in appearance involves shifting the level of meaning through a representation of the concrete in an abstract category (Solheim, 1998, 2008). Furthermore, levels of logical abstraction from the concrete to the general are not continuous, but instead discrete levels of logical types[9] (Bateson 1972, in Solheim, 1998).

Paper 3 builds on these ideas and argues that a set of cultural norms exists at a higher level of abstraction from the concrete, observable behaviour that people practise in their daily life. Cultural norms are here defined as one of the abstract control

[9] Bateson does not, to my knowledge, relate his theoretical reasoning on levels of logical abstraction to critical realism. Nor am I aware of any reference to Bateson in Bhaskar's writings. There are, however, some quite striking similarities in the ways that they both reason about abstract thinking at different levels. The two theories are not identical, but there are similarities between them – similarities across differences.

mechanisms for the governing of behaviour, a part of the patterns *for* behaviour (Geertz, 1973). People can choose to comply with or to oppose cultural norms, they can even be unaware of the existence of such norms and act accordingly. To violate a rule does not automatically change the rule. Cultural structures concerning gender relations must therefore be distinguished from the actual social practice of men and women; they exist at different levels of abstraction.

Likewise, in paper 4 I define two general categories of production strategies which differ in terms of the underlying motivation and purpose of cultivation: A subsistence logic aimed at fulfilling the household's and the community's needs, and a market logic aimed at making profit. The two logics are abstract concepts describing different priorities and purposes, which can make us understand the farmers' actual cultivation patterns. However, as I demonstrate in the paper, in practice people often combine the two logics by simultaneously cultivating for subsistence on a large part of their land, while cultivating cash crops on a smaller part. By distinguishing concepts at different levels of abstraction, the analysis alternates between the abstract production logics and the empirically observable practice that is the outcome.

The analyses of flexibility in papers 1 and 2 also refer to two levels of abstraction. By defining flexibility as uncommitted potentialities for change, I refer precisely to the structural conditions which enable certain events to happen, while disabling other events: Given the current climatic and altitudinal conditions in Maina Pokhari it is possible to change crop from maize to tomatoes, but coconuts are not viable. It is possible to obtain one annual yield of paddy, not three as in a tropical environment. Although it is structurally possible to obtain good yields of maize, tomatoes and rice, crop failure may also occur for various reasons as the system is open. Furthermore, each household cannot realize all potential options at the same time due to resource constraints, which I call upper and lower thresholds of tolerance that impose constraints to flexibility of scope. To identify the local opportunity situation is to reason at a higher level of abstraction than the observable, specific crop composition of each farm. The analyses of flexibility thus not only identify the current specific adaptations of each farming household, they also reason abstractly about the range of

possible adaptations in the system, the options that are available but currently not in use, and what the main constraints to these potentials are. This kind of analysis requires thinking at two levels of logical abstraction: the currently employed adaptations, and the available but uncommitted potentialities which constitute the adaptive capacity in the system.

In paper 1, the unit of analysis is the community farming system, while in paper 2, the primary analytical unit is a household farm system. There are two ways of looking at the difference between the concepts ‘farming system’ and ‘farm system’. The first way is to treat a farming system as an abstraction from more specific farm systems. Farming system then refers to a general type of agricultural production system that highlights similarities across differences among various farms. For instance, farm A cultivates only maize and millet in rainfed plots, while farm B cultivates buckwheat, chili, and garlic in addition to maize and millet. Farm C has large herds of livestock and grows rice on irrigated land, and only livestock feed on their rainfed land. Despite such variations, these and other farms are organized in similar ways and they grow different combinations of the same range of crops, among which a large share of the produce is grown for subsistence and the level of mechanization is low. They can therefore be described in general terms as a typical Himalayan hill farming system (Ashby & Pachico, 1987), which is a concept at a higher level of abstraction than single farm systems.

The second way is to look at farming systems and farm systems as concepts at different scales (Dixon & Gulliver, 2001). Explaining this distinction requires a brief theoretical discussion of the concept of scale and how I have treated scale analytically in the papers.

3.3 Definition of core analytical concepts

3.3.1 Scale

Being one of the foundational concepts of geography, scale has been used and defined in a number of different ways (Howitt, 1998; Haarstad, 2014). Various disciplines also have very different understandings of the same word, which has caused some confusion (Gibson et al., 2000). Broadly speaking, there are three approaches to scale in geography: Scale as size, scale as level, and scale as relation (Howitt, 1998). In the first understanding of the term, scale refers to the size, quantity or spatial extension of the studied phenomenon (Gibson et al., 2000). For instance, in Grønhaug's (1978) social field analysis, scale is defined as the number of people directly affected by an event and the reach of effects of that event in socio-space. Barth responds to Grønhaug and argues that scale is a property of systems, not of events, and defines scale as "*size* in the sense of both the number of members or parts, and the spatial extension." (Barth, 1978: 253).

Secondly, many approaches to scale emphasize scale as level in a hierarchy (Howitt, 1998). The terms level and scale are frequently used interchangeably (Gibson et al., 2000), often referring to governance levels such as local, national and global. The nature of the hierarchy implies that the higher levels are more important and more powerful than the lower levels (Howitt, 1998; Herod, 2011). However, Haarstad (2014) argues that scale cannot be simply replaced by level as scale is much more than a point in a vertical hierarchy of institutional arrangements. Gibson et al. (2000) distinguish scale from level by defining levels as the units of analysis that are located at the same positions on a scale.

Thirdly, a relational view of scale redirects the focus away from discrete and taken-for-granted scalar categories or levels, and instead looks at how particular scales are only meaningful in relation to other scales (Howitt, 1998). According to this view, scale is not treated as separate levels of governance that can be analysed in isolation. Scales are rather seen as "interconnected arenas produced and constructed by how we

act and think about them" (Haarstad, 2014, p. 88) or, similarly, defined as "deeply interconnected as part of a continuum of social existence and praxis, with each scale shaping others" (Herod, 2011, p. XV).

The understanding of scale as interconnected arenas relates to the debate on whether scales are material entities or mental constructs. As ontological and epistemological positions differ, there is no clear agreement on this matter (Herod, 2011), but Howitt (1998) warns against the naturalization of scalar categories to the extent where we think about them as physical entities, and not as concepts that have been deliberately constructed for analytical purposes. All concepts are constructed, even simple concepts which represent something tangible and empirical, such as 'stone'. Since representations can never be the thing itself, all writing relies on metaphors and abstractions to communicate, and even more so when it comes to complex concepts such as 'system' or, for that matter, 'scale' (Howitt, 1998; Bateson, 2002). It is fully possible to treat scale as an analytical category without having to ascribe scale a status as ontological reality (Moore, 2008).

Disagreement has also arisen on how processes and events should be framed in terms of scale. Some argue that what is often considered global could just as well be framed as multi-local, and suggest that the scale concept should be eliminated from human geography (Marston et al., 2005). Others argue that the global scale is still a relevant category and that global scale processes are not reducible to local events, since to neglect the global reach of certain processes could lead to unintended consequences (Jonas, 2006). Climate change is a relevant example of Jonas's argument, as greenhouse gas emissions in numerous localities throughout the world have climatic consequences even in the most remote regions of the world, for instance the polar areas. Still, Marston et al.'s (2005) argument is relevant when it comes to processes such as international labour migration. For the majority of Nepalese foreign migrants, their destinations are concentrated in the Middle East, India, Singapore, and Malaysia. It is then misleading to characterize labour migration from Nepal as a *global* process. In the papers, I refer to 'large-scale processes' as a general term for

all processes that occur at national or larger scales, which have direct or indirect impacts in the study area.

Some attempts have been made to connect discussions of abstraction and similarities across differences to scalar concepts such as micro, meso and macro or local and global. Local and global are occasionally mixed into discussions of agency and structure, where 'local' is conflated with difference, the concrete, and agency, while 'global' is linked to sameness, the abstract, and structure (Marston et al., 2005). Taylor developed a three-scale structure model where the micro scale of the urban is the domain of concrete experience, the meso scale of the nation state is the sphere of ideology, and the macro scale of the global is the scale of reality (Taylor 1982, in Marston et al., 2005). Haarstad (2014, p. 88) states that "scale helps us understand relationships between the specific and the general".

For the purpose of analytical clarity, I have distinguished between levels of logical abstraction and variations in scale. A shift to a higher level of abstraction requires meta-thinking *about* the subject matter, a shift to another level of meaning. The norms and rules that govern social behaviour are different from people's actions when they choose to adhere to or violate a norm, but the difference is one of logical abstraction levels, not one of scale. Levels of abstraction are discrete and not continuous, as I argue in paper 3. In contrast, I treat scales as a continuous range where scalar concepts and levels are defined for the purpose of the specific analysis, as argued by Howitt (1998). Without disregarding other uses of the term, I here apply Howitt's first understanding of scale as size. Scale is then one characteristic of a system or another unit of analysis, which describes its quantity and, when appropriate, spatial extension (Barth, 1978).

3.3.2 The scales of farm systems and farming systems

As all concepts, a 'farm system' is a representation, an analytical tool for describing a farming household's relations to and organization of their productive resources. Some factors are included as variables, others are treated as external parameters that influence the system, some are deliberately excluded from the analysis, and theoretical assumptions of important causal relations are made. Just as 'farming system' is an abstract concept, so is a 'farm system' an abstraction, a constructed representation of a system based on empirical observations. In the farming systems literature, the approach is applied at several scales: "the farm, the village, or a small area – as the unit of analysis" (Turner & Brush, 1987, p. 3). Arguing that the scale of the unit for analysis must be defined, Turner and Brush find that any scale between a household and an agroclimatic zone is appropriate for a farming system analysis. They suggest the village or community as a useful scale in the study of peasant systems (Turner & Brush, 1987).

In the papers I let the concept 'farming system' refer to the scale of a community or small area, while 'farm system' refers to the scale of the household and its farm. The community farming system is the focus in paper 1. The main analytical unit in paper 2 is household farm systems, but the paper also gives a description of the farming system in the whole study area. Farming systems and farm systems are here treated as concepts at the same level of abstraction, but on different scales.

The scale of a farm system is defined as the number of people in the household and the spatial extension of the farm, in line with Barth's (1978) and Gibson's (2000) definitions. This is the scale applied to the term 'household farm system' in paper 2. The scale of a farming system is, in this dissertation, defined as the number of household farm systems in the community and the spatial extension of their cultivated fields. In paper 1, the community of Jharkot consists of 62 households, living closely together in a village at the top of a hill, surrounded by their plots of cultivated land. There is a high degree of cooperation in the community regarding communal sharing of irrigation water, communal management of pastures and herding responsibilities, organized cooperation for tree logging for timber from the community forest and

numerous arrangements for cooperative work which makes the community farming system a relevant unit for analysis. In Maina Pokhari, however, the houses are much more spatially dispersed, each with its cultivated fields close by. Many of the plots are rainfed, while the irrigated plots receive water from many dispersed streams and creeks. There are several community forestry user groups which coordinate timber extraction from forested areas but herding and fodder collection is generally taken care of by household members individually. The study area covers a complex pattern of networks for common resource management with different spatial extent and boundaries: municipalities and wards, community forestry user groups, irrigation councils (*pani samiti*) and other councils. The household farm system is therefore the unit for analysis in paper 2.

Papers 3 and 4 concern decision-making strategies. Paper 4 focuses on the *household* as one economic unit, where the scale of the household is the number of its members. There are many complicating factors regarding how to define and distinguish households, as discussed in section 3.3.4. In paper 3, I focus on intra-household relations, especially between husband and wife but also between sons and daughters and their families, in how they manage their farm system. In these two papers, the scale of the unit of analysis is defined in terms of the number of persons, while the spatial extent is not a relevant characteristic in these analyses.

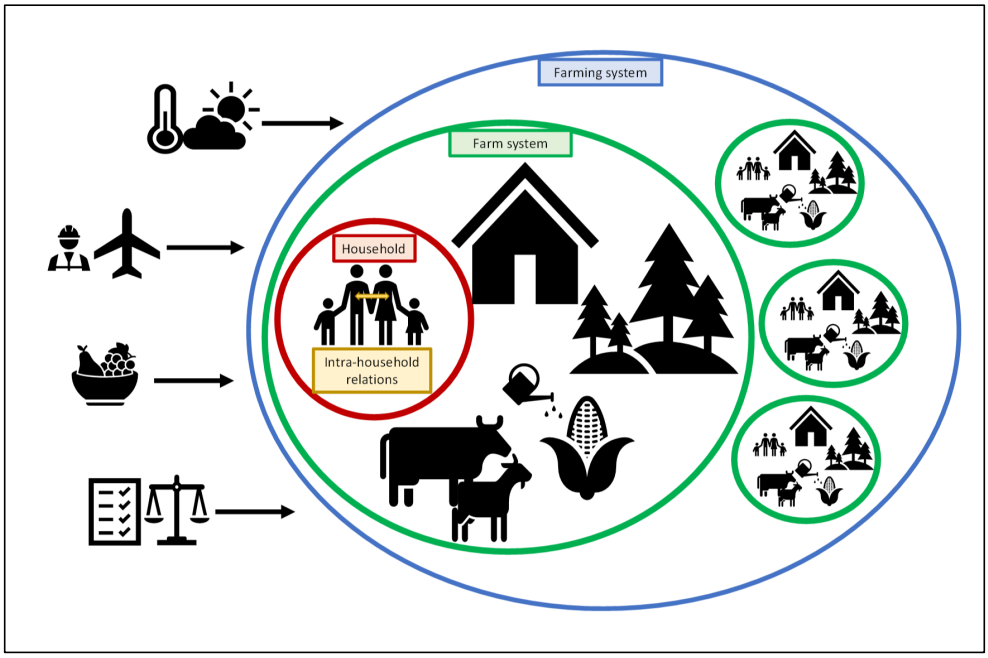


Figure 2: The scale of the principal units of analysis in the four papers. Climate change, labour markets and migration patterns, food markets and laws and policies are defined as parameters outside the analytical scope and are considered only in terms of their local impacts.

3.3.3 Functional region

In line with the discussion above on the understanding of scale as size, I have chosen to avoid the easily taken-for-granted assumption that the local governance level, the municipality, is the most natural and useful unit of analysis. Instead, I investigated what an empirically relevant spatial demarcation of the study area would be, finding that the use of Maina Pokhari as a primary market and transport nexus was common for all households within approximately 2.5 hours' walk from the village. I label this unit a functional region. The study area is thus defined in relative space, the walking distance, and not in absolute space or kilometres[10]. The local topography makes some

[10] No official population statistics were available for the area covered by the functional region. The population figure included in paper 2 (p. 154) therefore includes all inhabitants in the two municipalities Kavre and Chhetrapa. The actual population of the study area, the functional region, is smaller.

areas within the functional region unsuited for habitation and cultivation due to great steepness, shadowed areas, dense pine forests and other natural barriers, while other areas are easily passable. The demarcation of the field area on the map (page 14) is therefore an approximation.

Local innovation in agriculture is discussed in paper 2 and innovation is here defined in relation to scale: New crops and farming practices are innovations when they are locally new, irrespective of whether they are new to the world (which would make them inventions) (Mytelka, 2000). 'Locally new' here refers to being new in the functional region.

3.3.4 Household

'Household' is a widely used analytical category, although precise definitions of the term are not easily found. Despite great efforts to make a universally applicable definition, agreement has not yet been reached (Netting, 1993; Agergaard, 1999; Aase et al., 2019). The role of family and kinship in joint and individual decision-making within households varies greatly between different cultures (Agergaard, 1999) and, even within one culture, a complex and fuzzy reality complicates any clear-cut definition of households as analytical units (Aase et al., 2019).

In classical peasant economic theory, the household is an organized group of people who are often, but not always, in the same family, and where the household is a decision-making unit regarding production, distribution and consumption (Melhuus, 2018). The defining criteria here are thus joint decision-making and pooling of resources. Other frequently used criteria for defining household members are those who usually reside together and/or eat from the same kitchen, as defined in Nepali and Indian population censuses (Aase et al., 2019). However, the role of the household in decision-making regarding production, consumption, joint asset management and migration is not clear cut. Agergaard (1999) challenges the assumption that the household can be treated as one strategic decision-making unit, as this assumption suppresses intra-household differences and conflicting interests

among household members. Furthermore, while households are based on some kind of family and kinship relation, they are also subject to continuous change due to life-cycle developments and changes in the social and economic context (Agergaard, 1999).

The high prevalence of domestic and foreign migration in Nepal further complicates the matter. Many labour migrants reside, work, and eat from the same kitchen as their fellow workers, but normally they do not belong to the same household. Their incomes are to a large extent shared with their families at home, to whom many labour migrants also return. They often own or have rights to inherit land and other assets in Nepal, alone or together with other family members. Many Nepali households are multi-sited, characterized by two-way migration patterns and a splitting of the household where young parents work in the city while grandparents and children stay in the village (Aase et al., 2019). Age-selective migration, an aging farming population and multi-sited households engaged in a wide selection of local and extra-local livelihoods now characterize much of the smallholding population in Asia (Rigg et al., 2016b). Many households are also in a natural transition phase, splitting up due to marriage and inheritance of land and other assets (Agergaard, 1999). Instead of searching for a universal definition, the great variations in household forms and functions should be acknowledged by determining empirically what a useful definition would be in each case (Agergaard, 1999; Aase et al., 2019).

In the household survey and in paper 4, I define a household as an economic unit owning land or other assets together. Individuals who are directly affected by decisions regarding the common property are members of the household (Aase et al., 2019). Sons are part of the household until they split the land or settle the inheritance. Daughters leave their parent's household when they marry, after which they become part of their husband's household and family. Married women are economically part of their husbands' households even if they occasionally return to their mothers' houses, their *maitighar*, for shorter and longer periods. If a woman divorces and returns to her *maitighar*, she becomes part of her parents' household again. Migrants are part of the household unless they marry and settle permanently in a new location,

upon which a transfer of land, gold, assets, or money will take place and a new household is established. Many of the migrants from Maina Pokhari are young, unmarried men who go to Kathmandu or abroad for work or studies for a limited period and later return to Maina Pokhari, as discussed in paper 2. Some migrants settle permanently in Kathmandu, Charikot or elsewhere and establish new households there.

3.3.5 Small-scale farmer

Several overlapping and closely related concepts have been used in the literature to denominate the large and diverse group of people who cultivate food at a small scale (Rigg et al., 2016b): Peasant (Chayanov, 1966; Scott, 1976; Popkin, 1979; Shanin, 1987), subsistence peasant (Waters, 2007), subsistence farmer (Wharton, 1971; Gautam & Andersen, 2016), family farmer (Lowder et al., 2016; Friedmann, 2019), smallholder (Netting, 1993; Rigg et al., 2016b; West & Haug, 2017), small-scale farmer (Thompson et al., 2019) or farmer (Brookfield, 2001; Aase & Vetaas, 2007). While the term 'peasant' is used to describe a specific economic type with a distinct rationality (Chayanov, 1966; Scott, 1976), which I discuss in paper 4, 'smallholders' are often categorized in terms of the size of their landholdings (Thompson et al., 2019). The upper limit of two hectares is often used, although the difficulty of assigning a simple criterion to what counts as "small" is discussed and acknowledged (Lowder et al., 2016; Thompson et al., 2019). While a two hectare farm in Europe or the USA is easily regarded as small, it is three times the average farm size in Nepal (CBS, 2013a). Overall, acknowledging that it is difficult to find one term that precisely describes this group of cultivators, Thompson et al. suggests the term small-scale farmers. This is the term I have chosen to use in the papers, alongside 'farming household' and the shorter 'farmer'. In paper 4 I discuss the distinct subsistence logic that is well described in peasant studies and peasant economic theory, and therefore, I also use the term 'peasant'.

3.4 Literature reviews and contributions to the research field

The four papers relate to some distinct and some related research fields. In the following sections, I firstly review the literature on climate change in Himalaya and the projected impacts of climate change for the study area. Secondly, I discuss relevant literature on climate change adaptation and show how this relates to flexibility, adaptive capacity, and sustainability. Gender research is already reviewed in paper 3, while subsistence production and peasant theories are reviewed in paper 4. Instead of repeating these reviews here, I end with a discussion of the role of small-scale farming in Nepal's national agricultural policy and strategy for rural development.

3.4.1 Observed climate changes in Himalaya

The Himalayan region encompasses a great diversity of climatic conditions and a vast topographical relief which has complicated historic climate observations and imposed uncertainty to future climate projections (Bolch et al., 2012). Recent efforts to improve observational procedures (Maurer et al., 2019) and model accuracy for projecting impacts (Lutz et al., 2014) have however contributed to reduce scientific uncertainty.

Observations show that surface air temperatures in the Himalayan mountains have been rising over recent decades at a rate of 0.3 °C (±0.2 °C) per decade, which is faster than the global average rate of warming (Hock et al., 2019). Accelerated warming has caused significant reductions in Himalayan glaciers[11], snow cover and permafrost (You et al., 2017). Although there are regional variations, satellite analyses of the whole Himalayan range show significant ice loss over the last 40 years, where the ice loss between the years 2000 and 2016 has been twice as large as the loss between 1975 to 2000 (Maurer et al., 2019). Compared to the ice mass

[11] Glaciers are losing mass in most parts of the Himalayas, while stability and even mass gains are observed in parts of the Pamir and Karakoram ranges (Lutz et al., 2014).

present in 1975, 28% was lost by 2016, among which the loss was greatest at 4000 meters above sea level where mean ice thickness was reduced by more than one meter per year (Maurer et al., 2019). Changes in water availability, especially changing seasonality of river flows and shifting monsoon patterns, have also been observed in Himalaya (Xu et al., 2009; You et al., 2017). There is great natural variability in rainfall during the South Asian summer monsoon season, but the variability has further increased over the last 70 years and now includes more frequent dry spells and greater intensity in wet spells (Singh et al., 2014).

Projections for future impacts of climate change in Himalaya concern mainly two processes: Firstly, how rising global average temperatures will impact regional temperatures and consequentially the dynamics of snow, ice, and meltwater runoff, and secondly, changing precipitation patterns.

3.4.2 Impacts of projected warming on snow, ice and meltwater

The IPCC Special Report on Oceans and Cryosphere in a Changing Climate states that continued rise in temperatures of 0.3 °C per decade and a decline in lower elevation snow depth by 25% is projected until the mid-21st century, regardless of emissions scenario (Hock et al., 2019). Under a high-emissions scenario (RCP8.5)[12], reductions in snow depth or mass of up to 80% are expected by 2100 for elevations up to 3500 meters, while a low-emissions scenario in line with the Paris Agreement goals (RCP2.6) projects reductions of 30%. Interannual variability of snow conditions will continue and there is high confidence that glaciers in the region will lose substantial mass by 2100. By the end of the century, Hindu-Kush Himalayan glaciers are projected to lose 40% of the mass they had in 2015 under a low-emissions scenario (RCP2.6), and as much as 65% under a high-emissions scenario (RCP8.5) (Hock et al., 2019).

[12] RCP: Representative Concentration Pathways, used in the IPCC Fifth Assessment Report.

For high-mountain communities who depend on meltwater for irrigation, the availability of runoff from ice and snow is predicted to first increase during melting and subsequently decline with reduced glacier and snow masses (Xu et al., 2009; You et al., 2017; Hock et al., 2019). In high-mountain Himalaya, farmers' dependence on meltwater is greatest in the spring and autumn, outside the monsoon season (Xu et al., 2009). Changing amount and seasonality in snow-dominated and glacier-fed rivers have implications for agriculture in such regions (Hock et al., 2019).

These projections are of direct consequence for the case study area presented in paper 1, the village Jharkot in Muktinath Valley, Lower Mustang (3550 masl). Lying in the rain shadow of the great Annapurna mountain range, the area is semi-arid, and cultivation is fully dependent on irrigation from seasonal runoff of snow and ice masses in the adjacent mountains. The two main bottlenecks to cultivation are the short growing season in the cold, high-mountain environment, and availability of enough irrigation water in the spring. The paper analyses the current flexibility and constraints in the farming system and argues that although there is considerable capacity to adapt to climatic and market variability in the farming system, a crucial limit to the system's flexibility is future changes to local availability of irrigation water.

Downscaled climate projections were not available for the study area and given the great variations in local climatic conditions in this region, the prospects for future water availability for this site is uncertain. However, the paper concludes that the regionally projected impacts of climate change, with accelerated melting of ice and snow and more precipitation falling as rain instead of snow during the winter, indicate changes in amount and seasonality of local water supply that may be too comprehensive to be solved by local adaptation measures. Combined with uncertain local changes in the amount and seasonal distribution of precipitation, the regionally projected changes in water availability represent a great risk for future food production and for farming as a viable livelihood in this high-mountain community (Holmelin & Aase, 2013).

The IPCC Fifth Assessment Report (Hijioka et al., 2014) and the IPCC Special Report on Oceans and Cryosphere (Hock et al., 2019) include new research and projections that were conducted after paper 1 was published. The evidence is now even stronger, with more precise estimates of the magnitude of rapid and substantial melting of ice and snow and changing seasonality in meltwater runoff in Himalayan mountains. More precipitation will fall as rain instead of snow, and glacier melt will likely reach peak water, meaning first more runoff during melting and then drastically less meltwater runoff when the glacier is decimated (Hijioka et al., 2014; Hock et al., 2019). Unfortunately, the new knowledge does not improve the outlooks for future water availability for communities like Jharkot.

3.4.3 Changing precipitation patterns

Changes in precipitation patterns and extremes are projected for Himalaya this century, but future precipitation trends and seasonal variability remain uncertain and variable depending on the location (Xu et al., 2009; Immerzeel et al., 2013; Lutz et al., 2014). Hindu-Kush Himalaya may see an overall annual increase of precipitation of between 5% and 20% by 2100 as compared to today, but with great variations among regions and over seasons (Hock et al., 2019). Increasing intensity of rainfall episodes and more extreme precipitation is also projected, especially during the monsoon which will likely become more episodic (Hijioka et al., 2014; Hock et al., 2019). Future impacts of climate change will also increase the prevalence of insect attacks, pests and invasive species as habitats change and they migrate upslope into expanded habitats (Rosenzweig et al., 2001), a problem which is already experienced by farmers in Nepal following warmer local temperatures (Thorn, 2019).

Global and regional climate projections can be downscaled to smaller grids on the map to better account for the great spatial and altitudinal differences in natural climatic conditions. However, a drawback of downscaling climate projections is that the model uncertainty increases with decreasing scale of the grids (Fordham et al., 2011). HICAP has developed downscaled climate scenarios for selected domains of

the Hindu-Kush Himalayas based on historical daily precipitation and daily maximum and minimum temperatures (for details, see Bhatt et al., 2014). The projections follow a medium-emissions scenario (RCP4.5) leading to an average global warming of 1.7–3.2 °C and a high-emissions scenario (RCP8.5) leading to 3.2–5.4 °C warming by 2100. The scenario baseline period is 1996–2005, for which model output was compared with temperature and precipitation datasets from different sources (Bhatt et al., 2014), and projections are modelled for three future time periods: 2010–2030, 2030–2050 and 2050–2080. The projected change in daily minimum and maximum temperatures and in precipitation for selected model domains, among them one that covers the Middle Hills of Nepal, have then been bias-corrected, adjusting the *levels* for the reference period to match local meteorological data for specific field sites, but leaving the modelled *changes* for 2010–2080 and changes in seasonal pattern intact (van Oort, 2014, 2017). In this way, the projections better matched local conditions in terms of current temperature and precipitation levels, while the relative change matched those projected by the model. One of the site-specific downscaled projections was for Maina Pokhari.

The great altitudinal differences over short distances that are characteristic for Himalaya represent a challenge in making climate scenarios relevant for analysis of specific places (van Oort, 2014). Since absolute temperatures are heavily dependent on elevation, climate projections for the Middle Hills domain are adjusted to two different elevations for Maina Pokhari which represent slope (1500 masl) and ridge (2100 masl)[13]. The projected *relative change* in temperature and precipitation, including seasonality and extremes, are the same for the whole Middle Hills domain. Adjusting in this context means to add the relative change projected for the future to the absolute current climate of a specific site, which is extrapolated from data from the nearest weather stations of similar altitudes and adjusted for altitude based on statistical relationships between elevation and temperature (minimum and maximum)

[13] Note that the downscaling adjustment does not take into account whether the location is a slope, with slope-specific characteristics that differs on lee side and windward side, or sun exposed and shadow side of the mountain, or whether it is a ridge which may be more wind exposed, but only takes into account the elevation.

and precipitation respectively. The use of dynamic and statistical downscaling methods, as well as the assumptions made and uncertainties involved, are described in more detail elsewhere (van Oort, 2014, 2017) and will not be elaborated on here. The methodology enables analyses of what projected climate change would look like for specific places which, when combined with knowledge on optimal and suboptimal climate conditions for crops or with local geography, allows for drawing some tentative conclusions on how cultivation zones and snow lines would shift, or how water availability or flood risk may change (van Oort, 2014).

Paper 2 applies these projections in the analysis of how the current cropping pattern may potentially be affected by future climate change, while accounting for the uncertainties arising from the modelling exercise and the uncertain course of future global greenhouse gas emissions. Scenarios, per definition, must be considered as possible futures and not as certain predictions (van Oort, 2017). The RCP4.5 and RCP8.5 projections show very similar temperature changes until 2050 and diverge only after the mid-century with RCP8.5, the high-emission scenario, showing the greatest temperature increase. Paper 2 uses projections based on RCP8.5 when referring to the long-term, 2050–2080. Despite three decades of climate negotiations and five cycles of IPCC Assessment Reports, global CO_2 emissions are still growing, and current national policies put the world on a pathway of continued increasing greenhouse gas emissions through 2030 (Peters et al., 2019). Both current emission trends and trends corrected for national mitigation pledges present a large gap with the emissions reductions needed to reach the Paris Agreement of limiting global warming to well below 2 °C, preferably below 1.5 °C and reach net-zero emissions by 2050 (Peters & Geden, 2017). A high-emissions scenario is therefore, unfortunately, not an unrealistic outlook for the future.

For Maina Pokhari, less total rain is expected especially after 2050, and the seasonal distribution of rain is likely to shift. Significant uncertainty is connected to how the monsoon pattern will be affected and greater variability in monsoon onset and intensity must be expected, but the projections show a decrease in the total amount of monsoon rain, a larger risk of extremely wet days and a prolongment of scattered

rains throughout the autumn. Such changes involve new challenges for the main rice crops. Greater variability in monsoon onset makes it difficult for the farmers to know when to plant and transplant rice, and more scattered rain throughout the fall prevents ripening and good grain-filling of the crops. On the positive side, more rain in January and February combined with higher temperatures could facilitate more winter cultivation of vegetables. On the negative side, however, the projected slight reduction in the spring rains could aggravate the current problem of spring drought. In 2050–80 the temperature is projected to rise by 2 ℃ during daytime and 3.2 ℃ during the night, with seasonal variations that include a temperature increase of as much as 3.2 ℃ (daytime) and 5.3 ℃ (night-time) in October and November (van Oort, 2017).

Higher temperatures may enable rice cultivation higher up the slope than today. In 2010–2030 the current crops in Maina Pokhari can probably be grown at nearly 200 meters higher elevation and in 2030–2050, 325 meters higher following rising temperatures (Aase et al., 2017). However, even for the low-emission (RCP4.5) scenario, at 1500 meters the monthly average day temperature will approach 30 ℃ in the summer with increased risk of certain days crossing this temperature threshold. Historical yield trials from Africa show that for each degree and each day spent over 30 ℃, maize yields were reduced by 1% given sufficient irrigation and 1.7% under drought conditions (Lobell et al., 2011). Although some maize varieties are more heat tolerant than others, drought severely reduces the plant's tolerance for heat stress (ibid.). Given the outlooks for a drier spring and early summer in Maina Pokhari, maize cultivation in the summer is likely to suffer under future climate change impacts, especially in the lower part of the slope.

From projected impacts of climate change, I now turn to a brief overview of the climate change adaptation literature.

3.4.4 Climate change adaptation

Adaptation to changing environments has always occurred in social-ecological systems. For millennia, farmers have adapted their cropping patterns to the ecological conditions and climatic variability in the place where they live, which has resulted in a vast variety of farming systems worldwide (Turner & Brush, 1987). Much of the early ethnographic research from Nepal described the diversity of ecological and cultural adaptations among ethnic groups in Nepal and Trans-Himalaya (von Führer-Haimendorf, 1975; Messerschmidt, 1976; Guillet, 1983). Adaptation is implicit in much work within the political ecology field, where the relationships between ecosystems and political economy are seen as adaptive management of risks related to power relations, resource use, and global economies (Blaikie & Brookfield, 1987; Smit & Wandel, 2006). Over the last thirty years, adaptation has become a core concept in the climate change literature, often related to discussions on vulnerability, adaptive capacity and, lately, transformation (Bassett & Fogelman, 2013).

The framing of climate change adaptation research has evolved from an initial focus on biophysical and technical adjustments in response to projected climate change impacts. Changes to more drought resilient crops, changes in irrigation and farm infrastructure, and upward extension of the farmed area in mountain regions are in focus in the first assessment report of the IPCC (Tegart et al., 1990). This approach is often referred to as “impacts-led”, “end-point”, or “outcome” conceptualization of adaptation (Bassett & Fogelman, 2013). With the acknowledgement that people and places are also exposed to global processes of change other than climate change, there was a redirection of attention towards how multiple stressors interact, influence vulnerability, and create new winners and losers (O'Brien & Leichenko, 2000; Leichenko & O'Brien, 2002; Smit & Wandel, 2006). The understanding of vulnerability as a function of a system’s exposure to climate change impacts, its physical setting and sensitivity, and its adaptive capacity was established (Adger et al., 2003; Smit & Wandel, 2006; IPCC, 2007). The importance for adaptive capacity of trust, reciprocal action, and societies’ ability for collective action was also emphasized (Adger, 2003). In this context, adaptations are understood as

manifestations of adaptive capacity, which represents ways of reducing vulnerability (Smit & Wandel, 2006).

Adaptive capacity was defined by the IPCC in 2007 as "the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (IPCC, 2007, p. 869), a definition that has prevailed in later reports (Jones et al., 2014), and which is how I define adaptive capacity in this dissertation. As I argue in papers 1 and 2, flexibility of scope, type and temporality represent one way to study the capacity of farming and farm systems to adapt to uncertain and variable climatic and market conditions. The flexibility of a system consists of the buffers of unused capacity, the full range of uncommitted potentialities, and the ability to rapidly adjust production. Adaptive capacity is closely related to a range of other concepts besides flexibility, such as adaptability, coping ability, robustness and resilience (Smit & Wandel, 2006). The different concepts give slightly different approaches to the study of adaptive capacity. Among the many possible approaches, I have chosen the theoretical angle of flexibility, which is discussed in subsequent sections (3.4.5 and 3.4.6).

The concept of adaptation has become "slippery" in the sense that it is broadly interpreted with numerous definitions in the climate change literature (Pelling, 2011, in Bassett & Fogelman, 2013). Generally speaking, however, adaptation refers to a process, action or outcome in a system "in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity" (Smit & Wandel, 2006, p. 282). Adaptation actions can be anticipatory or reactive, autonomous or planned, directed at climatic and other environmental and social stresses (ibid.). It has been recognized that not every adaptation to climate change is in accordance with sustainable development pathways and that sustainable adaptation strategies involve attention to social justice and environmental integrity (Eriksen et al., 2011). The framing of adaptation research has thus moved from its initial focus on biophysical risks and exposure towards the social, economic and political drivers of vulnerability (Eriksen et al., 2015), people's ability to respond, and the importance

of flexibility and safety margins in the face of uncertainty (Noble et al., 2014). A full review of the literature on climate change vulnerability and adaptation is too comprehensive to be included here, but a thorough review and overview can be found in the IPCC Fifth Assessment Report (IPCC, 2014).

A distinction has been made in the adaptation literature between incremental and transformational adaptation to climate change (Kates et al., 2012; Park et al., 2012; Noble et al., 2014; Eriksen et al., 2015). The aim of incremental adaptation is to *maintain the essence and integrity of the system*, for instance through adjustments to cropping systems such as use of new varieties, changing planting times, or improved irrigation, while transformational adaptation means to "*change the fundamental attributes"* of the system in response to actual or expected climate and its effect (Noble et al., 2014, p. 839). Adaptations are characterized as transformational when they occur at a much larger scale or intensity than incremental adaptations, when they are truly new to a region or resource system, or when they transform places and shift locations (Kates et al., 2012). O'Brien et al. (2015) focus on the underlying factors that drive vulnerability and argue that there is a need for transformation of the processes that have contributed to vulnerability in the first place. In their view, adaptation is a social process that empowers individuals and groups of actors to challenge the drivers of risk and promote alternative pathways to development (O'Brien et al., 2015).

Most transformational adaptations are explicitly planned and implemented, but the distinction between incremental and transformational adaptation is not always clear-cut since incremental adaptation by many autonomous actors may also accumulate into what in retrospect appears as a transformational adaptation (Kates et al., 2012). O'Brien et al. (2015) recognize that the concept of transformation can be difficult to operationalize, but they argue for a broader and more holistic approach to adaptation that focuses on how adaptation processes may be transformed away from reproducing vulnerability and towards supporting climate-resilient pathways for sustainable development.

It is somewhat unclear what transformational adaptation towards pathways for sustainable development would mean in specific cases and different contexts, other than implying a fundamental change of the current system. For instance, Nagoda and Eriksen (2015) argue for transformational adaptation through a case from Humla, Nepal. They state that the causes of vulnerability vary between groups and individuals, and that distribution of food and seeds in this case has reinforced inequalities instead of reducing vulnerability. They argue for greater attention to local power dynamics to better target adaptation and food security interventions and to avoid deepening dependency and inequality. However, Gautam (2019) disputes the narrative that food aid creates dependency among food-insecure Nepali households. Gautam shows, also through a case study from Humla, that the local farmers have maintained diverse traditional crops and increased their crop diversity through local agricultural innovation, while receiving food transfers. Although the assistance programs could improve their targeting towards the most vulnerable households, terminating the food aid altogether would hamper the food access of many poor households and increase their vulnerability to food insecurity by removing an important safety net (Gautam, 2019). Thus, to transform existing adaptation and development programs could also come at a cost and produce new losers.

As stated in the introduction, the objective of this dissertation is to study whether and how it is possible to maintain local food production in rural Nepal. In paper 4, I show that there is a strong preference among people to maintain traditional cropping patterns alongside some investments in new cash crops, and to preserve established social systems for risk spreading, local labour exchange, and reciprocal sharing of resources. The goal of the farmers is to keep their farming system viable, productive, and with the ability to adapt to changing circumstances; they do not seek a transformation of the system which would involve a drastic change in the very fundamental attributes of the system. The kind of agricultural transformation that is currently being planned and implemented by the Nepali Government, which aims at commercializing 80% of all agricultural production in Nepal through regional specialization, mechanization and land consolidation (GoN, 2015), is not in the interest of the small-scale farmers and does not match their priorities nor their

intentions with agricultural production. While transformational adaptation might be justified and called for elsewhere, especially in societies with high per capita greenhouse gas emissions, it is not the focus of this dissertation.

Ensor et al. (2019) criticize current adaptation research for focusing too narrowly on the direct impacts of climate change on rural farming households, thereby overlooking the wider social, political, economic, and demographic processes of change that alter rural economies and livelihoods. They argue for an opening of adaptation research by asking which changes farming households are adapting to, what aspects of rural livelihoods they are adapting, and how adaptation needs are socially differentiated.

The approach to adaptation in the papers of this dissertation are in line with the suggestion by Ensor et al (2019). Social differentiation in terms of gender, wealth, caste, and education is the topic of paper 3. The local negotiation of norms for appropriate social behaviour of women and men occur in a context of men's out-migration, rising levels of education, national policies for increased gender equality, and establishment of loaning and saving cooperatives. Adaptation to economic risk and labour market uncertainty is in focus in paper 4, which also describes people's strategies for minimizing the risk of food insecurity. Paper 2 shows how the farming system is adapted to the environmental surroundings, which include altitude, wild animals, available forest and pasture resources, local water availability and the current climatic variability. The potentials for and limits to adaptation to projected local impacts of climate change is also analysed in paper 2, as one among several large-scale processes of change to which the farmers must adapt. International labour migration, alternative livelihoods, and the question of whether young people will return to the village are also discussed, which relate to the long-term temporal flexibility of the farming system.

3.4.5 Flexibility and adaptive capacity

Flexibility has been applied as a theoretical concept in various disciplines. In industrial economics, Carlsson (1989) highlights the need of business firms to be flexible in response to uncertain production environments. Carlsson distinguishes between operational, tactical and strategic flexibility, defining operational flexibility as the ability of the firm to switch quickly and cheaply between products in a short-term perspective; tactical flexibility as the ability to change production capacity and product mix over the course of several years; and strategic flexibility as the ability to change the firm's overall strategy for the future and reposition itself in the market in a long-term perspective. In agricultural economics, Weiss (2001) focuses on the competitiveness of small family farms and puts particular emphasis on the difference between flexibility to adjust the output volumes produced, and flexibility to switch productive capacity from one good to another through diversification. This difference has parallels in my distinction between flexibility of scope and type in paper 1. The distinction between short-term and long-term temporal flexibility builds on Carlsson's theory.

In system dynamics, De Leeuw and Volberda (1996) focus on flexibility in the management of organizations, arguing that flexibility is a characteristic of the dual control relation between the organization and its environment, which in their case consists of other market actors. They conclude that in a dynamic environment, flexibility is a requirement for a higher order of system stability. In project planning where decisions must be taken under uncertainty, Colombo and Byer (2012) find that to build in flexibility enables adaptation to climate change uncertainty. Various other analyses of complex systems generally refer to flexibility as a system's capacity for adaptation in a situation of uncertainty (Lev & Campbell, 1987; Golden & Powell, 2000; Dreyer & Grønhaug, 2004; Aase et al., 2010; David et al., 2010; Ingrand et al., 2017).

The importance of flexibility for adaptation to dynamic and variable environments has been highlighted also in analyses of small-scale farming systems (Niemeijer, 1996; Adams & Mortimore, 1997; Mascarenhas, 2001; Aase et al., 2010; David et al.,

2010; Andrieu et al., 2015). With particular attention to the temporal dimension of flexibility in farming systems research, Lev and Campbell define flexibility as "the relative capacity of the system to respond or conform to changing or new situations" (1987, p. 123). They note that the time horizon of the researcher does not always match the time horizon of the farmers who must make their decisions under uncertainty. Lev and Campbell further demonstrate that the extent to which a farming practice is flexible depends on the time horizon considered, meaning that a specific strategy might increase flexibility in the short run while in fact reducing flexibility in the long run, and vice versa. The latter point is confirmed by paper 1 where the conversion of plots from cereal crops to apple trees increases the temporal flexibility in the short-term, since it enables flexible redistribution of irrigation water and labour, the two major constraints in this farming system. However, apple trees occupy the land for many years and reduce long-term temporal flexibility by restricting the farmers' opportunity for changing back to cereals or other annual crops on that land. The farmers solve this problem through diversification, by only planting trees in parts of their land and keeping the rest for versatile annual crops. The farmers in Maina Pokhari manage their farm systems in a similar way when they prioritise annual cereal and vegetable crops on most of their land, as shown in papers 2 and 4.

Organic farmers in Europe choose the same strategy when they resist the pressure for specialization and intensification in the agri-business sector. Instead, they choose to diversify their products in order to spread the economic risk, thereby ensuring flexibility through retaining the capacity to reorganize the system (David et al., 2010). Ingrand et al. (2017) also find that the adaptive capacities of farm systems depend on how the farmer perceives risk and market uncertainty and highlight the importance of flexibility, which they define as the diversity of procedures and the speed at which they can be mobilized, for farm system adaptation under uncertainty. Farmers' perceptions of risk and uncertainty is discussed in paper 4.

3.4.6 Relations between flexibility, adaptive capacity and sustainability

The theoretical contribution of papers 1 and 2 to the literature on flexibility consists of an operationalised theoretical approach to analysing flexibility as adaptive capacity in farm and farming systems. Building on Bateson's definition of flexibility as "uncommitted potentialities for change" (Bateson, 1972, p. 497), I distinguish the three aspects flexibility of scope, flexibility of type and temporal flexibility and show how they are related. I argue that the potentiality for changing the degree of resource utilization and alternating between different crop compositions in short- and long-term perspectives represent the structural adaptive capacity in the system, which exists within the constraints of upper and lower thresholds of tolerance. The actual resource utilization and crop composition at any point in time are directly observable and represent the current adaptations of single farms.

The contention that flexibility is a requirement for a higher order of system stability (De Leeuw & Volberda, 1996), which I connect to levels of logical abstraction in section 3.2, finds support in Bateson's theorization about ecological systems: "Certain variables (…) must have great flexibility, which he uses to maintain the stability of other more fundamental and general characteristics." (Bateson, 1972, p. 498). Paper 1 (2013) argues that flexibility helps to ensure the general sustainability of small-scale farming systems under dynamic and uncertain production conditions, especially climatic and market variability. Recent research supports this argument and concludes that flexibility enables sustainability in farm systems facing economic and climatic uncertainty (Ingrand et al., 2017). In this context, as stated in paper 1, sustainability can be defined as the ability of a farming system to maintain productivity when subject to major disturbing forces or shocks (Conway, 1994; Mascarenhas, 2001).

Ensuring sustainability in farm and farming systems thus means to maintain their ability to function as agricultural production systems providing people with food and a livelihood, often in combination with off-farm activities. In a dynamic and uncertain environment, I argue that to preserve and increase farming flexibility can

contribute to the general sustainability of the system, and show through analysis how flexible adaptation at one level of abstraction can help maintain the essence and integrity of the system at a higher level. In this way, to create flexibility is to create preadaptation to unpredictable change (Bateson, 1972).

Keeping the farm system viable under variable conditions preserves the opportunity for young migrants to return to the family farm and local community, on occasion or permanently, after having sought education or work elsewhere. Since only a minority of the farming households in Nepal are self-sufficient from own production (CBS, 2013a), combining subsistence farming with market production and other livelihood is the rule rather than the exception, as I discuss in papers 2 and 4. What role small-scale subsistence farming plays in agricultural development and in rural households' adaptation under economic uncertainty is discussed in the following.

3.4.7 Agrarian change: The role of small-scale farming

Rural development policy in Nepal largely concerns the agricultural sector. A common economic argument for agricultural development in Nepal is the need to raise per capita productivity and increase the sector's contribution to economic growth in the country (Deshar, 2013; Dahal, 2015; Thapa et al., 2019). The argument underpins the current 20-year strategy for agricultural development in Nepal, the Agricultural Development Strategy (ADS), which describes the small-scale and subsistence-based agricultural sector as a barrier to economic growth and poverty reduction (GoN, 2015). The sector is here characterized as being in a low stage of development, lagging behind the economic growth rates seen in other Asian countries. The "weak growth performance" is in the ADS explained by a lack of specialization in commercial production, too small and fragmented landholdings, and low levels of mechanisation. In its outlooks for the coming decades, the ADS expects an economic restructuring to occur in Nepal: "Over the course of this period, the structure of the agricultural sector in Nepal will change considerably and agribusiness and non-farm rural activities will grow relative to agriculture." (GoN, 2015, p. 3).

The strategy presents a number of policy measures, indicators and targets for fulfilling the vision of an agricultural transformation in Nepal from subsistence-based agriculture to a sector where more than 80% of the production is commercialized (GoN, 2015). The transformation is to be implemented by means of a ten-year project, the Prime Minister Agriculture Modernisation Project (PMAMP), which introduces policies for replacing subsistence farms with specialized, large-scale, mechanized, and modernized agricultural units (Sharma, 2019). The project was launched in 2016 and includes policies for comprehensive land consolidation into large production pockets, blocks, zones and super zones ranging from 10 to 1000 hectares, and regional specialization in designated cash crops (Pokharel, 2019).

The ADS and the related PMAMP are not the first attempt at transforming the Nepali agricultural sector. In 1995, Nepal launched its first 20-year strategy, the Agricultural Perspective Plan (APP), which sought to raise agriculture's contribution to gross domestic product through Green Revolution technology. Between 1995 and 2015, the plan was to raise agricultural productivity and incomes, assuming this would free up labour and generate growth and employment outside agriculture. The plan is almost a replication of the classic dual economy theory of Lewis (Lewis, 1954; see also Ray, 1998). The APP rested on the assumptions that farmers were willing to take significant risks without insurance based only on technical advice from the State, that their motivation was to maximise marginal rates of return through market forces, and that they possessed an available surplus of women's time and energy (Cameron, 2009). It was envisioned that the farmers themselves would transform their farm systems from subsistence to commercial production, but by the end of the period it was evident that the vision was not nearly fulfilled (Sugden, 2009; Roka, 2017). Lack of attention to social inequality (Cameron, 2009) and uneven distribution of land and assets contributed to the plan's lack of success, which is acknowledged in the new ADS strategy (GoN, 2015).

While the APP attempted to push labour out of agriculture and over to industry and service sectors by raising productivity and making agricultural labour redundant, the new ADS strategy seeks to pull labour out of agriculture and into rural and urban

non-farm occupations through specialized commercialization, mechanization, and land consolidation. The ADS builds on an economic theory of agrarian change and rural development promoted by the World Bank (Sharma, 2019). It describes a structural transformation where strong economic growth in non-agricultural sectors will lead people to move out of rural areas and seek higher-paying work in urban industries and services (Li, 2009). According to the theory, higher incomes and fewer people employed in agriculture will lead to mechanization and a natural structural transition towards larger farms (Hazell and Rahman 2014, in Rigg et al., 2016b). The theory depends on rapid growth in the industry and service sectors and assumes that the experiences of Western Europe and more recently, China, are replicable in developing countries today (Li, 2009; Rigg et al., 2016b; Paudel & Waglé, 2019).

However, such a structural transition is neither automatic nor guaranteed (Paudel & Waglé, 2019). Although out-migration of youths from rural areas has increased exponentially over the last decades, Paudel and Waglé argue that a structural transformation has not occurred in Nepal. Out-migration and remittances have not contributed to build a strong industrial sector with high rates of economic growth. Instead, there is a transient, back-and-forth shift between agriculture, overseas employment, and tourism and informal services. People are not moving permanently out of agriculture; the number of farms in Nepal is increasing and the average land holdings is decreasing (Paudel & Waglé, 2019). A natural, structural transition towards mechanized, larger farms has thus not occurred in Nepal.

One could argue that overall economic growth is still low in Nepal and that the structural transformation has just not happened yet. Previous decades' population growth and equal inheritance rights to land for all sons have contributed to land fragmentation (see paper 2). Furthermore, there is no abundance of reliable, higher-paying jobs in the industry and service sector, as assumed by the structural transition theory. However, in many of the rising economies of South and Southeast Asia, mechanization and land consolidation into larger farms have not occurred either; to the contrary, smallholding farmers have continued to persist also here (Rigg et al., 2016b; Rigg et al., 2018). Between 1960 and 2000, average farm sizes have

decreased in India, Sri Lanka, Pakistan, Indonesia, Thailand, Philippines, as well as in Nepal (Lowder et al., 2016).

Through a case from Thailand, Rigg et al. (2018) explain this puzzle by showing how small-scale, subsistence-based farming is a livelihood that encompasses much more than income generation: The family farm is also the centre of household consumption and care for family members, it is ingrained in customs of exchange and norms of reciprocity, and land ownership is important for symbolic and affective reasons in addition to providing a reliable source of food.

Although the wider economic contexts differ, there are striking similarities between the case from Thailand and the case from Maina Pokhari. As I argue in paper 4, a narrow focus on labour productivity and economic growth in agriculture ignores the important role that small-scale subsistence farming plays for reducing the risk of food insecurity for households and in communities. Reciprocity-based systems for sharing food and exchanging labour, and mutual obligations based on kinship and long-lasting relationships, provide people with a kind of social security net that is lacking in the informal service sector and for foreign migrants. Families keep the land even though the young generation does not wish to only cultivate for subsistence, and the youth see farming as a reliable back-up plan in case of economic failure 'outside', in non-farming livelihoods. Aspirations for earning money elsewhere do not eliminate the wish to return home, especially so when it is time to marry and start a family. As shown in paper 2, the opportunity to make some money from limited cash cropping makes a return to the farm more attractive, but no one finds a full conversion to specialized cash cropping a wise farming strategy. The typical migration pattern is circular rather than one-way from rural to urban, well described by an informant in paper 2: "they come and go". That some of the household members remain on the farm enables others to leave for a period and later return. Elsewhere in Nepal, Korzenevica and Agergaard (2017) show how siblings negotiate and sort out migration aspirations and household obligations on rotation, because "the house cannot stay empty" (Korzenevica & Agergaard, 2017, p. 134). The household

members are thus not either migrants or stayers, they are both in a complementary duality (ibid.).

Compared to labour migration and a search for urban employment, farming remains the most reliable source of employment (Paudel & Waglé, 2019), despite the risks of pest- and weather-related crop failure. Although small-scale farming households in Nepal are vulnerable in many ways, alternative non-farming livelihoods are precarious in other ways (Rigg et al., 2016a). Paper 4 shows how cash cropping involves significant risk of financial loss and indebtedness due to transport impediments and large price fluctuations. Sudden overproduction relative to market demand and increased competition from Indian markets of popular high-value crops like cardamom and kiwi have reduced sales prices for the farmers (DiCarlo et al., 2018). Furthermore, people have recent experiences of failing market supply of food, such as in 2015 when transport was first impeded due to several major earthquakes, and later imports of food and fuel were halted for months due to an Indian blockade (Adhikari, 2016). The plans of the ADS and PMAMP for transforming small-scale farming into commercial production of specialized cash crops through mechanization and land consolidation lack compensatory efforts for mitigating the farmers' increased risk of economic losses and unstable access to food through markets. In 2020, the borders are again closed due to a global pandemic, which is hitting the tourism sector hard and is hindering repatriation of foreign migrants who have lost their employment (Khadka, 2020). The importance of local food production and reciprocity-based food and labour exchange for household and community food security has certainly not diminished for the small-scale farmers of Maina Pokhari.

4. Conclusions

"In the market you may starve, but in the village, you will never starve."

Climate change imposes new challenges for small-scale farmers in Nepal by adding uncertainty to the existing natural climatic variability. Indirectly, climate change is also expected to disturb regional food production systems and food markets through increased yield variability and more volatile prices. In this dissertation, I explore the potentialities for sustaining local agricultural production under uncertain large-scale changes in climate and markets for food and labour. Through a case study from the Nepali Middle Hills, I ask whether, and if so, how the studied farming system is sufficiently flexible to adapt to external uncertainties and ensure food security and livelihoods for the households.

I approach the study of adaptation under uncertainty through the theoretical lens of farming flexibility. Existing buffers of unused capacity in factors of production, and potentialities for change of crops give room for manoeuvre, which constitute the adaptive capacity of the farming system. The flexibility theory distinguishes between two levels of logical abstraction by identifying not only the current specific adaptations of each individual farm system any point in time. I argue that adaptive capacity is a concept at a higher level of abstraction because it encompasses the range of opportunities for change in the community farming system, the options that are available but not always in use, which exist within certain constraining thresholds. To alternate between cultivation of cereals and spices exemplifies an opportunity for change, while seasonal water scarcity exemplifies a constraint to flexibility.

In the case of Maina Pokhari, there is significant flexibility to rapidly adjust production in household farm systems. A diversified cropping pattern consisting of traditional and robust staple crops, various legumes, oil seeds, fruits, vegetables, and spices contribute to a local opportunity situation from which the farmers can choose their crop combinations. Local innovation has expanded the opportunity situation since newly introduced crops have been added to, instead of replaced, traditional

crops and varieties. Keeping old crops and practices viable enables farmers to return to traditional and well-established strategies when needed and contributes to ensure a basic level of subsistence food production in the community. By using the flexibility of scope, type, and temporality, farmers combine subsistence production on most of their land with occasional market production on a smaller part. Versatile subsistence production combined with some marketable crops reduce the risk of household food insecurity by ensuring that if one crop fails, there are others to eat, and should several food crops fail, some income from cash crops can compensate for the loss. The current opportunity situation is expected to be affected by rising temperatures and more variable and uncertain precipitation patterns in the future. Although conditions may improve for cultivation of winter vegetables, the outlooks for increased water scarcity in spring, more erratic summer precipitation, and greater variability in the timing of the monsoon rains increase the local climatic uncertainty in the long run.

Remittances from men on foreign migration have contributed to raise household incomes but have also led to increased agricultural work burden for the remaining population, especially women. I find that women already take a large part in decision-making in household and farm-management matters, while their participation in public, financial and market spheres are more restricted. However, local gender roles are currently in change as women take over all farm-management decisions in their husbands' absence, and increasingly enter new social spheres. In the context of two competing sets of cultural gender norms in Nepal, the ability to negotiate a new role for women is socially differentiated. Individuals who stand strong in hierarchies of caste and ethnicity, wealth, age, and marital status can change local gender roles, while less fortunate individuals feel caught in a cultural conflict. The interactions between modern development norms and traditional gender norms inspire local cultural change which has implications for women's participation in public life, local markets, and microcredit cooperatives.

Young students and migrants who consider whether to return to the village see cash cropping as an attractive option. Still, the production strategy of the farming households in Maina Pokhari is not primarily driven by a desire to maximise profit.

Cash cropping is considered a high-risk option which offers an alternative to labour migration and off-farm income, but not an alternative to subsistence food production. The market logic of evaluating crops by their exchange value is combined with a subsistence logic based on use value. According to the latter, the main purpose of farming is to ensure a stable access to food for the household by means of own production, to contribute to and benefit from reciprocity-based systems for sharing food and labour in the community, and to maintain social ties and traditions.

In conclusion, there are two main factors that threaten the adaptive capacity of the studied community farming system. The first factor is the implementation of national laws and policies that restrict farmers' flexibility. The governmental strategy for transforming the agricultural sector involves land consolidation and enforcement of specialized, commercial agricultural production at the expense of subsistence cultivation. However, this strategy runs the risk of depriving farming households of the opportunity to flexibly balance subsistence and market production and alternate between farming and off-farm livelihoods. The government's efforts to raise economic growth and improve national availability of food grains and high-value fruits and vegetables could, paradoxically, contribute to reduce food security for farming households who need a stable access to food, which they ensure through combining local subsistence production with a partial involvement in markets.

The second threat to adaptive capacity is posed by severe and pervasive impacts of climate change. Although there is significant adaptive capacity in the farming system to cope with natural variability and moderate changes in local climatic conditions, the limits of adaptive capacity may be surpassed if precipitation patterns are severely disturbed. Physical adaptation measures such as irrigation pipes and water storages are to some extent helpful in improving the local distribution of water, but such measures are insufficient if the total seasonal water availability becomes severely restricted. Social security systems largely exist within the extended family and local community though loyalty- and reciprocity-based systems for exchanging food and labour, and not through a national system of taxation and redistribution of resources. In the context of unreliable markets for food and labour, the maintenance of local

food production systems and the opportunity to return to farming will probably continue to be important parts of the households' food security strategy. Even though alternative livelihoods to farming attract the attention of the youths, there is little reason to expect a rapid decline of small-scale farming in Maina Pokhari any time soon.

Some theoretical lessons can be drawn from the Maina Pokhari case study, which may be transferable to farming systems elsewhere in Nepal where similar processes and situations occur. Despite inevitable empirical variations from place to place, a search for similarities at a higher level of abstraction can generate some useful insight. For farm-system adaptive capacity under large-scale uncertainty, a combination of subsistence and market production is more flexible than specialization in either one. Local innovation increases flexibility if the local opportunity situation is expanded, since it serves the farming household with the option to explore new opportunities, but also to return to traditional, well-established practices and robust crops should the need arise. Flexible adaptation to a dynamic environment contributes to maintain the essence and integrity of the system, and thus its general sustainability.

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Flexibility of Scope, Type and Temporality in Mustang, Nepal. Opportunities for Adaptation in a Farming System Facing Climatic and Market Uncertainty

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Abstract: Climate change is projected to increase the seasonality in river flows in the great river systems of Himalaya and impose challenges to regional food production. Since climate change increases the uncertainty in local weather patterns, people's ability to maintain local agricultural production will probably depend on how flexible the local farming systems are to adjust to unpredictable changes. The objective of this paper is to investigate the flexibility of one such farming system which is located in Mustang, Nepal, Himalaya. Defining flexibility as "uncommitted potentialities for change" following Gregory Bateson, the paper identifies opportunities for change in the farming system, as well as factors that constrain flexibility. Further developing the concept of flexibility, it is suggested that flexibility may be analyzed in terms of scope, type and temporal flexibility. Although there are several underexploited resources in the studied farming system, the present situation is not regarded as one of irrational and suboptimal exploitation of resources. Instead, unexploited resources imply opportunities for change, which provide the system with flexibility to rapidly adjust agricultural production to varying and uncertain conditions of production.

Keywords: flexibility; farming systems; climate change; adaptive capacity; uncertainty; Mustang; Nepal; Himalaya

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1. Introduction

A book recently published by the United Nations University bearing the title "Weathering Uncertainty", highlights how rural communities have elaborated numerous strategies to adapt to unstable environments, such as diversifying their use of the landscape and maintaining genetic and species diversity in fields and herds [1]. While modern agriculture tends to be highly standardized, specialized and intensified, small-scale farmers have often been viewed as traditional, irrational, and resistant to change [2]. However, several studies of mountain farming communities have shown that the diversified practices which often characterizes small-scale farming systems enable people to be flexible in response to changes [3–6]. In this paper we argue that small-scale farming systems may indeed be highly flexible, although there are also constraints to flexibility. To analyze farming system flexibility is one way of studying adaptive capacity in small-scale farming systems under uncertain conditions of production, which has implications for the general sustainability of local food production systems.

The impacts of climate change on the Himalayan region are likely to include raising average temperatures and increased melting of ice and snow during this century [7], particularly in mountain areas up to 6,000 meters above sea level [8]. As a consequence, the peaks in meltwater runoff are expected to shift to winter and early spring, away from summer and autumn when the demand is greatest [9]. Mountainous regions of Nepal have been observed to amplify the regional warming trend and show high sensitivity to climate change [10]. Temperatures in alpine areas are predicted to increase by disproportionate rates and as much as 5–6 °C during the 21st century [11], depending on near-future achievements in reducing global emissions of greenhouse gases and on the sensitivity of the climate system.

The outlooks for precipitation patterns are however more complex and uncertain [9]. Shifts in the monsoon patterns have been observed in Himalaya over the last few decades, but the picture remains ambiguous [10,12]. Climate projections show that increased variability in precipitation is expected in the years to come [7,8]. At the local scale however, the vast differences in micro-climatic conditions that characterizes complex mountain environments such as Himalaya [13] make climate prospects for specific localities highly uncertain [6]. As climate change add to the natural variability inherent in the climate system, the prospects for future climatic conditions for Himalayan farmers become increasingly difficult to predict [14]. For mountain farmers who depend on the weather for securing good harvests, changing local temperatures and water availability have significant impacts on their ability to maintain local food production. While the sharp rise and instability in global food market prices the recent years have multiple causes both at the supply and demand side [15], food prices are expected to remain high and volatile in the years to come [16]. The combination of climatic and market uncertainty that faces Himalayan small-scale farmers raises the question of how the farmers may adapt their food production systems to this uncertainty. While a common response to risk is to build resilience, uncertainty is perhaps better met with flexibility. Flexibility generally refers to the adaptive capacity of a system in a situation of uncertainty [17].

This paper investigates the flexibility of one such farming system which is located in Lower Mustang, Nepal Himalaya. The paper firstly explores theoretically the concept of flexibility and suggests that flexibility may be analyzed in terms of three specific aspects: Flexibility of scope,

flexibility of type and temporal flexibility. Defining flexibility as "*uncommitted potentialities for change*" ([18], p. 497) the paper next identifies opportunities for change in the studied farming system, as well as factors that constrain system flexibility. Lastly, a discussion on the transferability of conclusions is included.

2. Farming System Flexibility

Empirical studies have shown that through flexible diversification of crops and productive strategies and the ability to rapidly adjust agricultural production to dynamic environments, small family farms have indeed proved to be highly successful [17,19,20], despite the dominant farming policy to "get big or get out" ([19], p.391). Most of these studies focus on flexible decision making at the household farm level [17,19,21]. One exception is Aase *et al*. [6], who analyze farming system flexibility at community level as the range of opportunities for change that exist in a mountain farming system, which are currently uncommitted but can be explored if necessary. Aase *et al*. [6] draws on Gregory Bateson's [18] general notion of flexibility in complex systems.

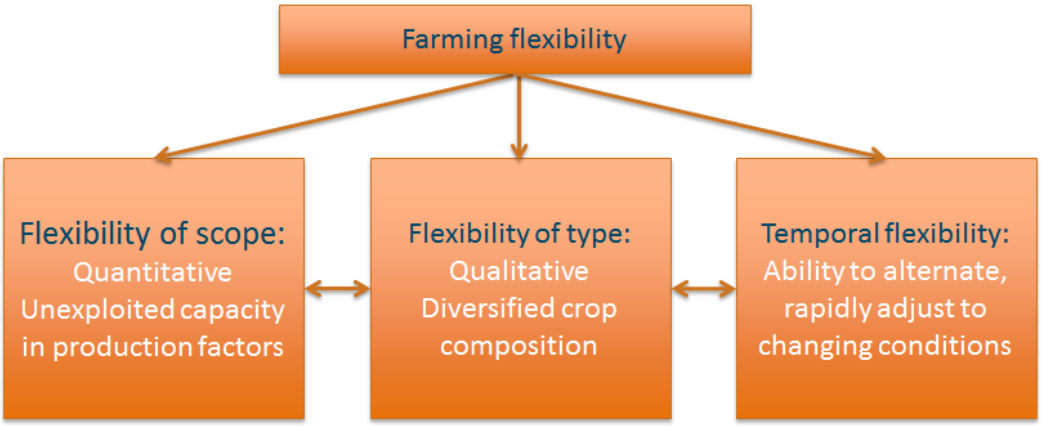
Bateson defines flexibility as "*uncommitted potentialities for change*" ([18]. p. 497). He describes a system as consisting of a set of interlinked variables where each variable has an upper and a lower threshold of tolerance. Within its thresholds the variable's value can be moved to reach adaptation, but when a variable is exposed to stress and takes on a value close to one of its thresholds, the system lacks flexibility. If Bateson's terminology is transferred to farming systems, the system variables refer to the factors of production in the farming system, such as labor, cultivated land, water, pastures, forests, livestock and capital. Since sufficient capacity in all the factors of production must be available in order to enable cultivation, relative shortage of any crucial factor of production imposes a constraint to production in the farming system. Social organization and cooperation at the local level, including formal and informal rules for entitlement to resources, influence how the system is managed. Farmers are the managers of the farming system and can make decisions that influence farming system flexibility, although factors outside the control of the farmer, for instance climatic variability, also affect the performance of the farming system.

When one of the system variables is stressed so that its used capacity is near the upper or the lower tolerance limit, Bateson holds that the interlinked nature of the system leads to spreading of inflexibility because other variables cannot be adjusted without pushing the stressed variable beyond its threshold. The solution is then to rebuild a positive budget of flexibility, by saving up a buffer zone of unexploited capacity that can "be spent (like fat) upon needed change" ([18], p. 497). It follows that the only way to preserve system flexibility is to avoid permanent exploitation of the maximal capacity in system variables. Flexibility then becomes the exact opposite of intensification, in other words to avoid pushing the value of a variable to its threshold. The general flexibility of a system depends on keeping many of its variables at values somewhere in the middle of their space of tolerance, to make sure that there is unexploited capacity free to be used in times of need.

For the purpose of analyzing flexibility in small-scale farming systems, we distinguish between three aspects of flexibility (Figure 1). First, *flexibility of scope* refers to the buffers of unexploited capacity in the system variables, which is the main concern of Bateson. Available, but currently unused capacity in the factors of production such as land, manure, water, labor and capital provide the

farming system with uncommitted potentialities for change through the opportunity to employ these productive resources if the farmers choose to do so. However, to only increase the scope of production through intensification reduces flexibility in the long run. Therefore, the second aspect is *flexibility of type*, which refers to the uncommitted potentialities for change in the composition of crops, species and productive practices in the farming system. Diversification increases flexibility of type by expanding the opportunity situation of farmers, that is, by increasing the range of possible crops to cultivate, the number of wild plants and forest resources to collect and ways of shifting productive capacity from one good to another. Flexibility of type thus resembles what Weiss [20] and, by implication, Carlsson [22] calls operational flexibility. The third aspect is *temporal flexibility,* which may be analyzed in both short-term and long-term perspectives [22,23]. Short-term temporal flexibility here refers to the ability to rapidly alternate between different crops and productive practices and reallocate available capacity of production factors to where it is most needed. Long-term temporal flexibility has parallels to Carlsson's term strategic flexibility, which he refers to as the strategic positioning of a firm with respect to a menu of choices for the future. Transferred to farming systems, long-term temporal flexibility is a matter of farmer's decisions regarding how they plan for the future under conditions of uncertainty. For instance, to maintain a certain level of local food production, even if non-agricultural work for the time being seems more profitable, is a strategic decision which provides the farming households with temporal flexibility to increase or reduce, diversify and change agricultural production also in a long-term perspective. If agriculture is fully abandoned for many years, then fields will not be maintained, livestock cannot be kept and practical competence may be lost. As time goes by, the investment costs of returning to an abandoned farm increases, although leaving the land fallow could have some positive effect on soil fertility. The system in such a situation has crossed its lower thresholds of tolerance and consequentially lost much of its flexibility. Flexibility must therefore be used once in a while in order to prevail [18].

Figure 1. Three aspects of flexibility in a small-scale farming system.



3. Analytical Approach

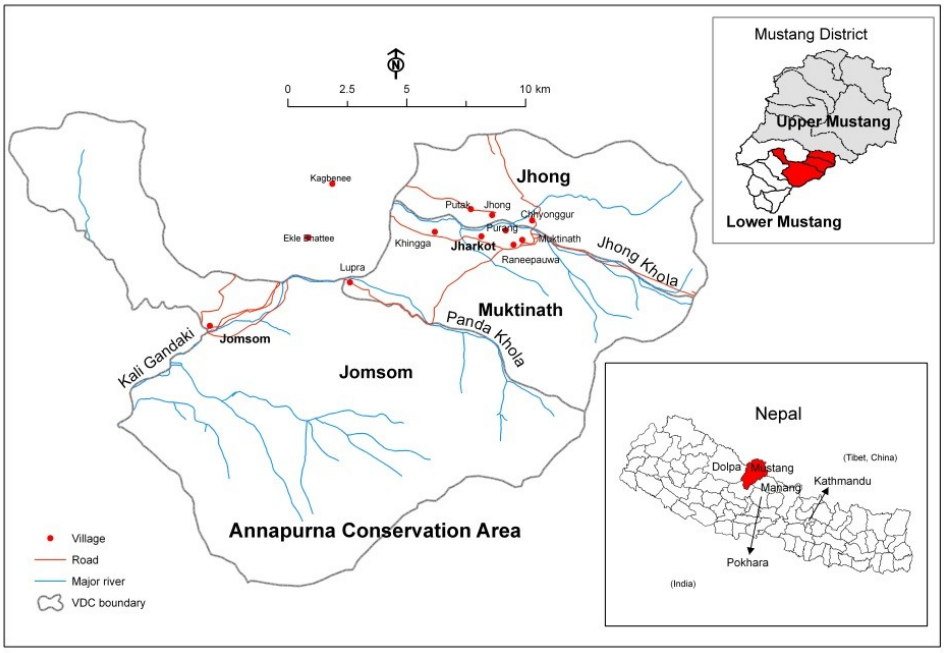
This paper analyses the flexibility of one particular small-scale Himalayan farming system by means of the terms flexibility of scope, flexibility of type, and temporal flexibility. By looking for the potentials for change in the farming system as well as factors that constrain the performance of the system, flexibility is seen as an expression of the capacity of this farming system to adapt under conditions of climatic and market uncertainty.

Social inequality exists even in small and tightly interconnected rural communities, and households may have differentiated capabilities to realize existing opportunities for change. Principles of social differentiation such as caste, religion, income, age and gender may affect households' capability to change. Households are important organizational units and the basic economic unit in terms of land and agricultural production. However, in this case from Lower Mustang, Nepal, the households' participation and membership in the village community council is decisive for their entitlement to common property resources such as irrigation water, pastures and forests. The endowments of such common property resources belong to the community. All households are represented in the council and the council leader (*gemba*) is appointed on annual rotation among all present males between the age of 18 and 60. The council ensures equitable distribution of rights and responsibilities; it settles disputes and calls all households for community work whenever this is needed. The same system of local governance is found in other Trans-Himalayan farming communities too [5]. While each household makes decisions for its private farm system [24], the village council manages the community farming system of Jharkot. A farming system is here defined as "any level of unit(s) engaged in agricultural production as it is wedded in a social, political, economic, and environmental context" ([25], p. 13). In this case the village level of scale is in focus since access to and management of pastures, forests, irrigation water and herding responsibilities are organized by the community. Inequality between and within households is not a subject for analysis in this paper, as the objective here is rather to explore the opportunity situation at the community level, which reflects the general flexibility of the farming system.

4. The Farming System of Jharkot

Jharkot is one of four villages in Muktinath Village Development Committee (VDC) of Mustang District, Western Nepal (Figure 2), and is located at 3550 meters above sea level. The Muktinath valley surrounding Jharkot lies at 83°35' east, 28°49' north. The people of Jharkot are culturally and linguistically Tibetan (*Bhotias*), though they are residents of Nepal. They confess to Buddhism and belong to the ethnic groups *Gurung* and *Thakuri*. Until recently, no passable road for cars reached Jharkot, meaning that all goods had to be carried for six days by porters or pack animals to reach the markets. In 2006 Jharkot was connected by road to the district center Jomsom, while a full road connection to the city Pokhara was completed in 2008. Once motorized transport was made possible, the transport cost for goods was reduced by 75% and the transport time declined from six days by pack animals to one or two days by car. The local price of rice imported from lower parts of Nepal declined by 32% with the completion of the road.

Figure 2. Map of Jharkot village in Muktinath VDC, Lower Mustang, Nepal.



People in this area practice a traditional form of agro-pastoralism which is quite common in mountain regions of Nepal. Barley (*Hordeum vulgare*), wheat (*Triticum aestivum*) and buckwheat (*Fagopyrum esculentum, F. tataricum*) are cultivated in terraced fields, while fruits and vegetables are cultivated in orchards. Yak-cow hybrids (*jhopa,* or *dzo*) serve as draft animals while horses are kept mainly for travel. Herds of cows, goats and sheep are brought out daily to graze in the alpine meadows, while they are stall-fed during the winter with foliage, grass and crop residues. The winter fodder is cut during the growing season and stored for the winter. The livestock provide manure which is essential for maintenance of soil fertility through the recycling of micronutrients from forests and pastures to the cultivated fields. Manure is thus an important link in the agro-pastoral farming system. No inorganic fertilizers or pesticides are currently used in Jharkot. All households in the village have entitlements to the pasture areas that exclusively belong to the community. All Jharkot households also have entitlements to collect wood from a nearby community forest, although foliage and wood from privately planted trees are more commonly used. Figure 3 represents a model of the farming system.

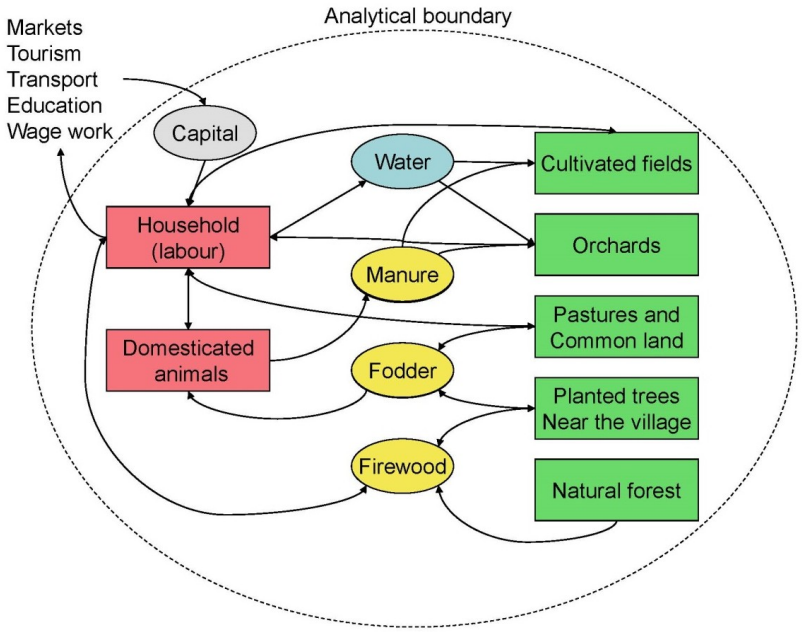
Streams of meltwater run down from the snow and ice covered mountain peaks surrounding the valley. Located in the rain shadow of the great Annapurna mountain range, the valley is semi-arid and cultivation is fully dependent on irrigation. A climate characterized by strong winds and intense sunlight causes high evaporation and contribute to the semi-arid conditions [26]. Exact and recent figures of precipitation are scarce, but Fort [27] reports that annual precipitation is approximately 352 mm (ten year average). However, even between villages located a few kilometers apart, there are large variations in precipitation due to the steep topography of the area. In Jharkot, most of the precipitation falls in July and August while only little falls as snow during the winter months, which

probably indicates the influence of the monsoon and contrasts the climate of Muktinath Valley from that of the Western Himalaya [27].

Seasonal water scarcity and a short growing season impose climatic constraints to agricultural production in Jharkot. Yields are thus generally lower in Jharkot than in farming systems located at lower altitudes. Local agricultural production can support the population for approximately six months of the year [28]. Seasonal migration during the cold and lean winter has for centuries been a common adaptive strategy. Historically, the people of Mustang took part in the Trans-Himalayan trade between Tibet and India, bringing salt and wool from Tibet down to the lowlands and returning with food grains. Large herds of goats, sheep and mules were used as pack animals [29] along the Kali Gandaki river bed, one of the main trading routes between Tibet and the lowland markets [30]. The trade flourished from the 15th century and especially throughout the 19th century [31] before it declined with the Chinese occupation of Tibet in 1959.

Today, alternative livelihoods in tourism, transport services and labor migration accompany agricultural production. Widespread abandonment of agricultural land has occurred both in Jharkot and more generally in Mustang over the last couple of decades [26], just as in the neighbor district Manang [6,32]. The herds of animals and the number of people in Jharkot have historically been higher than today. While there were 75 households in Jharkot twenty years ago, today there are 62. The number of large households in the village has also declined. Similarly, while 216 households were registered in Muktinath VDC in 2001 [26], now there are 169. Still, agro-pastoralism constitutes the economic and social backbone of Jharkot community. The terraced fields which are now abandoned could in fact contribute to flexibility in the farming system, as agricultural production may be increased if people in the future choose to return to farming [6].

Figure 3. The farming system of Jharkot.



5. Flexibility of Scope

Due to the high-mountain environment with a naturally short growing season, subsistence production in Jharkot has traditionally been supplemented with trade and food import. Engagement in alternative livelihoods to farming has contributed to net out-migration and the abandonment of agricultural land [26]. The current scope of agricultural production should therefore not be confused with the maximal potentials for production in the farming system, as the capacity of many farming system variables are far from fully exploited in Jharkot. The scope of food production has historically been higher through cultivation of a greater number of terraced fields, combined with larger herds of cows, goats, sheep, and yaks. The yaks range in herds far from the villages in pastures located higher than 4,000 meters above sea level and do not provide suitable manure for fertilization of fields, but are kept by Tibetan communities for milk, meat and wool. Today, many households have chosen to reduce their herds of livestock, and only a few wealthier households hold yaks.

The pastures have historically proven able to support much larger numbers of animals, also during the winter when animals must be stall-fed. There is thus flexibility of scope in winter fodder availability, unexploited capacity which gives the opportunity to increase the utilization of fodder resources. Firstly, more cultivation produces more weed and crop residuals, and consequently more fodder. Secondly, more trees could be planted in village lands which would provide foliage for fodder and bedding, although newly planted trees would need about three years of growing before they yield. A third opportunity for increasing fodder availability is to alter the composition of the herds. The significant number of horses in the farming system already consumes large amounts of both grains and winter fodder without producing suitable manure for the fields [33]. In the neighbor district Manang, horses consume the produce of 16% of all cultivated land in the valley [6]. With the introduction of jeeps and motorbikes in Jharkot after the completion of the road, the importance of horses for travel is reduced. Thus, if winter fodder availability at times should be scarce, an uncommitted potentiality for change is to reduce the number of horses in the farming system and allow human consumption of the grains that are now spent as horse feed [6]. Larger herds of goats could potentially be raised instead. The reallocation of winter fodder from horses to goats would increase the returns of manure relative to winter fodder and relieve manure as a potential constraint for increased grain production. If farmers choose to reclaim abandoned fields and dedicate them not primarily to grain production but rather to vegetable cultivation, the number of poultry could be increased at the expense of horses, since poultry gives manure of high quality, but in much small amounts than goats and cows.

Horses have historically had a high cultural significance in Jharkot. Every year in August a horse race festival (*Yartung*) is held, an old tradition in the area. This is a still a popular event in the community and many young male migrants return to the village for the festival in time before the harvest. In Manang, horse keeping is an index of success [34] and traditionally they have the same high position in Mustang [29] as items of conspicuous consumption [35]. However, motorbikes have become increasingly popular in the valley the recent years, especially among young men. A motorbike indicates that the owner has been able to raise a significant amount of money and it gives income opportunities by driving Indian pilgrims to the nearby Muktinath temple complex. If motorbikes are currently substituting horses as items of conspicuous consumption, people might choose to increase the

number of goats or cows at the expense of the number of horses. A shift to fewer horses would thus increase the production potential of the system.

The number of abandoned fields, underutilised pastures, planted trees and forests in Jharkot serve the farming system with flexibility through the uncommitted potentiality to reclaim land and increase manure producing livestock herds. Should the people of Jharkot find it necessary or beneficial to again increase their reliance on local food production, they can do so by allocating more of their labor into agriculture at the expense of alternative livelihoods. Additional labor needs can be met by hiring casual workers in peak periods and by encouraging more sharecropping, opportunities which have already been partly committed in Jharkot. Groups of casual workers from poorer neighbor districts to Mustang reside periodically in Jharkot, where they seek temporary work. Traditionally, casual workers were paid in kind; earning food and accommodation as the only payment for their labor, but now casual workers do earn some money in addition to food and shelter. Other migrants rent land by sharecropping. Usually, sharecroppers keep 50% of the yields while the land owner gets the other half, but there are cases where sharecroppers are permitted to keep more than half of the yields. Instead of regarding the situation of declined agricultural production as one of suboptimal exploitation of resources, an alternative approach is to acknowledge that unexploited capacity involves opportunities for change which provide the system with flexibility to increase agricultural production in response to large-scale changes, such as rising food prices or reduced opportunities for off-farm income and labor migration.

However, one bottleneck in this farming system is the availability of irrigation water in the spring. Meltwater from snow and ice is essential for irrigation of barley and wheat crops from March to early June, before the monsoon rain reaches Jharkot. Water storage systems are constructed only for drinking water in a closed pipe system and for open animal ponds, but not for the significantly larger amounts of irrigation water. Irrigation rights rotate among the households in the village to ensure that all households have the chance to irrigate their fields at least twice during the dry spring period. Too little water may destroy significant shares of the major food crops. The short growing season restricts the time period for grain cultivation, allowing time for a second crop of the fast-growing buckwheat only after barley, which ripens earlier than wheat. If winter temperatures should rise in the future in the mountains surrounding Jharkot, more of the winter precipitation could fall as rain instead of snow, and thus run past the farming system at a time of year when the farmers cannot utilize the water for farming. However, if the growing season is prolonged with higher temperatures, there could be time for two crops per year even in the wheat fields, though only if sufficient amounts of irrigation water are available at the time of year when farmers need it. The future climate to which the farmers of Jharkot must adapt their farming system is in other words uncertain. People's adaptive capacity depends on how they deal with and respond to uncertain conditions of production.

6. Flexibility of Type

Over the years the people of Jharkot have experienced that they reduce the risk of crop failure if they rely on a wide diversity of crops and productive strategies, much similar to the experiences of small-scale farmers in other mountain regions [2,5]. Grain cultivation is complemented by vegetable and fruit production and collection of a wide variety of medicinal plants, herbs, fungi and berries from

common lands. With the reduced transport costs to the market, people in Jharkot have started to explore new opportunities for market production. Some have constructed simple technology greenhouses for vegetable production. Apples are seen as a promising cash crop and many farming households in Jharkot have recently planted apple trees in one or two of their fields. Villages further south in Mustang district have for long been well known for their successful apple production, and now farmers in Jharkot see the potential to draw on the good reputation of "Mustang apples". To expand the scope of apple production from a few garden trees for subsistence to larger quantities of apples as a cash crop is to make use of the flexibility of type in the farming system, by shifting part of the production capacity of land, labor and water over from barley and wheat to apples. Although the shift demands investments for a few years before revenues can be obtained, the benefits of this shift are several: Once the apple trees are well established, they demand less labor than grain cultivation, cash crops are seen as a more attractive option than subsistence production for young people, the expectations for profit from market sale are high, and damaged apples not suitable for sale can still serve the purpose as animal feed. However, investments in commercial apple production also involve uncertainty, mainly in three ways. Firstly, fluctuating sales prices make commercial apple production occasionally unprofitable, despite the recent reduction in transportation costs. Competition from cheap Chinese apples could challenge Mustang apple producers. Mustang apples cost 130–140 NPR per kg in the urban markets, while imported Chinese apples in 2012 sold for 100–140 NPR per kilo in Kathmandu. Branding their apples as organic could however help to justify higher sales prices. Organic Mustang apples are in 2012 advertised for as much as 250 NPR per kilo delivered in Kathmandu. The second uncertainty is pest attacks which may destroy large shares of the harvest. Farmers reported of pest attacks deteriorating the apple quality in 2010. The third uncertainty is the risk of road blocks which inhibit the apples from reaching the market in a fresh state. Some farmers have however explored opportunities for making apple brandy, juice and dried apple rings, which are storable and thus less dependent on continuous market access.

A full conversion from subsistence grain production to specialized apple production would reduce the flexibility of type in the farming system. While cash crops are exposed to market uncertainty, revenues from years with high prices may serve as a buffer compensating for occasional crop failure in subsistence production. The most flexible solution is therefore to convert only a small share of the cultivated land to apple production, while maintaining grain production in most of the cultivated land. The combination of subsistence and market production reduces the dependency on each strategy, thereby reducing the vulnerability to climatic and market variability. This kind of combined farming practice is currently the common strategy among the farmers of Jharkot. No household have so far chosen to specialize fully in producing apples for the market.

Another flexibility of type lies in the utilization of wild plants in the common lands. Non-timber forest products (NTFP) are a collection of wild growing edible plants, medicinal plants, and non-edible plant resources traditionally used in subsistence based farming systems and some which are objects of trade. In Mustang at least 70 species are used for medicine by *amchis,* Tibetan doctors [26], while more than one hundred NTFP species are consumed by the local people of Mustang [36]. The collection, use and sale of NTFP is widespread also in other districts such as Manang [37]. In Jharkot, NTFPs contribute to increase the opportunity space of productive activities and offer occupational alternatives in lean seasons. Several community projects based on NTFP have been

initiated, though people are still in an early phase of developing niche products for sale in Kathmandu. The local awareness of various potentials for niche product development and the existing capacity for local cooperation serves Jharkot community with flexibility of type.

Among the economically most important species is *yarzagumba* (*Cordyceps sinensis*). *Yarzagumba* is a larva infected by a parasite fungus, and the name literally means "winter worm—summer grass" [38]. In traditional Tibetan medicine it is eaten dry or soaked in liquor to relieve fatigue, altitude sickness, and knee pain, while various additional medical properties are documented [38,39]. *Yarzagumba* can be found in alpine meadows at 4000 m.a.s.l. from late May when the parasite fungus is properly developed. In early summer, young men from Jharkot go camping for several weeks and search for *yarzagumba*. The gathering is individual but the harvest is sold to contractors, who in turn export the pieces to China and Singapore. As an indicator of the substantial potential value in this business, people in Manang district sold *yarzagumba* worth 15 million NPR in 2005 [40]. Gathering is only allowed for a certain period of time in a dedicated area and it is regulated at the VDC level, which is the lowest administrative unit in Nepal. The annual *yarzagumba* gathering represents one of the existing opportunities of type in the farming system to utilize the rich diversity of non-timber forest products found in the alpine meadows. The benefit of economic diversification by making use of non-timber forest products have also been demonstrated in other mountain farming systems [41].

7. Temporal Flexibility

In a short-term perspective, temporal flexibility here refers to the ability to rapidly rearrange the factors of production in order to make the most out of scarce resources. Irrigation water is seasonally a constraint to agricultural production in Jharkot, but at the same time water is a resource with high short-term temporal flexibility. Through the irrigation system, water can rapidly be reallocated from apple orchards to grain or vegetable fields. In comparison, to plant new trees takes several years from the decision is made to the results are seen. While the conversion of a grain field to an apple orchard reduces short-term flexibility for that particular field, diversification increases the temporal flexibility at the household farm system level by enabling farmers to rapidly reallocate their scarce resources. Since land availability is currently not constrained in Jharkot, the main concerns of the farmers are how to best allocate their labor and water in the peak seasons. The combination of staple food crops, vegetables, cash crops and non-timber forest products gives the farming system high temporal flexibility and renders possible a deliberate spending of water and labor in times of relative scarcity, which is essential for the utility of opportunities of type and capacity of scope. At the same time, flexibility of type in the cultivated fields, orchards and common lands reduce the sensitivity to seasonal drought since not all crops are in critical need of irrigation at the same time. Only a combination of all three aspects of flexibility can reflect the adaptive capacity of the farming system to short-term climatic variability.

Some farmers in Jharkot reflect on their farming strategy also in a long-term perspective, considering the opportunities for their children to engage in farming in the future. In the context of uncertain local impacts of large-scale changes, the adaptive capacity of Jharkot farming system depends on people's ability not only to rapidly respond to changing conditions of production, but also to strategically plan for future uncertainty. One farmer (male, 48) expressed that: *"We have to make*

new things, opportunities here, or else the children will not come home. Hotels, apple trees, that's good. At first I didn't want to plant [the apple trees], I said, 'who will come back here to keep them?' But my wife wanted to, for the children. And it's good."

According to Guillet ([42], p.567) "a potential for change in strategy" is one of the basic elements of adaptation in mountain environments. By making use of the range of crops and productive strategies which are possible to adopt, the farmers of Jharkot explore the existing opportunity situation in the village. If food prices remain as high and volatile in the future as projected by the FAO (2012), local food production might increase its importance in achieving household food security. While seasonal migration represents the system's flexibility of scope in labor, too much migration involves a loss of flexibility as it will be increasingly cumbersome to return to farming as time passes by in the city. In the words of a mother (55): *"When the children are home, they don't work in the fields. They can't work in the fields, they don't know, they are students".* A father (48) who had recognized this stated that *"I always bring my children back home, in every holiday. So they remember, or else they will forget, if they are not here for many years".* In one particular case, a household from Jharkot chose to give up its flexibility to return and instead abandoned their house and fields altogether, moving permanently to Kathmandu. As land cannot be sold to non-Jharkot residents, the family chose to permanently hand over their fields to the community, which in turn manages the fields collectively by sharecropping them out and letting the owner's share of the yields be distributed among the village households. This strategy leaves the community in control over the land, while the original owners have lost their flexibility to return. Another household, also of which all members live permanently in Kathmandu, chooses to keep their house and fields empty in Jharkot. One of the sons occasionally visits the home village and although he does not farm or keep livestock, he manages to keep the social relations active. The long-term flexibility to return to farming is to some extent maintained for this household. To utilize the space of maneuver once in a while is necessary in order to preserve flexibility in the system [18].

8. Flexibility, Adaptive Capacity and Sustainability

The case from Jharkot shows that flexibility is an essential feature of the adaptive capacity of this small-scale farming system to variable and increasingly uncertain production conditions. The case supports the conclusion of Aase *et al*. [6] that Himalayan farming communities are better described as dynamic than fragile, and that farming flexibility is a highly viable strategy for adaptation under conditions of uncertainty.

A similar conclusion is reached by Niemeijer based on his analysis of African agriculture. He states that "[t]he more dynamic the natural or social environment, the more important it becomes to rapidly adjust subsistence patterns to benefit from new opportunities and to avoid pressing constraints" ([43], p. 93). Niemeijer argues that African agriculture is strongly characterized by flexibility and adaptability, and that it is precisely the dynamic response of African agriculture to changing natural and social environments that have guaranteed its long term survival. Guvele [44] concludes that crop diversification reduces income variability among Sudanean farmers facing uncertainties in production costs, yields, and market prices. In Bangladesh, Rahman [45] found that crop specialization has reduced productivity, while crop diversification has improved farm efficiency

by allowing for more effective use of household labor in lean seasons and avoiding bottlenecks in labor usage. Rahman concludes that by combining subsistence and cash crop production, farmers are enabled to select enterprises that complement each other, given the high seasonality in labor demand for each crop. The conclusions of these studies are much similar to the case of Jharkot. Instead of generalizing single practices from particular cases, one may rather look for the transferability of some general structural aspects [46]. It seems that in small-scale farming systems, the combination of subsistence and market production is a more flexible strategy than specialization in either one. A diversified farming practice preserves the opportunities of farmers to rapidly adjust the scope of each crop and reallocate scarce productive resources such as labor and water to alternative crops in response to changing conditions, thereby keeping the short-term temporal flexibility high.

Flexibility in response to climatic and other external changes and management of biophysical diversity is thus essential for successful adaptation of agriculture in a dynamic world [4]. In this way, flexibility helps ensuring the general sustainability of small-scale farming systems under dynamic and uncertain production conditions. The sustainability of farming systems here refers to their ability to maintain their function as systems of food production. Since the importance of flexibility for adaptive capacity in agriculture seems to be noted in many parts of the world, some lessons on how flexibility is important might be transferable from one case to another.

Based on the case from Jharkot, we argue that the general flexibility of a small-scale mountain farming system depends on maintaining the potentialities for change in production. Flexibility of scope is not to seek intensification, but rather to keep some buffers of unexploited capacity in the factors of production which can be spent in times of need or for exploration of new opportunities for diversification in crops and productive practices. To maintain a diversified composition of crops and wild plants gives the system flexibility of type by allowing for opportunities for change of crops that may be cultivated or gathered. Diversification, rather than specialization, enables flexibility of type. Local innovation may increase the flexibility of type if the total range of possible crops and productive practices which are available in the farming system is increased. The ability to rapidly respond to changing conditions of production by combining and alternating between different crops and production practices, and rapidly reallocate scarce productive resources to where they are most needed for the time being, constitute the temporal flexibility of a farming system. In this way, flexibility of scope, type and temporality represent the capacity of a farming system to adapt to locally uncertain climatic and market conditions.

However, constrained capacity in one central variable may function as a bottleneck for the general performance of the system. If a central goal is to increase flexibility, it is therefore important to address these bottlenecks and look for ways to either increase the capacity of the constrained system variables, or rearrange the system in order to make agricultural production less vulnerable to occasional scarcity of the constrained variable. Institutional, political, social or religious structures might also play a role in either imposing barriers to flexibility, or contribute to enable farming system flexibility. There are a vast diversity of small-scale farming systems embedded in highly different contexts across the world, which result in a variety of particular opportunities for and constraints to adaptation in each farming system. Adams and Mortimore [21] note that there is no simple relationship between intensification and sustainability, as in some farming systems there may be capacity for intensification without reaching the ecological thresholds of vital system variables, while in other farming systems

intensification might push the agricultural ecosystem towards production that is not sustainable in the long run. The term "sustainable intensification" implies that there is room for intensification of agricultural production while at the same time maintaining flexibility of scope through buffers of unused capacity in the farming system or alternatively, by permanently relying on external inputs. If, however, the exploited capacity of one important system variable is pushed towards its limit, the system lacks flexibility of scope for that variable and the result may be loss of sustainability. Reduced soil fertility and increasing sensitivity for seasonal water scarcity are examples of such a process. Flexibility thus offers freedom of manoeuver that can be lost in the process of intensification [21]. As long as each case is analyzed in its specific context, to look for uncommitted potentialities for change and the factors that constrain flexibility is one way of approaching adaptive capacity in small-scale farming systems under conditions of uncertainty. The case from Jharkot demonstrates how farming system flexibility may be analyzed by looking for the opportunities for change in terms of flexibility of scope, type and temporality, as the ability to rapidly adjust agricultural production to uncertain local impacts of large-scale processes of change.

9. Conclusions

The rising temperatures and changing patterns of precipitation which are expected consequences from global climate change, combined with high and volatile food prices in the international markets, are some of the large-scale changes to which small-scale farmers must adapt. In the diverse Himalayan region, the local impacts of global changes are highly differentiated and uncertain. The adaptive capacity of small-scale farmers largely depends on their flexibility to adapt agricultural production to uncertain conditions of production. Defining flexibility as "*uncommitted potentialities for change*" ([18], p.497), this paper argues that farming system flexibility may be analyzed in terms of the three aspects flexibility of scope, flexibility of type and temporal flexibility. Available, but currently unexploited capacity of scope in factors of production, serve the purpose of buffers which give opportunities for change in agricultural production. A diversified crop composition and the combination of a variety of productive strategies reduce farmers' vulnerability to climatic or market variability and enable farmers to alternate between different productive strategies. The ability to rapidly shift production capacity of land, labor, water or capital to where it is most needed for the time being constitutes the capacity to adapt to unpredictable changes.

For mountain communities, greater integration in regional and global markets may amplify local vulnerabilities through higher dependency on food and labor markets. However, greater market integration may also create new opportunities in agriculture for market production of vegetables, fruits, herbs and medicinal plants. Successful diversification into high-value crops have increased incomes and improved food security in many mountain communities [47,48]. The case of Jharkot shows how diversified practices can enable farming flexibility under uncertain production conditions by increasing the local opportunity situation of possible crops and production strategies.

If high and volatile food prices or limited labor opportunities for migrant workers reduce the ability to secure an income from off-farm work, people in Jharkot might again wish to invest a larger share of their labor in agricultural production. If they choose to do so, there are several opportunities for change in the farming system that they might explore. They can reclaim abandoned fields such as in

Manang [6] and raise larger herds of livestock; they can plant apple trees and vegetables as cash crops, and invest more in collecting medicinal plants and develop other non-timber forest products. Although all households are probably not willing or capable to explore every potentiality for change in production, opportunities at the village level constitute the flexibility of type in the farming system of Jharkot. Through the recent initiatives to develop local niche products, the community of Jharkot has proven the ability to manage collective projects in combination with private entrepreneurship. Innovative creation of local business opportunities may expand the flexibility of type in the system. In a long-term perspective, the creation of agriculture related business opportunities may even inspire the younger generation to engage more in farming.

However, relative shortage of one factor of production may constrain the performance of the whole farming system and impose bottlenecks to agricultural production. Too little irrigation meltwater in the spring is one such bottleneck in Jharkot; a problem which could become even more severe if the snowcover is reduced following rising temperatures. The community of Jharkot has recently addressed this problem. Through establishing a community project they have constructed an additional irrigation canal from a well located several kilometers away from the village; a water source which until now has been underutilized because of the difficult topography in the area. Now, the community has found it worth the investment to explore this uncommitted opportunity. Capital has been raised from external sources and the construction work was done by representatives from all households in the village. The people of Jharkot's capacity for local cooperation and active local institutions for management and maintenance of common property are essential for completion of such a project.

However, if global climate change in the future results in such drastic temperature increases as are now projected for Himalaya, the impacts on local water supply may be too comprehensive to be solved by local adaptation measures such as constructing more and longer irrigation canals. But still, as long as the water availability is not radically altered in Jharkot, there are vast opportunities for maintained and even increased agricultural production in this farming system in the years to come. The combination of various forms of production for subsistence and for the market reduces the dependency on each strategy. The risk of large economic losses due to unpredictable events such as seasonal drought, crop failure and pest attacks, but also market uncertainty due to volatile prices or periodical road blocks, is reduced through diversification of crops and productive strategies.

An analysis of flexibility must address both the opportunities for, and constraints to, change in each specific case and pay attention to both the upper and the lower tolerance limits of vital farming system variables. The analytical approach to study farming flexibility in terms of flexibility of scope, type and temporality might be relevant for studies of adaptive capacity to climatic and market uncertainty of small-scale farming systems in other parts of the world.

Although the perception of the Himalayan environment as vulnerable and fragile is remarkably persistent [49–51], others prefer to characterize the Himalayan region as highly dynamic [5,6,52]. A dynamic environment calls for flexible responses. For Himalayan farming systems facing a climatically uncertain future, ability to change rapidly is of vital importance for successful adaptation. Returning to the general argument of Gregory Bateson [18], to create flexibility is to create preadaptation to unpredictable change.

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Conflict of Interest

The authors declare no conflict of interest.

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II

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6

MINOR CROPS AND MAJOR OPPORTUNITIES IN DOLAKHA, NEPAL

Nina B. Holmelin

> For me, it is better to stay here and grow cardamom than to migrate, but the young people have not understood that yet. (Male, 66 years old)

INCREASED CLIMATIC VARIABILITY, volatile international food prices, new and rising economies, and other large-scale processes of change have differentiated impacts on specific communities (Battisti and Naylor, 2009; Lipper et al., 2014). While some will benefit from emerging labour markets, from new domestic market niches, or even from higher temperatures, others will experience increased economic hardship, unstable access to food, and declining yields in agriculture. As the specific opportunities for adaptation and the constraints met by farming communities are context dependent, one way to study adaptive capacity in agriculture is to analyse one specific place and farming system in its proper context. This chapter explores the challenges and opportunities for adaptation in the farming system of Maina Pokhari, Dolakha, in the middle-hills of the Central Development Region of Nepal.

Many rural communities in the mountain regions of Nepal are challenged by lacking or unreliable road connection to markets, few

local income opportunities outside agriculture, and high rates of poverty and illiteracy. According to Nepali law, all sons have equal rights to inherit land. A period of high population growth in Nepal, which from 1991 to 2001 was 2.25 per cent per year (Central Bureau of Statistics [CBS], 2006), has resulted in widespread fragmentation of cultivated land. Over the 20 years from 1981 to 2001, the total number of households owning land has increased by 50 per cent while the average area of land holdings has declined from 1.11 ha to 0.80 ha per household (CBS, 2006). Labour migration to the large cities of Kathmandu and Pokhara or abroad to India and the Middle East is considered to be a solution for food deficient families. Extensive male out-migration and widespread land abandonment have been observed in communities, for instance, in Mustang (Holmelin and Aase, 2013), Manang (Aase et al., 2010), Pokhara, and other hill and mountain areas of Nepal (Khanal and Watanabe, 2006).

In Maina Pokhari, however, young men have started to return after a period of migration. They are now looking for new opportunities to invest in the farm and make an income from small-scale production of cash crops and niche products. Innovative local farmers have started cultivation of vegetables for sale, cardamom and chilli, broom grass (*Thysanolaena maxima*, a tall grass which is used for making brooms for cleaning), bamboo and *argeli* (*Daphne Bholua*, which is used to make 'Nepali paper'), as well as various seeds and medicinal plants. While the farming system is historically dominated by subsistence production of rice, wheat, maize, and millet, it has now become increasingly popular to dedicate a small part of the land to various cash crops.

Interestingly, no one has so far chosen to specialize in any particular cash crop. Instead, they choose to continue with traditional staple crop production in the main part of their plots and allocate, on average, 20 per cent of their land to production for the market. Scepticism towards the market exists among people who experience high transaction costs in the local markets and large fluctuations in demand and supply. In a place where personal relations and kin-based networks influence economic interaction and where barter trade is prevalent, it is not easy to enter the sphere of the market as a new small-scale supplier. Still, quite a few innovative households have managed to establish small but viable value chains of new cash crops, from production

to sale in local and even national markets. This chapter explores how some households have managed to achieve a successful combination of subsistence and market production, which has increased their adaptive capacity to climatic uncertainty. Considering that the local markets are uncertain and that growing conditions vary with shifting weather patterns, it is argued that the most flexible farm systems are those which are able to rapidly adjust to changing and uncertain circumstances. Ensuring a basic level of staple food production, while at the same time allowing for monetary contributions from farming, render possible flexible adjustments to varying environments, which by consequence enhance household food security.

THE STUDY AREA

Maina Pokhari

The village Maina Pokhari is a small marketplace located at 1,970 m above sea level (masl) in Kavre Village Development Committee (VDC, the lowest administrative unit in Nepal), Dolakha, Central Nepal. An all-weather road passes right through Maina Pokhari and makes the village a small nexus for transport and trade. Several buses link Maina Pokhari to the district headquarter Charikot—two hours away (Figure 6.1)—and further on to Kathmandu—seven hours away. The road was completed in 1978 by means of Swiss development assistance. It is passable all year, even during the monsoon season, when dirt roads are frequently blocked.

Over the last 20 years, Maina Pokhari has grown into a dynamic and rapidly expanding marketplace. Today, Maina Pokhari contains four credit and savings cooperatives, of which one is exclusively for women, a store for agricultural utensils including seeds and chemical fertilizers, a veterinary, a health post, one secondary and two primary schools, several local non-governmental organization (NGO) offices, an auto repair shop, hair dressers, tailors, paper shops, and cell phone shops. Basic internet connection is available. An agricultural research centre is located nearby. A local hospital which is financed by foreign development aid is currently under construction (2014). Wholesale and retail sale of food from Kathmandu gives Maina Pokhari an important role in ensuring local availability of food during lean seasons.

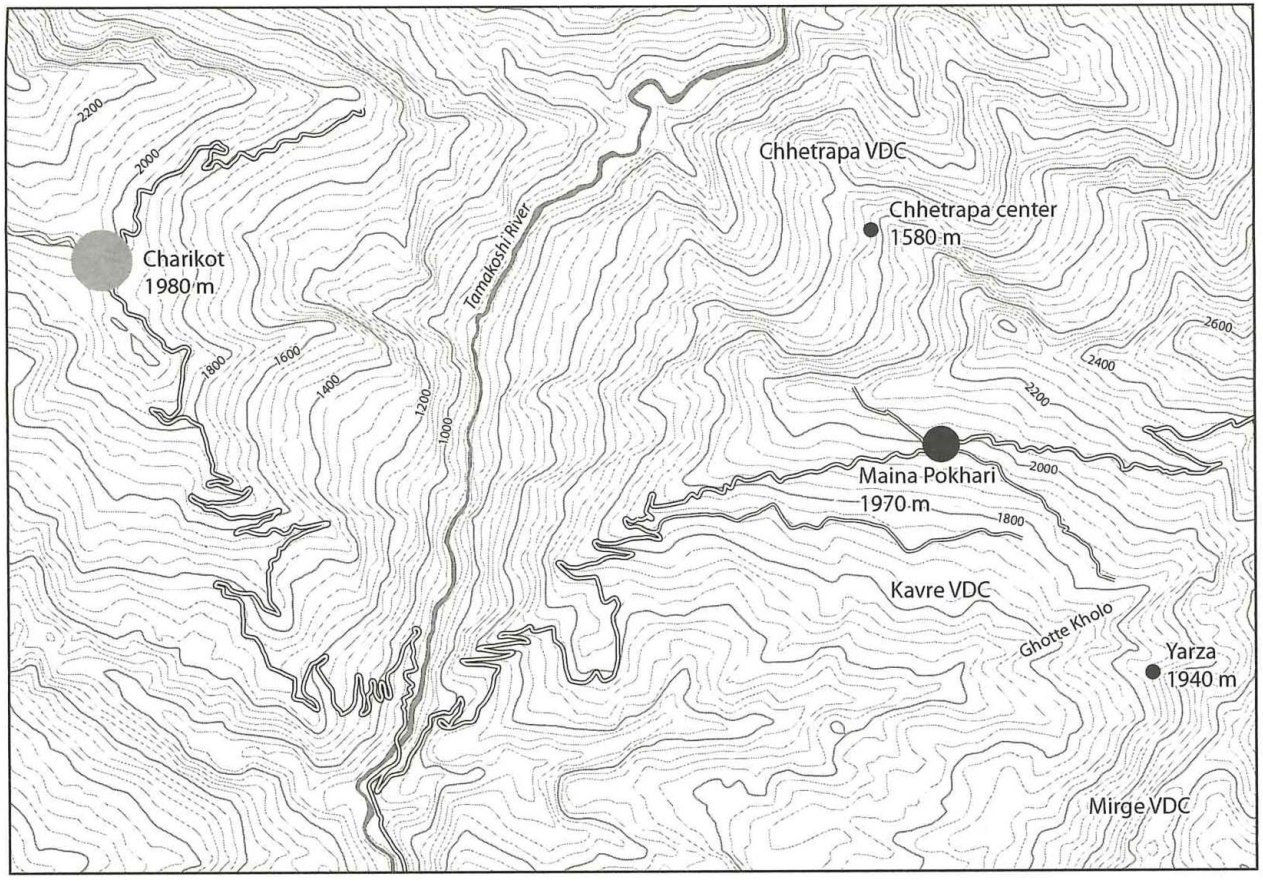

Figure 6.1 Location of Maina Pokhari

Note: This map is not to scale and does not depict authentic domestic or international boundaries of India.

Roads in mountain areas like Dolakha are often placed on the ridges which are relatively less steep than the surroundings, and the road through Maina Pokhari is no exception. Downhill from the road, several hundred family farms cover the slope. Large and fertile paddy fields are located in lower parts of the slope where the temperature is suitable for rice. Great steepness prevents the area by the riverbed from being cultivated. Rainfall on the ridge accumulates in creeks and irrigates the paddy terraces (*khet*). Uphill towards the ridge, the paddy fields blend in with rain-fed plots (*bari*). Cultivation close to the ridge has historically been dominated by maize and millet. Yields per hectare tend to decrease with higher altitudes, but the highest cultivated field at 2,100 masl is still well within the altitude range of maize and millet.

The case study area comprises households that use Maina Pokhari as their primary market. The area includes all settlements in Kavre VDC, most of the settlements in Chhetrapa VDC, and a small settlement called Yarza in Mirge VDC. For the sake of simplicity, the studied area is referred to as Maina Pokhari here. Settlements lying outside the range of 2.5 hours' walk from the marketplace are connected to other market places and are not considered here. The majority of farms is located in the overlap zone between the rice-dominated lower and the maize- and millet-dominated higher area.

Population

A total of 9,000 persons in 1,900 households populated the field area in 2010, including migrants. Dolakha District has had a population growth of 2.5 per cent per year, which indicates a rapid increase in population (Dolakha District Development Office [DDO], 2005). Farming dominates as the main occupation for 86 per cent of the households, often supplemented by casual day labour (Chhetrapa VDC, 2010). The cropping cycle and tasks related to farming structure the daily life, and agricultural peak periods are important markers of seasonal activities. Students and migrants return home in time for the main festival period in October–November when Dasain and Tihar are celebrated, which also coincides with the rice harvest.

A purposive sample interview survey (see Chapter 1, this volume) of the households in Maina Pokhari (n=114) was conducted by the

author. The sample covers all castes and ethnic groups as well as the variation in wealth, land holdings, cropping patterns, farm altitude, food self-sufficiency levels, walking distance to the market, household size, and age profile. Whenever statistical numbers are presented below without other references, they refer to this survey.

Ethnicity and Religion

The majority of the population are high-caste Chhetri Hindus. Together with a smaller number of Bahuns, the two high castes constitute 68 per cent of the population according to local population censuses.[1] Low-caste Dalit groups make 11 per cent of the population. The remaining 21 per cent are from the ethnic groups (*janajati*) Sherpa, Jirel, Newar, and Tamang. They belong to the Tibeto-Burman language group and confess to Buddhism.[2] While some settlements are dominated by one specific family or ethnic group, other settlements are mixed in ethnic composition as a result of a long historical record of neighbourhood and coexistence.

THE FARMING SYSTEM

> In order to be a perfect farmer, you have to consider the five Js: First, *Jal*, water. Second, *Jangal*, forest. Third, *Janawar*, domestic livestock. Fourth, *Janashakti*, labour. And lastly, *Jamin*, land. The farmer who manages the five Js well, can be a successful farmer. We are always talking about the five Js, how to manage them. Not all farmers have all of them, they lack one or more. (Male group discussion)

The five Js described above show how the farmers consider their farm as an interrelated system of water, forest, livestock, labour, and land. The success of the farmer depends on how well (s)he manages all the five variables, and scarcity of one of them can hinder the performance of the system. The way of thinking is reflected in the farming system approach (Turner and Brush, 1987; see also Chapter 1, this volume), which is a way to analyse agriculture as a set of integrated

[1] In the survey by the author, the caste distribution is high castes 53 per cent, Dalits 16 per cent , and ethnic groups 31 per cent .

[2] Newars are, in some cases, Hindus elsewhere in Nepal.

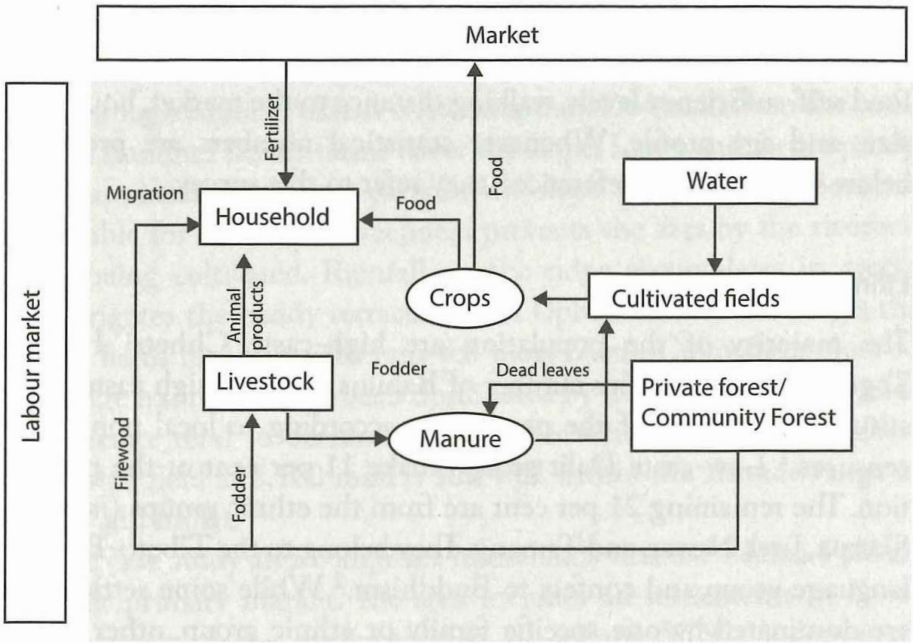

Figure 6.2 The farming system in Maina Pokhari

variables which are coupled in specific ways in order to enable agricultural production. Maina Pokhari is an agro-forestry farming system which is quite common in the Nepali Middle Hills. The main staples are rice, wheat, maize, and millet. The production is labour-intensive and the level of mechanization is low. Livestock is partly fed from the forests and with crop residues, and the manure ensures re-fertilization of the cultivated fields. In Figure 6.2, the dynamics of markets, climate, migration, and institutions are placed outside the analytical boundary in the figure because they are considered as external parameters of the farming system. The local climate is discussed in the fourth section.

Cultivated Fields and Crops

Irrigated rice and wheat are two of the main food crops in Maina Pokhari. Rice is pre-cultivated in nursery plots during the spring and transplanted into irrigated fields (*khet*) in June (Figure 6.3). The paddy needs to be flooded two to three times during the monsoon period, which lasts from June to September. The rice is harvested in October–November, before the fields are ploughed again. Manure is

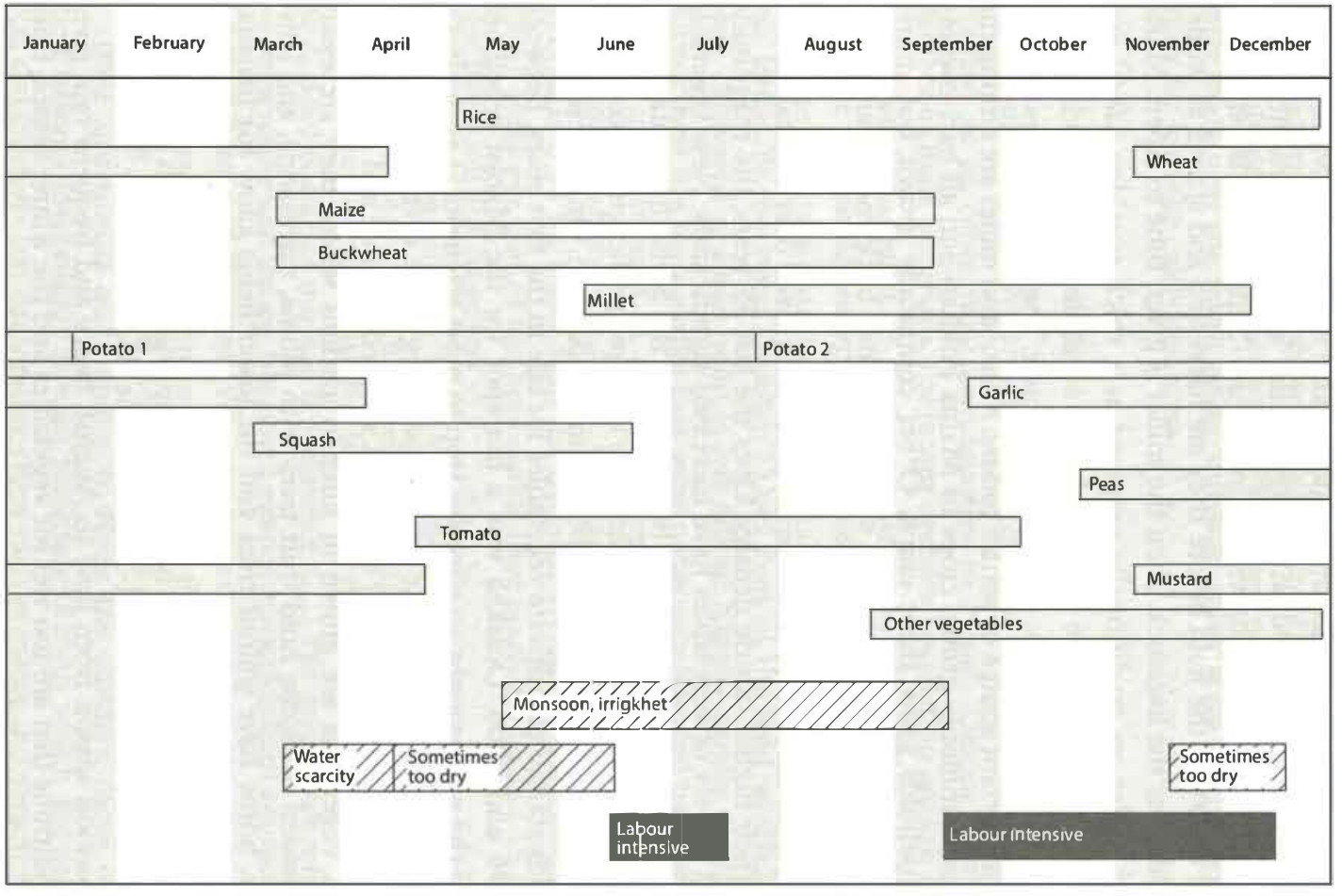

Figure 6.3 Agricultural calendar

then added and winter wheat is sown in the same fields in December. Two staple crops per year are grown in each field.

Rain-fed fields (bari) are planted with maize and millet, which can grow at higher altitudes than paddy. Maize is planted in March–April and then intercropped with finger millet about three months later. When the maize is harvested in August–September, the stalks are left to dry in the field before they are harvested and stored as winter fodder for the livestock. Then the millet is given time to ripen. Maize and millet are traditionally prepared as a thick porridge (*dedo*) and eaten as an alternative to rice. Maize and millet are used as livestock feed, for brewing beer, and distilling liquor. The crop residues are also an important source of winter fodder. Maize and millet are among the most commonly grown crops in Maina Pokhari and all bari-owning households grow these crops. Other commonly grown but minor crops are potatoes, mustard, sweet and bitter buckwheat, barley, and soybeans.

Staple crops have traditionally been prioritized over vegetables due to their higher calorie density. Over the last 35 years, the magnitude and variety of vegetables have increased significantly. New vegetable and fruit seeds were initially brought in by the Swiss, like squash, radish, apples, and pears. Over the years followed garlic, ginger, coriander, chilli, tomato, cauliflower, cabbage, and cardamom. Only a few households started to cultivate vegetables for sale in the first years. Between 1996 and 2006, Dolakha was a hot-spot for the Maoist rebellions and the war brought an effective stop to most attempts at agricultural development. Since peace was restored, vegetable diversification and cultivation for the market have been adopted by more and more farmers. Vegetables are grown in kitchen gardens where they are easily attended to. Some hold fruit trees with plums, mandarins, and lemons. Some have walnut trees and the lower fields allow for bananas and peanuts.

The vegetables are cultivated in the spring from March to May and in the autumn from mid-August to the end-November. During the monsoon season from June to August, heavy and frequent rain gives conditions that are too wet for vegetables and the winter season from December to February is currently too cold. One crucial constraint to vegetable production is the need for irrigation during the dry spring and autumn growing seasons. Some households have been able to

afford plastic-pipe irrigation while others have not. Irrigation is found more frequently in the downhill areas where rainwater has accumulated into creeks.

Crops are sometimes destroyed by pests, insects, and animals. Red ants attacking the potatoes and snails eating the vegetables are the most widespread problems. Some porcupines, rabbits, and bears take their share near the forest edges, but wild animals do not normally move far into the cultivated areas.

Degree of Land Exploitation

Abandonment of cultivated land is not quite as widespread in Maina Pokhari as in other rural communities in Nepal. Despite a high number of male emigrants, the recent decades' population growth has necessitated that most of the land continues to be cultivated. Out of all the households surveyed, 61 per cent cultivate all of their land while the rest have abandoned only small plots that lie far away, are less fertile, or too steep. In total, 15 per cent of the land which has been cultivated at some point is left fallow. Elderly people say that during their life span, slopes that were previously forested have been cleared and cultivated. A process of land fragmentation has taken place here as elsewhere in Nepal. In Maina Pokhari, the average land holding is 0.54 ha, lower than the national average of 0.8 ha (CBS, 2006). Fifty per cent of the households have up to 0.4 ha and 15 per cent have only 0.1 ha or less.

The cropping intensity varies with the household's labour capacity and needs. According to a male farmer (62), 'We cultivated more before. It is easier now, with the fertilizers, you don't have to work so hard. But because of our age it is difficult. (...) We grew more when we were young and strong, but now I cannot work that hard anymore.' A female farmer (62) stated: 'We grew more crops when my sons were home. We had 6 cows, oxen and buffalos at that time and many goats. But after my husband died, we sold most of them and some died.'

Their situation is quite common. After the children move out, their parents increasingly live off remittances from which they buy rice, and cultivate less demanding crops such as maize and sometimes only one crop per year. However, they do not sell the land. It is either sharecropped or extensively cultivated for animal feed.

Even if many parents cannot tell whether one of their sons would eventually move back home and cultivate, none of the surveyed households had sold or wanted to sell arable land. Their sons would inherit the land whether they chose to farm it or not. A proxy for land prices is the collateral demanded from the loaning and saving cooperatives, where one *ropani* (0.05 ha) of bari is estimated to Nepali Rupees (NPR) 100,000 (NPR 200 per square metre).[3] The only properties which are traded lie in the heart of Maina Pokhari marketplace. A favourable shop location by the road can reach a price more than a hundred times higher than a cultivated field. The marketplace is rapidly expanding with small shops and businesses.

Livestock

Each household has on average four to five goats, which need less staple feed than other animals and produce manure of good quality. They graze during the day and are stall-fed during the night with crop residues, foliage, and twigs, which are not suitable as cow fodder. Goat meat is preferred for festival meals during Dasain. There are three emic categories of goats: Female (*bakra*), male (*boka*), and castrated male (*khasi*). The meat of the khasi is preferred over boka due to the latter's hormones, which leave a strong taste. However, bokas and bakras are kept for manure, reproduction, and food.

Cows and buffaloes are kept for manure, but only by those who can afford to give them sufficient feed. A buffalo needs very large quantities of leaves, grass, and crop residues in addition to a significant amount of cereal crops. Cows and buffaloes produce milk, which is a valuable source of animal protein. One *mana* of milk (approximately 1 litre) is sold for NPR 20 and one buffalo can produce 3 litres of milk each day. Buffaloes are not used for ploughing. According to Hindu traditions and Nepali law, cows are holy creatures which are not slaughtered for meat. The tradition is upheld even among the Buddhists.

A pair of oxen is needed for ploughing. Only the wealthier households can afford to keep and feed oxen, which are a valuable source

[3] 100 Nepali Rupees (NPR) equals 1 USD (exchange rate 5 March 2015).

of income throughout the growing season. The local rate for renting a pair of oxen including a man's labour for ploughing is NPR 500 per day (USD 5). The wet paddy fields require animal draught power, but preparation of bari for maize, millet, and vegetables is done by hoe. Farmers rank the importance of fodder sources in the following order, from the most to the least important: 1. crop residues; 2. private forest; 3. cultivated fodder (maize, millet); 4. community forest; and 5. purchased fodder. There is no government forest in the area.

Out of all households, 90 per cent have goats, two-thirds have chickens, and every second household has at least one buffalo. Half of the wealthy households have oxen, while only one poor household has one. For cows, the figures are 35 per cent and 9 per cent respectively. Three Jirel households breed pigs and one Newar household has sheep. Five wealthy families keep doves, which are either sacrificed or released in pairs during certain religious ceremonies, and especially if someone is seriously ill. The doves are believed to bring luck and blessings to the owner.

Manure and Chemical Fertilizer

Paddy, wheat, and vegetables are fertilized with organic manure from the household's own livestock. Animal dung is mixed with leaves and straw from the stable bedding and decomposed in heaps. Chicken produce manure of high quality, but in small amounts that are primarily spared for the kitchen gardens. Goats give good quality manure in larger amounts and are preferred for the paddy fields, though often mixed with manure from cows, oxen, and buffaloes. The manure of the largest livestock is found to be rough and not the best if used alone, but on the other hand, the quantities are much larger.

Chemical fertilizers have been available since the road was opened in 1978, which was quite early compared to many other rural communities in Nepal. Farmers are now accustomed to using some chemical fertilizer in combination with manure. On average in the VDC, people use 240 kg of manure and 3.5 kg chemical fertilizer per ropani. The chemical fertilizers are applied mainly on maize and millet crops, even though these crops are mostly used for animal feed and less for food. People wish their paddy fields to be fertilized mostly by animal manure. Still, there is no taboo on applying chemical fertilizer

on paddy. When asked whether they need more chemical fertilizer if they were to increase their yields, farmers said no, more fertilizer would only deteriorate the soil and make it too compact. The typical amount bought is one bag of 30 kg per year.

> We used a lot of buff manure before. We cultivated a lot of land, but got smaller yields than now. Now we cultivate smaller areas, but still we get larger yields because we use chemical fertilizers. (Man, 60, in group discussion)

The size of livestock herds has decreased since chemical fertilizers were introduced, and the yields per unit area have increased. There is wide agreement that the use of fertilizers is very labour-efficient and that once they have started using it, it is hard to return to complete organic cultivation. One farmer described the conversion as 'like going from hell to heaven'. However, people often say that the food tastes better without fertilizer and that fertilizer must be mixed with manure to avoid soil degradation. Here, as elsewhere in Nepal, fertilizer use has spread rapidly over the last 35 years.

Forests: Fodder and Fuel-Wood

Mixed forests dominated by deciduous trees such as alder (*Alnus Nepalensis*), chilaune (*Schima Wallichii*), morello cherry (*Prunu Scerasus*), and rhododendron cover most of the non-cultivated area. In 1998, the Swiss planted pine trees in order to stabilize barren slopes. The risk of land slide was reduced, but farmers wished that deciduous trees had been planted instead. Farmers do not use pine needles for fodder, no under-wood is growing under the dense pine canopy, and the farmers claim that the pines deteriorate the runoff water by turning it too acidic. The soil under pine forests in Dolakha is strongly acidic, contains little organic matter, and is low in nitrogen, which altogether makes the soil in the forest floor infertile for other crops (Rimal, 2013). The wood is still used for furniture and firewood while the needles are useful as stable bedding.

Trees are either commonly managed or privately owned. In Maina Pokhari, most of the forested area is managed through Community Forest User Groups and 91 per cent of all households get their firewood from a community forest. In order to gain access, each household must pay a fee and be acknowledged as a community member.

A locally appointed management council decides the rules for fodder collection and timber cutting. The bottom-up decision-making structure results in slight variations in the rules from one community forest to the next, but the overall rules are similar and within the framework set by the District Forest Office. Fodder and dry twigs can be collected at any time, but the cutting of trees for firewood is only allowed during a defined opening time, normally between five and thirty days each year. A study of forest cover change in Dolakha District shows that the forest-covered area has increased and forest density has improved between 1990 and 2010, mainly due to the Community Forestry Programme (Niraula and Maharjan, 2011).

Any commercial exploitation of community forests is prohibited in order to ensure a sustainable and fairly equitable use. Berries, herbs, medicinal plants, and other non-timber forest products can be collected only for non-commercial purposes. Violation of the rules is sanctioned by fines, or in the worst case, by exclusion from the Community Forest User Group.

The second most important source of firewood is private forests. They are located on steep slopes nearby the fields. Most of the private forests have been standing for over a decade, but the use of such forests is currently changing. The traditional use value of having available construction materials, fodder, and firewood is now being supplemented with deliberate cultivation of cardamom, broom grass, bamboo, medicinal plants, and *argeli*. Cardamom, which thrives in moist soil under the shadow of alder trees, has become a valuable cash crop in recent years and is sold for NPR 900 per kilo. The main ecological constraint for cardamom cultivation is more often too dry and sandy soil, not the lack of shadow trees.

Household

The average household consists of 4.8 persons and owns 0.7 ha arable land, which is insufficient to fulfil the household food requirements. Two-thirds of the households have too little land to ensure food self-sufficiency throughout the year, despite recent increases in yields. Forty-one per cent of the households are self-sufficient for three to six months while 13 per cent produce only enough for less than three months. The majority (70 per cent) of the households have enough

maize and millet for the whole year and vegetables in the season, but additional rice is bought by about two-thirds (65 per cent) of the households.

Given the land they own, the farmers rank labour for farming as the relatively most constraining factor for increased production. The level of mechanization is low and family labour is the main, and at times, the only labour input. The farmers are thus peasants in the sense that they are 'small agricultural producers, who, with the help of simple equipment and the labour of their families, produce mostly for their own consumption' (Shanin, 1988 [1971]: 3). According to Chayanov (1920, in Chibnik, 1984), the economic rationality of peasants differs from a capitalist firm, since the peasants do not pay for their family labour while they need to fulfil at least a minimum requirement of food. The producer/consumer ratio (P/C ratio) is an indicator of the relationship between labour capacity and consumer needs in a peasant household, which, according to Chayanov, strongly affects the total volume of production in peasant societies (Chibnik, 1984). The P/C ratio varies with the age and health of the family members. The ratio thus highlights the life cycle aspect of poverty in contrast to structural causes of poverty.

P/C ratios are calculated for all households in the survey sample. There is, however, no significant correlation between the P/C ratio and months of food self-sufficiency from own production. One reason for the lack of correlation is the high frequency of labour migration, which withdraws the labour of productive family members from the farm system.

The need for an external income to buy rice, combined with the emergence of new labour markets, have led to pervasive emigration of men. About three in every four households (74 per cent) have at least one migrant, who occasionally return to their family house and can be summoned when needed. 'People go abroad, they don't want to farm anymore. But some come back, some. In the peak season they don't go abroad' (male, 77). Due to the high population growth, the substantial migration does not leave Maina Pokhari depopulated. The women and the elderly maintain cultivation in the absence of adult men. The majority of households (61 per cent) have not left any arable land abandoned, but the women cultivate less intensively when they are alone. A quite paradoxical situation has thus arisen as population

growth and land fragmentation caused scarcity of land relative to labour, which was followed by out-migration and scarcity of labour relative to land.

The rising consumption needs of a growing population and the desire for external incomes have been met by quite flexible combinations of strategies on-farm and off-farm. Circular migration gives the family flexibility to adjust the number of people on the farm after how much labour they need and how many mouths they can feed. It also serves the migrants with the opportunity to return home when they lack employment. High expectations for external income underpin the migrants' decisions just as much as the needs for their labour on the farm, and many take the risk of large loans. Kathmandu is their most common destination, while recent decades have seen a drastic increase in migration abroad and especially to the Gulf countries. One-fourth of all households now have a migrant abroad, which mirrors the trend throughout Nepal. At present, 1.9 million Nepalese people or 6.7 per cent of the population reside abroad (CBS, 2012).

Especially young men meet high expectations to earn an income off-farm. 'You must go outside to earn money, buy rice and take home' (male, 60). Remittances are spent on food and other necessities, to support old parents, and to invest in small businesses. A widely used short-term coping strategy after crop failure is to buy rice (75 per cent of all households). Since the village became better connected to national markets, the availability of imported rice has improved. Elderly people often choose to reduce their farming and rely more on remittances from their sons. The fact that people buy more imported rice than before is thus not necessarily an indicator for reduced production potential, but may just as well indicate increased off-farm incomes.

Intra-Household Relations

The community makes decisions over collective management of forests and water in the village farming system, but it is the single household that manages its family farm system. Following Grønhaug's (1978) example, scale is treated as a variable in this analysis. The household decides how to allocate their productive resources in order to fulfil their needs. At a lower scale, gender relations and other

intra-household relationships have implications for the division of labour and the decision-making process.

The gendered division of labour is quite relaxed, with few absolute taboos on which agricultural chores women and men can do. Still, the survey reveals that women generally do much more of the farm work than men do. Without any male assistance, women execute tasks such as planting of all crops, weeding, fodder collecting, herding, and harvesting in the majority of households. Men rarely perform these tasks alone (less than 6 per cent of the households). Ploughing with oxen in khet is the only task solely performed by men, but women prepare bari land with hoe. By renting oxen and male labour for ploughing, some women do all necessary tasks related to cultivation and animal husbandry during their husbands' absence. Women are also preferred over men as casual labourers because they are said to 'have faster hands' and are more thorough than men are during planting and harvesting. Still, women are paid half of a man's salary for one day's work.

When Esther Boserup (1989) discussed the varying relationships between rural population increase, farm system organization, and labour division, she explicitly assumed that rural women have a subordinate status to men and that the decision-making power belongs to men only. She further argued that when family labour is unpaid and land is abundant, women are responsible for producing subsistence crops while men prioritize cash crops and external income. The case from Maina Pokhari deviates from Boserup's general descriptions. Here, women alone make decisions over cash crops almost twice as often (42 per cent of the households) as men alone do (25 per cent). Both women and men sell crops in the local market. When all farming decisions are considered, which include decisions over cereals, vegetables, livestock, cash crops, and chemical fertilizers, women alone make decisions in 45 per cent of the households while men decide in only 25 per cent. In the remaining 30 per cent, the husband and wife decide together. However, men still dominate heavily in public affairs and in decisions regarding education and migration. Gendered patterns of labour division and decision-making have implications for how people organize their farm systems and for their adaptive capacity now and in the future, as will be demonstrated later in this chapter.

THE CURRENT LOCAL CLIMATE

Precipitation and Irrigation Water

The seasonal rainfall pattern is a crucial determinant for good crop yields. Snowfall is rare in the area, and although there are mountains of more than 7,000 masl close by, no streams of melt-water reach the hills of Maina Pokhari. The great Tamakoshi River which crosses Dolakha (see Figure 6.1) is inaccessible for irrigation purposes as it runs several hundred metres below the main cultivation area. The local perception is that rainfall is more frequent on the ridge compared to downhill. This is confirmed by meteorological data showing that the ridge receives 2,200 mm rain per year, compared to 1,500 mm per year in the downhill slopes (Chapter 3, this volume). On the other hand, the slopes have a much larger catchment area for runoff water. The downhill slopes thus have better conditions for irrigation, which is a requirement for paddy cultivation, than the more erratic rainfall on the ridge.

As much as 81 per cent of the annual precipitation falls from June to September, in which period there is abundant water for cultivation. In the winter, however, rainfall is scarce and the winter crops are prone to drying out. Farmers wait for 'the small rains', a one-to-two weeks' period of rainfall in February.

The farmers rank water as the second most important constraint to increased production, referring especially to the dry winter and spring seasons. There is a suitable period for vegetable cultivation in the winter, but only for the farmers who have irrigation pipes and water rights to a well. The water scarcity is high from March to May.

Altitude and Temperature

In mountain farming systems, altitude greatly impacts the cultivation potentials both in terms of yields and of crop composition. The growing season in Maina Pokhari is shorter near the ridge than downhill and the local altitude limit for rice cultivation is 1,890 masl.

Observational data from a weather station nearby Maina Pokhari have been adjusted for altitude to 1,500 m (downhill) and 2,100 m (ridge). The 600 m of altitude difference gives an estimated temperature difference of 3–4°C, which declines with altitude. At the

ridge, frost nights occur from December to February. Downhill at 1,500 m, there is normally no night frost although frost may occur in extreme cases. Farmers distinguish between 'black frost' and 'white frost'. Black frost refers to frozen ground while white frost means only frozen dew while the ground temperature stays above 0°C. Only the ridge farms experience black frost, which can do great damage to the crops. Although the monthly average temperature stays above freezing point, occasional night frost has recently destroyed rice crops as early as October–November at 1,833 masl. White frost in the early morning does not damage the crops, but rather adds moisture to the soil.

Historical Weather Shocks

The year 1970 marked the largest weather-related disaster in people's memory. A long and severe drought caused pervasive crop failure and severe food scarcity throughout the autumn and winter. Some governmental crisis relief was provided, but many families had to sell off their livestock and several people died of hunger. The fields were left dry and unproductive for almost a year. Due to fodder scarcity and the slaughtering of livestock, there was a lack of manure in the following spring and people's working capacity was reduced. However, the farming system proved resilient[4] enough to raise the production back to a normal level once water was available again.

Less dramatic but still damaging weather events are shorter droughts, intense rainfall, unexpected rain during the harvest, hail, strong winds, and frost. Very heavy rainfall can wash out the top soil and cause terraces to slide or collapse. The staple crops need a period of dry and sunny weather in the final stage of ripening. The 2013 rice harvest was rainy for five days and made the rice straws wet, hard to thresh, and increased the risk of mould during storage.

[4] Resilience is here defined in a narrow sense as 'capacity to absorb shocks and still maintain function' (Folke, 2006: 253). For the sake of concept clarity, the original definition is here chosen over the recent widening of the resilience concept to include capacity for renewal, re-organization, innovation, development, and potential to create opportunity for doing new things (Folke, 2006).

Hail and strong winds destroy more crops than rain as the ripe crops are hit to the ground. In the spring of 2013, a short but intense hailstorm hit the village and destroyed more than 50 per cent of all standing crops in less than 20 minutes. Still, the timing of the hailstorm could have been much worse had it hit the main staple crops. This time, only winter crops were destroyed.

Farmers' Perception of Change in Weather Patterns

> Twenty years ago it used to be colder. There was a lot more white frost before, much more frequent. (...) The water has started to dry up now, much more than it did 20 years ago. Now it is dry throughout the year, even now in Katic [October–November] there is less water coming. I had a source here, a small creek, but it dried up and now it is gone. (Male farmer, 77)

Many farmers have never heard about global warming. Those who have, see it as an abstract phenomenon 'outside', with limited relevance to them. Still, since they live off agriculture, people monitor closely the local weather patterns. People's perceptions of change cannot be directly interpreted as an indicator of local climatic change, as people reconstruct their historical accounts in the light of their present situations (Briggs, 1986). Still, their accounts point to specific events that may indicate local change. Farmers perceive that temperatures have increased over the last 20 years, and that droughts occur more frequently, especially in winter and early spring. The variation in rainfall has increased and days with very intense precipitation happen more often. Overall, farmers estimate that the total volume of available well water has decreased. Smaller wells and water sources have dried up and some have disappeared completely.

The perceived higher water stress can be caused by natural changes, by an increase in population and farming, or both. While the population has grown over the last 20 years, the increase is not evenly distributed. The marketplace in Maina Pokhari has grown several times more than the remaining settlements further away from the road. A rapid growth in seasonal and semi-permanent migrants counterbalances population growth and has left most settlements with small or no changes to their farming population. Higher yields per hectare from new seeds and chemical fertilizers may have increased the water demand, but since

farmers rank labour as their major constraint to increased production, the households' production potentials are probably not significantly higher than earlier. With the exception of the marketplace, there is little reason to assume that the water demand in agriculture has been substantially altered over the last two decades. Minor changes in demand may have occurred due to some increased cultivation of vegetables with pipe irrigation. Settlement changes and population growth may also have altered the demand for water from certain wells.

Changes in plant and animal species have been observed. The bird Meauli, which normally lives at 1,200–1,300 m, has now nested above 2,000 m. New pests, weeds, insects, and snails destroy the vegetables. Mosquitoes were never observed before but are now commonly seen. Some traditional beans and the guava fruit are now difficult to cultivate. Migration of species may happen for other reasons than a changing climate. Some hold that the mosquitoes started coming with the trucks after the road was built.

A continuous process of adaptation to an inherently variable local environment has always been a necessity for the farmers. The question is whether and how the variability itself will change, to what extent uncommon weather conditions will occur more frequently in the future, and how fast the changes will come. Climate change will exacerbate the local climatic uncertainty to which the farmers must adapt. Furthermore, if environmental changes occur much faster than in earlier times, they can compromise the adaptive capacity of local environmental knowledge systems and traditional adaptation strategies (Fernandez-Llamazares et al., 2015). The importance of local innovation to flexibility by mitigating certain adaptation challenges is discussed in the following section.

INNOVATIONS IN FARMING

One way of defining innovation is to follow Schumpeter, who distinguished between innovations and inventions. While an invention pushes the technological frontier to create something completely new, innovation is the process of creating local change which is new to the user (Schumpeter, 1939). The introduction of new crops and farming practices are innovations when they are new to those concerned at the local scale, irrespective of whether they are new to the world (Mytelka,

2000; World Bank, 2006). The following section discusses three cases of innovation by single households, each representing locally new options and ways of combining a farm's available production capacity into new outputs.

Vegetables for the Market

The first person who started cultivation of vegetables for sale in Maina Pokhari was a woman (now 65). She had inherited 120 ropani of land from her father, and contrary to normal practice, her husband moved to her house at marriage. They cultivated only staple crops for subsistence until 1987, when she became a member of a farmers' organization which provided training, seeds, and knowledge of market production. She started to cultivate cauliflower, *rayo* (a leafy vegetable), potatoes, and other vegetables for sale. The organization initially assisted in transportation and sales, but after some years she had established her own trading network.

The innovative element in this initiative was not primarily the types of crops she cultivated, but rather the deliberate production for sale at a time when there was no local market in the village. Although people would occasionally buy additional rice and other goods from 'outside', their own production was purely for subsistence purposes and some barter trade. Still now, there is a strong attitude that food cultivation is primarily for own consumption. The reluctance towards selling partly builds on an experience of the market as highly uncertain, and a habitual practice of sharing whatever you have in abundance. Sharing is practical in a rural community with limited storage facilities for fresh fruits and vegetables, but the mutual benefit of giving and receiving is also a confirmation of social relationships. How the exchange of gifts and favours functions as a social glue in the community is particularly visible during festival times, when a number of rituals involve the exchange of gifts such as fruits, nuts, rice, and other 'delicious foods'.

It is thus not so surprising that the woman who started to sell her vegetables for money met initial resistance and gossip about her being greedy. Over time, however, when she managed to be well-connected and got a significant income from 'outside', she became a much appreciated local employer. Today she hires several workers on an all-year basis and more than 20 seasonal workers return to her farm every year.

Her main cash crops are cauliflower, chilli, garlic, potatoes and sugarsnaps, which she sells in Maina Pokhari, Charikot, and Kathmandu for a total of NPR 250,000 per year.

Cardamom and Forest Products

Another local innovation is cardamom cultivation. Large cardamom (*Amomum Subulatum*) is a valued spice in Kathmandu and India. It has become a successful cash crop especially in eastern Nepal, but there the revenues have been severely reduced by pest. Cardamom is a perennial plant which thrives in moist soil without direct sunlight. It grows well in the shade of alder trees (*uttis, Alnus nepalensis*).

> When I first started to plant cardamom, people said I was mad not to plant maize. I spread the word to people to plant cardamom and broomgrass, but they did not listen to me. I have planted cardamom for ten years, and only now people are following. (Cardamom farmer, male, 54)

The quoted farmer was one of the first cardamom farmers in the area. After the establishment of a community forest nearby his fields, wild animals came closer and destroyed much of his rain-fed crops. During a study trip to Ilam in eastern Nepal, organized by the Community Forest User Groups and financed by foreign donors, he learnt about cultivation of cardamom and broomgrass. He was chosen by the group because he was an active farmer who wanted to learn new techniques. Upon return, he and his wife together chose to convert one-sixth of their cultivated land to a private forest where they planted alder trees and cardamom. After some years, they doubled the area to one-third of their land while keeping two-thirds for maize and millet. They now harvest 7 kg dry weight cardamom per ropani, which is sold for NPR 900 to 1,200 per kg. One kilo of dried cardamom is worth approximately the same as 25 kg imported rice bought in the local market. The calculation is somewhat hypothetical as cardamom is grown under forest cover and can be cultivated in moist rain-fed land and on steep hills, while rice needs irrigated and terraced land. Cardamom growers mostly convert bari to private forest, and so far only one farmer has chosen to convert some rice fields to cardamom and alder forest.

> Training is good. People are learning, slowly they will grow more cash crops, I think. People still think in traditional ways here. They grow maize

> and millet. But now as the prices are better, they have started slowly to grow broom grass, cardamom and other things too. (Cardamom farmer, male, 54)

The local innovation in this lies in the deliberate cultivation of tree crops for sale. Cardamom differs from vegetables by having minimal subsistence value and must be sold to be useful. However, the return from cultivating one ropani of cardamom is four times that of cultivating one ropani of local rice. Dried cardamom is also storable and low-weight, which gives lower transport costs and low risk of deteriorated quality before it reaches the market. Local middle-men come to the farms and buy the whole batch for an agreed price. Other forest-grown cash crops have also become popular, such as broom-grass (*omlisaw*), argeli, bamboo, and a Himalayan yew called *lodsalla* or *lauthsalla* (*Taxus wallichina*), which is used by pharmaceutical companies for cancer medicine. Once they are well established, these forest products demand less labour input than staple crops and vegetables. The parents of migrated youths grow tree crops to save labour and to generate some cash income, hoping that this will make a return to farming a more attractive option for their sons in the future.

Off-Season Tomato Project

The third example of innovation is off-season tomato cultivation. The initiative came in 2006 from a farmers' organization which appointed Lead Farmers and sent them on study tours. They received special training in new farming techniques and access to seeds. The Lead Farmers then started to arrange trainings for other farmers using the new seeds and techniques. In Maina Pokhari, the Lead Farmer started modern tomato cultivation in plastic tunnels, improved techniques for potato planting, and optimized use of different fertilizer components and new techniques for compost manure. He taught tomato cultivation techniques to interested local farmers. The tunnels were made of local bamboo covered with plastic sheets that protected the plants from the heavy monsoon rain. The investment costs were covered through public funding and the farmers' organization. The project now benefits from cultivation during the summer, when it is too hot and rainy in low-land Nepal and the market prices are relatively high. Other benefits are the good water availability in summer

and the suitability of the crop for farmers with small land holdings of bari land. Today, 45 farmers take part in the project, getting free seeds and plastic, while providing land, labour, manure, and water themselves. Through their effort and the VDC investment of NPR 150,000, the farmers have generated an annual income of NPR 3.2 million after two years.

In addition to vegetables, forest products, and sheltered tomatoes, several other innovations have been attempted recently, though so far with limited commercial success. Some farmers have tried fish farming, but the input cost of pellet feed is high and the large water demand of the dam is in conflict with the needs of neighbouring households. Others have invested in kiwi vines, pears, and lemons for sale. Traditional beekeeping is common in the area, and one farmer has now tried to produce honey for sale in Kathmandu. Another farmer has attempted cultivation of stevia (*Stevia rebaudiana*), which is a naturally sweet plant much used by the food industry. Several medicinal plants that grow naturally in the area can potentially be commercialized, and one farmer runs a nursery farm with more than twenty medicinal plants.

The total range of traditional and new crops, tree crops, and livestock rearing constitutes the opportunity situation of the village farming system, the full range of locally obtainable options in farming (Table 6.1). When the seeds, technology, and cultivation practice of a new crop are demonstrated as feasible in the area, it becomes an option that others may choose to adopt. The opportunity situation is thus not a list of crops that is feasible to be grown by one single household, but rather the range of locally possible options from which the farmers may choose, given their relative resource limitations. Table 6.1 gives an overview of the opportunity situation of Maina Pokhari, divided into traditional and recently introduced options (newer than ten years), according to land type. Only the species that are most important to the farmers are included, and altitude is considered only in the bottom row.

FARM-SYSTEM FLEXIBILITY

Flexibility in ecological systems is here defined as 'uncommitted potentialities for change' (Bateson, 1972: 505). The definition stems

Table 6.1 Opportunity situation of Maina Pokhari

Opportunity situation of Maina Pokhari					
Time (altitude) and land types	**Khet**	**Bari**	**Kitchen garden**	**Private forest**	**Other farm activities**
Traditional crops and practices	rice wheat	maize millet buckwheat mustard	saag (lettuce) rayo morel (poyo)	firewood fodder herbs, own use	local casual labour beekeeping livestock rearing milk, butter production
Introduced since 1987		potato pear apple guava	garlic radish turnip ginger turmeric squash/ zucchini sugarsnaps onion		hybrid cattle and buffalo
Introduced since 2003		kiwi pomegranate orange	tomato cabbage cauliflower vegetable seeds	cardamom broomgrass chiraito lodsalla argeli bamboo timur	broiler chicken
Up to 1,890 masl (traditional crops)	rice	peanut	banana guava orange		

from the understanding of an ecological system that comprises a set of interdependent variables, where each variable possesses an upper and a lower threshold of tolerance in its capacity (see Chapter 2, this volume). System flexibility exists if all the variables are exploited to

a degree which lies somewhere in between their respective tolerance limits. If the degree of exploitation of one variable is pushed towards the upper or the lower tolerance limit, the system lacks flexibility for that variable. Since sufficient capacity must be available in all variables to enable production, inflexibility spreads throughout the system if one variable is under severe stress. Further production can, thus, not be maintained without pushing the stressed variable beyond its tolerance limit. The result is unsustainable use of resources and degradation of the system.

Farming-system flexibility is one aspect of adaptation to uncertain local effects of climate change (Holmelin, 2010). In this chapter, I analyse flexibility primarily at the scale of the household farm system, and briefly at the community scale. As distinguished from a livelihood approach which focuses on the household and all its potential livelihoods within and outside agriculture, the focus for analysis here is the integrated system of agricultural production. The difference between the general community farming system and the household farm system here is understood as a difference of scale (Dixon and Gulliver, 2001).

The farmers manage their farm systems by means of their households' labour and by making decisions on how to allocate their productive resources to enable agricultural outputs. They are furthermore conditioned by the rights to, and distribution of, common property resources such as forests and water. Within the limited amounts of land, labour, water, livestock, forest, and the natural constraints imposed by altitude and climate, each household decides which combinations of crops it prefers and to what extent it invests labour on the farm or in other livelihoods. Farm-system flexibility is the uncommitted potentiality for change in exploitation of factors of production, in crop combinations and practices, and in how rapidly such changes can be made. There are thus three aspects of flexibility, which I have labelled scope, type, and temporal flexibility (Holmelin, 2010; Holmelin and Aase, 2013).[5] The following sections will address

[5] Flexibility of scope and type corresponds to the terms flexibility of retention and alternation in the theoretical introduction (Chapter 2, this volume). This chapter uses the terms 'type', 'scope', and 'temporal flexibility' in accordance with the above referred publications from 2010 and 2013.

these three aspects of flexibility in household farm systems in Maina Pokhari.

FLEXIBILITY OF SCOPE

Flexibility of scope refers to the potential, but currently unexploited, capacity in the factors of production (Holmelin and Aase, 2013), which in the context of agro-forestry means land, labour, water, forest, and livestock. Bateson's notion of flexibility in ecological systems mainly points to flexibility of scope. The emphasis lies on how there must be available capacity for change in all the main system variables in order to make the necessary room to manoeuvre, which is flexibility. The variable which is the closest to its upper or lower tolerance threshold will restrict the performance of the whole system.

In organic agriculture, manure is often a constraint to increased production. The large amount of animal manure needed to maintain soil fertility requires great labour input in livestock rearing and fodder collection. A study from the Indian Himalayan state Uttarakhand shows that each household must collect between 64 and 84 kg of green fodder plus the same amount of dry crop residues every day in order to feed their livestock in an agro-forestry farming system (Dhyani *et al.*, 2011).

In Maina Pokhari, people have added chemical fertilizers to organic manure since the early 1980s. Manure has thus become less significant as a production constraint. The use of chemical fertilizer is very labour-efficient compared to manure. However, it requires cash and farmers have experienced that chemical fertilizers must be applied in modest amounts in order to avoid soil degradation. 'The taste of local rice was better before the fertilizer, but production is better now. Before the fertilizer, we needed a lot of livestock to get enough manure for the rice' (female, 61). Taste is a high priority for the farmers and there is a trade-off between more tasteful organic rice and higher production through chemical fertilizer. The common choice is to use mostly organic manure and add smaller amounts of chemical fertilizer. Because the farming system has previously supported larger livestock herds, the flexibility of scope for livestock means that the number of animals could again be increased if found necessary or desirable in the future.

The availability of forest resources is currently good and does not constrain production. The use of private forests is high and the system of Community Forest User Groups ensures a collective forest management with agreed rules for firewood extraction. Tree crop cultivation and extraction of products for sale is permitted only from private forests. The current exploitation of local community forests is thus far from its upper tolerance limit.

Land: First Constraint to Flexibility of Scope

Each household has a given amount of arable land that is relatively stable, as sale of cultivated land is very rare. Land is a precious resource and the assumed price from sale is too low to be acceptable. Land ownership thus changes hands almost only through inheritance, but land holdings tend to decrease for each generation when several sons must split the land. Nonetheless, there is some flexibility of scope in land through the system of sharecropping, where the sharecropper pays 50 per cent of the yields to the land owner. Currently, 6 per cent of the surveyed households rent and sharecrop plots, on average 1.3 ha per sharecropper.

One major turnover of land occurred after the 1997 Amendment to the Land Reform Act. Farmers who had sharecropped the same land for a certain number of years became entitled to 50 per cent of the land they had sharecropped (Aase et al., 2010). The new regulation was criticized by land-prosperous groups, but the sharecroppers were naturally satisfied. In Maina Pokhari, several previously poor sharecroppers now have their own private land.

Labour: Second Constraint to Flexibility of Scope

> If we have friends and family over to work for us, we don't pay. We come to your farm today and my farm tomorrow. If we have non-family workers, then we pay per day. In money or in grains.(Group discussion)

Although a family's labour capacity is fixed in the short term, there are four strategies for creating additional flexibility of scope in the amount of available labour for farming. The first three strategies constitute flexibility at the community level of scale, while the fourth represents flexibility at the scale of the household. First, there is the

system of sharecropping which has deep historical roots in Nepal. After the 1997 Amendment, however, people are more reluctant to lease out land for longer periods.

Second, to hire casual labour on a daily basis is a very flexible strategy. Many small-holders who need additional income prefer to work as casual labourers instead of sharecropping because they are guaranteed immediate payment. Casual labour can cross caste boundaries and is an important economic bond between castes (Miller, 1990; Onta and Resurrection, 2011). Land-prosperous families, who often are Bahun or Chhetri, can hire workers from all ethnic groups and castes, including Dalits. Bahuns do not plough and depend on rented labour for that task. However, to hire labour is not reserved only for the higher castes. A Dalit couple who has managed to buy land by means of the husband's migration and remittances hires casual workers in peak seasons. On the other hand, some Dalits are still bonded labourers who work for high-caste families.

The casual labour system is not a free market. Large-holders have their established networks of neighbours and friends whom they can call for whenever there is work to do. In return, they are more or less obliged to find some task when a loyal casual worker comes and asks for work. Neither the casual workers nor the employers see much difficulty in finding work or workers when needed, despite the very high seasonal fluctuations in demand. If someone from another area arrives and seeks employment, however, the answer is often no. Traditions, loyalty, and family bonds regulate much of the casual labour transactions and make the interaction quite predictable for all involved. Poor families often say that they would not survive without neighbours who give them work when they need it.

Third, a traditional system of labour exchange (*parma*) exists here as elsewhere in Nepal (Miller, 1990). A parma is a network that can be mobilized for collective work. All households in the same parma join their forces and work at one family's fields for one day, moving to the next family's fields the next day. No payment is given but all involved know who owes labour and who is next in line. Each family then gets all or most of its land harvested in one day. Normally, all parma workers belong to the same caste (Miller, 1990).

Last, the fourth strategy to increase labour capacity is to summon household members. Migrant workers cannot always afford to return

home every year, but when they do, they prefer the busy rice harvest and festival period in the autumn. Many families use Kathmandu as a second dwelling where their sons, daughters, and relatives occasionally stay. The Sherpas are particularly used to having multiple dwellings, but the expression 'they come and go' is frequently used by all castes and ethnic groups when they refer to circular migration.

Of the four forms of labour exchange, casual labour and circular migration offer most flexibility of scope. By hiring extra people during peak seasons, one family can produce more than their own labour capacity would allow for. It is thus not surprising that there is no statistically significant correlation between household size and production, nor between households' P/C-ratio and wealth, cash crops, or level of self-sufficiency respectively. Casual labour is very flexible in the short term but does not bring any significant income above subsistence level, while migration is a more long-term labour investment which may, though at a risk, generate a much larger profit than what is possible to achieve locally.

Productivity can be assessed in at least three ways. First, productivity of land is measured in yields per unit area, such as metric tonnes per hectare. High efficiency in land use is then regarded as high productivity. Second, productivity can refer to labour productivity, or income per working day or per hour. Third, productivity can refer to water productivity, that is, the amount of food or calories that is produced per unit of available water. According to the third way of measuring productivity, rain-fed maize and millet cultivation is a highly productive and rational strategy. Maize and millet crops have lower water requirements than paddy. They are reliable and relatively drought resistant crops, and the practice of intercropping spreads the risk of damage from drought periods. If maize yields are reduced due to water scarcity, farmers plant millet earlier in the season and with greater seed density than normal. Whenever the monsoon brings little summer rain and consequently reduces rice yields, the millet will still yield quite well. Productivity can thus be considered as a measure of optimization relative to the most constrained production factor. Households that have rice fields with good irrigation systems and many workers have high land productivity while water and labour productivity is lower. Conversely, households that have limited labour capacity will manage their farm system to keep labour productivity

high while allowing land productivity to be lower. Other times, farmers prioritize to make the most out of their available water. When several of the factors are limited, farmers must choose their strategy while balancing the options, priorities, and needs of the family. To acknowledge only one of the measures of productivity would be to neglect the complexity of situations in which farmers make their decisions.

Water: Third Constraint to Flexibility of Scope

The drought in 1970 demonstrated how a severe lack of water can put an effective stop to the total system's performance. The water availability was critically low and the variable was exploited at its upper threshold of tolerance. Inflexibility spread throughout the farming system, leaving the fields of the whole community unproductive until more rain appeared. At the other extreme, too much water can reduce production by flooding and washing out the top soil, by reducing grain filling, or by hitting ripe crops to the ground.

Seasonal variability in precipitation can also constrain production even if the annual amount of precipitation is unchanged. A delay in the monsoon rain can create large problems for rice cultivation as the seed samples must be transplanted within a short time span. Gravity-based irrigation canals and water tanks can bridge shorter drought periods, thereby offering some flexibility of scope in water availability. However, the amounts of water needed for the staple crops largely exceed the capacity of small water tanks. The types of crops and their natural water requirements are very important for determining yields under variable rainfall.

While flexibility of scope concerns the available capacity of input factors, the second aspect of flexibility points to the opportunities for change in output.

FLEXIBILITY OF TYPE

Flexibility of type is the ability to change the crop composition, to have a range of potential crops and agricultural products to choose from, when the weather, the market, or other conditions change. It involves the potential to use the available factors of production in

various ways and for various purposes. Flexibility of type thus refers to the space of opportunity for changing the produced output. The following discussion demonstrates various ways in which the farmers use flexibility of type in their farm systems.

'We don't even have enough to eat, how can we sell anything?' The statement points to the high priority of subsistence production over cash crops. Crop diversity is characteristic for traditional farming, where most of the household needs must be fulfilled by means of own production. Rice and wheat are food favourites while maize is used for porridge and snacks.

Local seed varieties that perform well and are robust are selected for recycling the next season. The specific characteristics of the seed varieties, like suitability for the soil, water requirements, drought tolerance, grain filling abilities, threshing properties, and not least the taste, are important aspects that the farmers consider before choosing seed varieties. When testing a new seed, they plant only a small test plot for at least one season before deciding whether to adopt it. Farmers prioritize differently, depending on their priorities and resources. Those whose fields are strongly sun-exposed and tend to dry out choose more drought-resistant seed varieties while others choose varieties with higher yield potential under optimal conditions. Still others choose varieties that demand much labour but give the best taste and cooking qualities. Farmers exchange seeds or buy new varieties from the market and from neighbouring areas. They often have three or four different rice varieties in the same field for, as they say, 'if one fails, then we have the others to rely on'. The great range of locally cultivated varieties serves farmers with flexibility of type by enabling them to experiment with different varieties of the main staple crops and alternate between different crops.

Another flexibility of type lies in the many combinations of food crops. Some choose sweet and bitter buckwheat, naked barley (*uwa*), hooded barley (*dzou*), potatoes, or mustard seeds as second crops after maize. Various beans, radish, lettuce, peanuts, cauliflower, cabbage, squash, garlic, chilli, plums, and walnuts are all commonly cultivated for subsistence. Farmers do not normally distinguish between subsistence and cash crops. According to a female farmer (45), 'If one crop fails, we have the others to eat. I don't want to specialize. Sometimes when I get good yields I sell some, but other times I get less and don't

sell anything'. Although she lost three-quarters of her standing crops of potato, wheat, and peas in a hailstorm, she ploughed again and planted the safer crop of maize, succeeded by millet and peanut. Her choice of not specializing enables her to alternate between pure subsistence crops and food crops that can be consumed in the household as well as sold.

> One year all the garlic failed. The next year we planted cauliflower instead, we ate the cauliflower and sold the seeds. We got a good price, 900 NPR per kilo for the seeds. But potato is the preferred crop, both for eating and selling. It can be stored for a long time. (...) Earlier we had to find work in other places, as seasonal labourers. Now we don't have to go away anymore, we can stay here and cultivate and live only from that. (Male, 45)

This household's ability to switch from one crop to another represents the flexibility of type in the household farm system. When locally new crops such as potato, garlic, and cauliflower became widespread, the households chose to invest more labour in their own farms instead of migrating. Almost all households in the settlement of Yarza have increased their vegetable cultivation after they got seasonal road access. Their settlement is located too high for rice cultivation, but they have cut down on winter wheat to make room for vegetables. The possibility for including high-value crops is a third example of farm system flexibility of type. The spreading of an innovation has enabled most households in this settlement to cultivate vegetables for sale, thereby adding another opportunity that the farmers may choose.

A fourth flexibility of type is to combine field cultivation with forest products such as cardamom, argeli, broomgrass, and the medicinal yew, lodsalla. To combine the two forms of cultivation is important and specialization is not favoured: 'For eating, rice is most important. For money, cardamom is most important' (male, 41). The perception and experience of market uncertainty makes a specialization into only one type of crops not preferred. Furthermore, the different land types are suitable for different crops. This farmer cultivates rice in his khet, maize and millet in his bari, vegetables and fruits in his orchard, and cardamom in his private forest.

Last, a fifth flexibility of type is to alter the balance of crop cultivation and livestock rearing. Livestock is not only a source of manure, but also a form of stored capital and a food buffer. In times of need for

cash, a goat is slaughtered and the meat sold. A good goat can raise as much as NPR 10,000. If the crops fail one year, people put more effort in collecting fodder and raise more goats. Poorer households with small land holdings often choose this strategy.

The five forms of flexibility of type show some of the available opportunities for adaptation that exist in the household farm systems. The farmers are managers of their farm systems and are the ones who choose their crop combinations and cultivation strategies, but as shown earlier, they must operate within the space of opportunities limited by the resource constraints that their farm system offers. Without any khet land, paddy cannot be cultivated. However, local innovations that occur in the village farming system have increased the opportunity space from which the individual farmers choose. As long as no comprehensive specialization or land abandonment occurs, the spreading of local innovations increases the flexibility of type by offering farmers more options for alternative crops, new combinations, and new practices, in addition to the traditional ones.

Flexibility means opportunities for adaptation, and any change needs time to occur. The third aspect of flexibility is temporal flexibility, which refers to the time needed to change and alternate between different crops, varieties, and agricultural practices.

TEMPORAL FLEXIBILITY

While vegetables ripen in a few months, cardamom, fruit trees, and other tree crops take years before they yield. In the meantime, the soil is occupied and the new trees need much water and care. An investment in tree planting must thus be chosen with a longer time horizon than vegetable cultivation. A distinction can be drawn between short-term and long-term temporal flexibility (Carlsson, 1989; Holmelin and Aase, 2013; Lev and Campbell, 1987). Short-term temporal flexibility is defined here as the ability to rapidly alternate between different crops and practices and reallocate available capacity of production factors (Holmelin and Aase, 2013); more specifically, the capability to change within one growing season and from one season to the next. Long-term temporal flexibility is the opportunity for change over a longer time horizon, such as several years or generations, and

thus concerns farmers' options and plans for the future in the face of uncertainty (Holmelin and Aase, 2013).

Not all innovations are successful the first time. When a crop investment fails, the ability to quickly re-cultivate the fields with a safe traditional crop is an expression of short-time temporal flexibility in the farm system. Such temporal flexibility was demonstrated by the farmer (female, 45) mentioned earlier, who sowed maize after her crops were destroyed by hail. Some typical combinations in bari land are maize–millet–fallow, maize–fallow–wheat, maize–buckwheat–fallow, and maize–millet and mustard intercropped. For khet, rice–wheat is the by far most common crop cycle. Potatoes can easily replace one of the bari crops, and summer tomatoes can be grown in khet land under plastic shelters. All vegetables can be cultivated within one growing season. The expansion of opportunities that has come with larger crop diversity has increased the temporal flexibility of the farm systems since the seed availability is good and a wider range of species can be cultivated now, compared to earlier. Greater flexibility of type has thus increased the short-term temporal flexibility.

> You can have potatoes twice in one year. Or, you can plant cauliflower after potato and maize. You can grow tomato and potato at the same time in different plots, because potatoes can grow also in the summer. Now, this winter season, I will plant a little chilli and some garlic. (Male farmer, 30)

Not only vegetables, but also spices like ginger, turmeric, chilli, and coriander are now available crops. The high-value, low-weight crops offer opportunities for cash income and function as safety valves or buffers that can save an otherwise difficult lean season that normally follows a staple crop failure.

A Case of Flexible Adaptation

The capability to switch rapidly between options is demonstrated by the following case.

A returned migrant farmer (male, 30) rented bari land on which he planted stevia, with delivery agreement to a company in Kathmandu for NPR 200 per kilo. The prospects for profit were good, the plant is perennial with a life cycle of 11 years, and the ripe leaves can be harvested up to six times per year. His savings from migration and a

loan from the local loaning cooperative enabled the investment. The cultivation was successful and the first yields were good. However, the company had gone bankrupt. His investment was unsuccessful, but the reason lay in the market outside his control. The farmer then chose to plant sugarsnaps while keeping only a few of the stevia plants on the side. He grew vegetables as a cash crop for one more season, before he again migrated to Dubai in order to pay his debt. His own land was never used for cash crops but was kept by his wife (22) for traditional cereal production. He stated that he primarily wanted to stay and work at home with his wife and child, but in order to secure an income, he needed to grow something for sale.

The case demonstrates how flexibility of scope, type, and temporality are interlinked and how an innovation may expand flexibility of type in a farm system. The family was constrained from expanding cultivation in its own fields, but by renting additional land, it removed the land constraint. Cultivation of stevia was a local innovation, but instead of investing in the new cash crop in all available land, it maintained traditional food production in its privately owned fields. The constraint of labour was severe when the husband was abroad. During that period, his wife had to care for her child and her mother-in-law while keeping the house and cultivating food crops. By returning home and investing his labour in agriculture, the husband was able to grow cash crops and help his wife with subsistence cultivation. The last important constraint to their flexibility of scope was sufficient access to water. Savings from migration enabled them to invest in a plastic pipe. By using the farm system flexibility of scope in terms of land, labour, and water, they could diversify from only subsistence crops to include a new cash crop. When the stevia was unsuccessful, they used the existing flexibility of type by changing their cash crop from stevia to sugarsnaps for the local market. The rapid conversion demonstrates a high temporal flexibility.

A CHANGING OPPORTUNITY SITUATION

The downscaled climate scenarios for Maina Pokhari for 2010 to 2030 (Chapter 3, this volume) project that the temperatures will increase by up to 0.9°C, with the strongest warming occurring at night time. The maximum daytime temperature is projected to peak at 27.4°C in June

at 1,500 m. Temperatures have so far not exceeded 30°C, which is the heat tolerance limit for maize (Lobell et al., 2011) and wheat (Lobell et al., 2012). The heat stress limit of wheat will not be a large problem in Maina Pokhari since wheat is cultivated in the cold season. For maize, however, the warming could become problematic. The daily variations within each month can give days with temperatures higher than 30°C, despite a slightly lower monthly average.

The total amount of rain is projected to decrease by 90 mm per year in the near future (2010–30). For the farmers who experience seasonal drought as a constraint to cultivation, the expected change in the distribution of rain is very important. Table 6.2 is derived from the downscaled projections (Chapter 3, this volume). Only the data for 2,100 metres is shown in table 6.2 as the differences in seasonal distribution are small between 1,500 and 2,100 m.

Table 6.2 shows a trend towards a reduction in the total annual amount of rain, although not dramatically in the near future. Exactly how the monsoon rain will change and whether the variation in monsoon onset will be enlarged, is uncertain. A larger share of the rain will fall outside the four wettest summer months, implying that the monsoon rains will be less heavy. However, there is a slightly larger risk for extremely wet days (see Chapter 3, this volume). The 'small rains' in the winter will increase, while the spring will

Table 6.2 Projected relative distribution of precipitation over seasons (2100 m asl)

Time period	1996–2005	2010–30	2030–50	2050–80
Total annual precipitation (projected change)	2,206 mm (Baseline)	2,116 mm (–90 mm)	2,111mm (–92 mm)	1,866 mm (–340 mm)
Summer (wet season, June–September)	81%	78%	81%	71%
Autumn (October–November)	4%	4%	4%	9%
Winter (December–February)	2%	5%	3%	8%
Spring (March–May)	13%	13%	12%	12%
Sum	100%	100%	100%	100%

probably receive slightly less rain over time, given the minor decline in relative share plus a total reduction in annual rainfall. October and November will receive relatively more precipitation in the distant future.

For the farmers, the changes that are projected in Chapter 3 include both good news and bad news. Less heavy precipitation during the wettest months reduces the risk of landslides and wash-out of topsoil. More rain in October and November is a disadvantage for the rice harvest, since rice needs a period of drying before it is stored.

More rain in January and February may be a benefit for the cultivation of winter vegetables, especially if the winter temperatures rise as projected. So far, only a small share of the households practise winter cultivation of vegetables, but if the climate conditions become more favourable, it represents an uncommitted potentiality for increasing the incomes in an otherwise lean season. Garlic, peas, mustard, and potatoes are currently grown in this period. Experimentation with other vegetables, spices, and medicinal plants could provide even more opportunities for diversification.

The agricultural calendar is extremely fine-tuned. A delay in the planting date, for instance, due to unexpected dry or wet weather, can leave too little time for the next crop in the cycle. Today, the season with the most severe water scarcity is March, April, and May. The spring water scarcity is more likely to worsen rather than to improve after 2030.

Maize and buckwheat will do better during drought than ripening potatoes. Pipe irrigation and small water tanks have been installed here and there, but they are of little use if there is too little water to recharge the ponds and streams. As expressed by a woman, 'kholsa chha, pani chhaina' (there is a creek, but no water). If the conditions for winter vegetables are improved, it is likely that people will use all available water for pipe irrigation in that period.

Higher temperatures can give longer growing seasons at higher altitudes and open new opportunities for crops normally cultivated downhill. The projected warming indicates that in 2010–30, current crops can be grown about 200 metres higher, while in 2030–50, today's crops can be grown at 325 m-higher elevation (Chapter 10, this volume). One farmer compares his area to the neighbouring district Namdu, located a few hundred meters lower.

> If it gets warmer here, like it is in Namdu, it might be possible to grow three crops here too. Maize, millet and wheat, all in the same year. But it must be warm both day and night. Having sun all day does not help if it is cold at night. But in Namdu they lack water. There is not much potato there, it is too dry. (Male, 54)

Two annual staple crops today could become three in the future. It is also likely that yields will increase over time. Lower risk for night frost in spring and autumn will reduce crop losses from sudden frost. Today, farms at 1,500 m are normally spared from night frost and in the near future even farms at 2,100 m could avoid frost. Temperature increases are expected to be higher in the mountains than in lower areas and are less uncertain than changes in precipitation, but climate projections calculate expected trends and cannot precisely predict the variations between days, months and years. Certain years in the future might even be colder than today, despite the trend towards a general warming. Uncertain weather conditions are part of the farmers' reality. The flexibility of scope, type, and temporality that exists in household farm systems and in the community farming system offers the farmers opportunities for change that enable them to adapt to uncertain climate and market conditions.

LONG-TERM TEMPORAL FLEXIBILITY: THE RETURN OF THE MIGRANTS?

What are the prospects for local agriculture in a long-term perspective, in the decades to come? Is it likely that the household farm systems are sufficiently flexible to adapt to unexpected changes in the future? The long-term flexibility of scope and type demands a look at the resource capacity, the opportunity space of crops, and the dynamics of change from a slightly different perspective than from season to season. Still, the requirements for farming flexibility remain the same: available capacity in production factors, a range of known though not always currently used crops and practices, and the ability to alternate between different strategies in order to avoid losses from limiting factors of production.

The flexibility of scope in the three constraints section, land, labour and water, is changing over time. Out of the three, land availability is the factor least likely to change much. So far, no one has sold their

agricultural land and the very thought of doing so is strange to the people of Maina Pokhari. 'I will keep the land, not sell it. If I don't have success abroad, then I can come back home and cultivate the land' (male, 21). People see land as a buffer, a resource to be saved for later use. This thought is in line with Bateson's metaphor that flexibility is produced by saving up a buffer zone of unexploited capacity that can 'be spent (like fat) upon needed change' (Bateson, 1972: 497). On the other hand, flexibility must be used occasionally in order to prevail. If it were not for the women who run the farms while the migrants are absent, a return to agriculture would be difficult and very costly in terms of money and labour investments. The women's continuous work at home allows for male migration without much loss of flexibility on the farm. If a farm is abandoned completely for years, the fields develop bush and tree vegetation, terraces collapse, irrigation channels are blocked or start leaking, and there is no livestock. The lower thresholds in the flexibility of scope can thus be crossed if the farm is completely abandoned for many years. If, however, cultivation is maintained at some level, even extensively, it is possible to change, for instance, from millet to potato or tomato cultivation without large investments. The strategy of senior farmers to plant private forests with cardamom, broom grass, and bamboo is one expression of investment in long-term flexibility. The forest products are not profitable the first years of cultivation, but once they are established, they demand less labour than staple crops. Furthermore, parents assume that high-value forest products make a return to the village a more attractive option for their sons.

Labour capacity fluctuates greatly and has high temporal flexibility in the short term. As labour for farming is one of the main constraints to increased production today, a major question is whether the young male migrants wish or see the need to return to the village after a period of migration. One parent has the following view of the situation:

> We have the feeling that now when children get education, then it is inferior to go back to farming. They want easy jobs instead, they think farming gives them lower status. People go out now, abroad or to Kathmandu, but later, sometime in the future, they will come back and farm again. (Group discussion)

Although the parent understands the interest in education and wage work among the youth, he still thinks that his sons will eventually

return to farming. Farming is regarded as a safety net, a secure though not too exciting backup plan if the dream of earning 'big money' is not fulfilled. People perceive the 'outside' world as uncertain and not reliable for making a living in the long run. 'Some people who don't want to farm, they go abroad instead. But it is not easy abroad either. The people who went to Malaysia did not earn much money, so they came back here and started farming again', said a father (41). The importance of local innovation for young people's interest in farming should not be underestimated. Few want to take over the farm only to grow maize and millet. With more education combined with demand for cell phones, modern clothes, motor bikes, and televisions, the young generation is increasingly interested in earning at least a small income. Still, those who have been to Kathmandu complain about traffic, air pollution, poor water availability and high living costs. The excitement and experience of going 'outside' is attractive, but after that, the young men's plans differ. A man (20) said, 'If I find a job here, I will come back. If I get a job in another place, I have to go there. But I will come back if it is possible.' Another man (15) stated, 'I want to go outside to study, but after that I want to come back here. I want to develop this place. Do business and some farming.'

The two men do want to return if they can do some business in addition to farming. As long as there is an opportunity for income, farming for subsistence is a natural part of village life. Local innovations that widen the opportunity space with new high-value crops make farming more attractive for the young, thus potentially relieving the labour constraint in the farm systems. To what extent the young men will return permanently to the village and farming is uncertain. However, so far the farm systems have proven sufficiently flexible to serve them with the opportunity to return if they choose to do so.

Future climate change will affect local water availability in various ways, but the inherent uncertainty of projections increases with the time horizon. The future of the markets for food and labour are likewise characterized by uncertainty. The Gulf countries are popular destinations for Nepali emigrants, where the need for cheap labour has grown exponentially in recent decades. If, at some point, there is a downturn in these oil-fuelled economies, the thousands of unskilled Nepali workers on temporary contracts will be among the first to lose their jobs. While a drop in demand for cheap labour may be

compensated by other growing economies, Nepal is far from the only country with emigrants seeking work. In the food markets, the Food and Agriculture Organization of the United Nations (FAO, 2012) predicts that international food prices will be strongly volatile and generally increase in the decades to come due to climate change impacts, increasing demand, and market dynamics. These large-scale uncertainties make local food production increasingly important for household food security in the future. Seeking to maintain and increase flexibility in farming is a viable strategy to meet these and other large-scale uncertainties, in a short as well as a long time horizon.

CONCLUSIONS: MEETING THE FUTURE WITH FARM SYSTEM FLEXIBILITY

The local effects of global climate change will alter the conditions for food production by changing at least two important variables: temperature and precipitation. Climate change coincides with other large-scale processes such as fluctuating food prices, a rapidly changing international labour market, infrastructure development, and greater integration of local communities into a monetized economy. The combined effects of changes in natural, social, and economic environments make the future local conditions for farmers quite uncertain. Their capacity to adapt to these large-scale uncertainties depends on their flexibility to regulate agricultural production accordingly. In Maina Pokhari, farmers are already coping with changes such as male migration and climatic variability.

While many rural communities with extensive migration experience land abandonment and declining agricultural production (Aase et al., 2010; Gooch, 2014), in Maina Pokhari, young men have started to return to the villages. Local innovations such as vegetable production for the market, combined food and cash crops, and forest products make agriculture a more attractive choice for young men searching for income opportunities. The processes of diversification, innovation, and new combinations of subsistence and market production are primarily driven by the women and men who stay permanently at the farms, but the inspiration for trying something new has arisen through travels and interactions, mostly by men, with people outside the local community. While the farming system is still dominated by traditional subsistence

production, over the recent years, it has become increasingly popular to dedicate a small part of the land to various crops for sale. However, no one has so far specialized completely in production for the market.

The transition from a purely subsistence economy to a partly monetized market economy is not unproblematic. Today, almost all households must buy some rice to fulfil their food requirements. They are already partly integrated in markets, though mainly as net purchasers. Any production that can generate an income mitigates their dependence on remittances from migrants outside and makes a return to the village more attractive for youths. A balanced market integration with a flexible combination of food production and high-value crops is, therefore, of high importance for household food security. The case of Maina Pokhari further shows that while women do more of the farm-related work, they are far from disfavoured in decision-making. On average, women are more influential in farm decisions than men are.

As long as the farmers continue to grow traditional staple crops in addition to newly introduced crops and practices, innovation contributes to enlarge the opportunity space from which the farmers can choose their combinations. Innovations that enable a diversification of the farming system increases the range of options available to the farmers, thereby increasing the flexibility of type in the household farm systems. However, a basic condition for cultivation of traditional as well as new crops is the available capacity in all of the production factors. Flexibility of scope requires buffers of unused capacity in land, labour, water, and so on, where constraints in one of the factors limit the performance of the system. The changing temperature and precipitation patterns expected with climate change will thus alter the flexibility of scope in the farming system.

Downscaled climate scenarios for the near future (2010–30) project that the local climate will change towards higher temperatures and a reduction in annual amounts of precipitation. The seasonal distribution will change towards a slight decrease in the summer rains, an extension of the rainy period into the autumn, and more rain in the winter. The total amount of rainwater in spring will decline, although the relative share of water in spring will decline only after 2030. Both the demand and availability of water are seasonally variable and reduced water in spring does not bode well for the spring crops. On the other hand, more water in winter may permit vegetable

production in an otherwise lean season. The flexibility of household farm systems to seize the new opportunities while at the same time keeping the safe, drought-resistant, and traditional subsistence crops will largely determine to what extent they are able to successfully adapt to climatic and market variability.

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Competing gender norms and social practice in Himalayan farm management

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ABSTRACT

Gender relations in Himalayan farm management are influenced by differentiated social expectations of men and women. How people negotiate their gender role space and how they relate to explicit and tacit gender norms, shape gendered patterns of decision-making in agriculture. In this case study from the Nepali Middle Hills I argue that there are two competing sets of cultural gender norms at work, in contrast to Sherry Ortner's classical theory of a gender hegemony, where she describes a hegemonic collection of cultural logics, meanings and practices related to gender. In this case, modern development ideas of women empowerment and gender equality currently challenge traditional gender norms, but there are also areas of conjunction between the two. Traditional gender norms constrain women's decision-making power to mostly within the household and farm. While men increasingly migrate for work, women take over more of the agricultural labor, and temporarily, all farm-management decisions. When both spouses stay at the farm they often decide together, contrary to common assumptions that men mostly decide in agriculture. However, cultural conflicts arise when women engage in social spheres outside the farm and household, such as in financial, public, or political matters. How people through social practice relate to competing gender norms, and to what extent they either feel caught in a cultural conflict or have a sufficiently strong social position to take advantage of the situation and alter local gender roles depends not on gender *per se*, but on other markers of social prestige such as caste/ethnicity, wealth, age, and marital status. Interactions between modern development norms and traditional gender norms inspire cultural change at the local scale, which has implications for women's participation in financial and market spheres.

1. Introduction

Vegetable cultivation for the market is currently contributing to improved livelihoods and reduced poverty in Nepal (Gurung, Thapa, Gautam, Karki, & Regmi, 2016; Rai et al., 2019), but investments are often required in order to diversify into market production. The increasing availability of microcredit, including for women, is contributing to making commercial vegetable cultivation a more available option for farming households (Adhikari & Shrestha, 2013). However, women in Nepal have traditionally been less engaged in financial and market activities than men. While women bear a large part of the labor burden in agriculture (Gooch, 2014), their expansion into financial and market spheres challenges traditional cultural norms and gender roles, according to which Nepali women are discouraged from engaging in income-generating activities outside the home (Adhikari, 2008). Governmental policies and development projects currently oppose these traditional norms by promoting empowerment and increased financial, political, and public participation for women. How men and women interpret and relate to new norms for increased gender equality as well as to traditional norms, and to what extent existing gender roles are changing as a result, is unclear. This article investigates how the social practices of women and men relate to cultural gender norms in a farming community where labor migration by men is prevalent. Although people often comply with influential cultural norms, these norms do not dictate behavior. Agency is expressed through various responses to and negotiations over diverging gender norms. For a better understanding of current household practices in farming, it is therefore necessary to explore how people negotiate and alter local gender roles when there are competing gender norms at work.

Gender analyses address the socially constructed differences between biological men and women (Nightingale, 2002) that are

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ascribed to the social roles of men and women in a particular cultural context, and how they intersect with other principles of social differentiation. Cultural norms shape how people perform their gender roles, which has implications for how farm-management decisions are gendered. Frequent absence of men also influences the context for decision-making on the farm. The empirical data for this case study was produced during fieldwork in Dolakha, Nepal[2] and describes the social practices of men and women in labor division and in farm management.

In Nepal and Indian Himalaya, women are taking over more and more of the agricultural workload while men increasingly migrate or engage in non-agricultural activities (Allendorf, 2007; Maharjan, Bauer, & Knerr, 2012; Gooch, 2014). This trend has been noted across the world for more than forty years (Jiggins, 1998; Adhikari, 2008), and is recently further spurred in Nepal by the massive increase in international labor migration, predominantly by men (Allendorf, 2007). Among those remaining, it is well documented that women farmers in Himalaya work longer hours than their husbands (Acharya & Bennett, 1981; Choudhary & Parthasarathy, 2007; Gooch, 2014).

When it comes to decision making, women are severely underrepresented in political, economic and professional domains in Nepal (UNDP, 2004) and their expertise is largely neglected in agricultural and rural development processes (Upadhyay, 2004; Adhikari, 2008; Pant & Standing, 2011). Women are also often denied equal access to and control over natural and productive resources (Agarwal, 1994; Adhikari, 2008; Bhattarai, Beilin, & Ford, 2015). However, whether women are underrepresented in decision-making on the family farm, especially over financial matters and cash cropping, is more disputed. Studies from Nepal (Onta & Resurreccion, 2011) and India (Kerr, 2008) have argued that women do most of the agricultural work, but men still decide over which crops to plant. Others have found that women at the most decide over subsistence crops while men make all financial and market-related decisions (Boserup, 1989; Bhattarai et al., 2015). In contrast, however, some studies from Nepal and Indian Himalaya have found that women do take part in decision-making on the farm, even in financial and cash-crop matters (Acharya & Bennett, 1981; Adhikari, 2008; Gooch, 2014). An important question in this regard is how local gender roles shape the social spheres in which women and men have decision-making authority, and how these spheres are changing in the light of competing gender norms and in the context of men's out-migration. In order to address this question I first outline an analytical approach for studying the relationship between cultural norms and social practices, and second, analyze social practice in farming in terms of labor division and decision-making. Finally, I discuss two sets of influential gender norms in Nepal and how men and women in various situations relate to and negotiate between them.

2. Perspectives on gender and cultural norms

Feminist scholars have since the early 1980s argued that the unpaid work of women amounts to female exploitation and that women are excluded from access to productive resources (Bhadra, 2001). The feminist movement was particularly concerned with women's legal status and lack of economic independence and implications for female decision-making power (Kerr, 2008). One reason for the gendered imbalance in workload is that women's work domestically and in agriculture is not registered as economic activity (Joshi, 2000; Bhadra, 2001; Choudhary & Parthasarathy, 2007; Adhikari, 2008), but falls under unpaid subsistence work (Acharya & Bennett, 1981; Choudhary & Parthasarathy, 2007; Sidh & Basu, 2011). However, Papanek (1979) had already shown how women's unpaid work can be important for generating social prestige for the whole family, contributing to higher incomes for their husbands and benefitting both sons and daughters in marriage arrangements. The shift of focus from the isolated income earned by women as opposed to men, to an integrated analysis of the family and its external and internal gender dynamics, is an early example of the shift in gender studies from focusing primarily on women to being a study of the interdependent relations between the genders as such. A relational view of gender has over time been integrated in development discourses, as the slogan "Women in Development" was replaced by more holistic approaches to "Gender and Development" in the 1990s (Bhadra, 2001; Arnegaard & Svarstad, 2003; Kerr, 2008).

The field of feminist political ecology emerged in the 1990s in an effort to combine political ecology with feminist development studies and environmental justice, addressing themes like gendered knowledge, gendered rights and access to resources, and gendered social movements (Rocheleau, 2010). For instance, Mehta (1996) showed how male out-migration created a pronounced gender dichotomy between the farm and off-farm domains in Indian Himalaya, which intensified women's agricultural labor burden while they were deprived of the resources, information and services needed for maintaining food production. In general, feminist political ecology literature demonstrates how gendered labor division and unequal access to and control over resources result in uneven power relations in environmental decision-making (Rocheleau, Thomas-Slayter, & Wangari, 1996; Nightingale, 2006; Truelove, 2011; Mollett & Faria, 2013). Attention to multiple axes of power shows how gender intersects with class, caste, ethnicity, race and other principles of differentiation, and how this influences ecological management (Rocheleau, Thomas-Slayter, & Wangari, 1996; Nightingale, 2002; Ge, Resurreccion, & Elmhirst, 2011; Mollett & Faria, 2013).

A classical debate in the early feminist literature addressed whether true matriarchies and egalitarian societies have ever existed, or if men have held the dominant position in all societies (Rosaldo & Lamphere, 1974; Ortner & Whitehead, 1981). Three quite different dimensions of gender relations were discussed (Ortner, 1990): First, whether men have higher cultural prestige than women, and whether this is universal. Second, whether men control women's behaviour and deprive them of decision-making authority. While some gender analyses assume that women and men have separate and opposing interests and that marriage is largely a mechanism of subordination, Jackson (2007) instead shows that men and women often have many shared interests, and that marriage can also be an arena where women exercise power. The shift of focus from gender characteristics to gender relations (Jackson, 2007) implies that women and men are not seen as discrete individuals, but rather as socially embedded and networked (Rao, 2017). Miller (1990) also finds that decision-making in high-caste Nepali farming households is embedded in a complex web of traditions, habits, social relations, religious practices and family relations. Decision-making power and responsibility in the household is negotiated within these cultural structures and is not solely a question of gender relations (Miller, 1990).

The third dimension is whether and how women control and decide over certain spheres of their community, household or livelihood while men control others. This argument was among others put forward by Rogers (1975), who argued that men had admittedly a higher position in peasant societies, but that women in practice had quite a lot of power over household decisions, which *balanced off* the gendered inequalities of higher cultural prestige for men. Ortner (1990) refuted this argument because to balance cultural prestige against actual social practice is like com-

[2] This study was conducted under Himalayan Climate Change Adaptation Programme (HICAP), in which Dolakha is one of the case study areas.

paring apples and oranges: they are different things. Still, a change in practice may contribute to change in gendered prestige. Schroeder (1996) shows that when women entered the sphere of cash cropping, one consequence was that they obtained more autonomy, power and prestige relative to men. The literature on gendered spaces and spheres has expanded significantly since this debate (Mehta, 1996; Acharya, 2004; Raju, 2011).

Gender analyses can be distinguished into two quite different approaches: the material and the symbolic approaches (Solheim, 1999; Nightingale, 2006). The material (sometimes called economic) approach sprang out of Marxist debates of production and focuses on the role of gender in economic production and social organization. Both the practical outcomes of gender differentiation in labor division and unequal access to and control over productive resources belong to this approach. The symbolic approach, in contrast, is based on anthropological culture theory and focuses on gender as a structure of meaning expressed through symbols and metaphors (Solheim, 1999). Culture is here understood as a historically transmitted pattern of meanings that are symbolically expressed, an abstract set of control mechanisms for the governing of behavior (Geertz, 1973). Intriguing analyses on the symbolic dimensions of gender are found in Ortner (1972), Hastrup (1989), Schroeder (1996), Solheim (1998), O'Reilly (2006), and Nightingale (2010).

An analytical approach to study how people relate to cultural gender norms through their social practices is outlined in the following. Social practices refer to patterns of behavior and specific actions as they are performed in the social sphere of the community. Cultural norms are defined as one of the abstract control mechanisms for the governing of behavior, a part of the patterns for behavior (Geertz, 1973). The focus for analysis is how people perform and negotiate their gender roles in the light of competing cultural norms, and how gendered spheres may change as a result. The inner, private sphere of individual households, with their gendered power relations and marital negotiations, is outside the scope of this study. Furthermore, the material approach to gender analyses is chosen while the symbolic structures of meaning and gendered metaphors are not addressed here.

The cultural structure of prestige is a different type of concept from the concrete and observable behaviour that people practice in daily life (Ortner, 1990). Concepts at different levels of abstraction must be kept apart; the map must not be confused with the terrain, or the menu with the food (Bateson, 1972). The culturally constructed set of norms for behaviour is of a higher level of abstraction than people's actual behaviour. People can choose to comply with or oppose norms, or even act as if they were unaware of those norms. It follows that the cultural structures concerning gender relations in a society, whether male dominant or not, must not be confused with the actual social practices of men and women. In a critical realist perspective, social practices are empirically observable events, while cultural norms that influence people's practices must be identified through analysis and abstraction. To balance off or conflate two concepts at different levels of abstraction is logically problematic since they do not exist on a continuum (Solheim, 1998).

Although Ortner (1990) does not explicitly distinguish between abstraction levels, she applies the same kind of distinction as formulated by Bateson (1972) and Solheim (1998, 2007). There is a kind of logic and order to cultural frameworks, including cultural aspects that concern gender relations (Ortner, 1990). Cultural frameworks can be seen as an interrelated system of ideas that build on each other and are based on some basic premises, in what Bateson (1972) calls an ecology of mind. Ortner (1990) introduces the concept *gender hegemony*. It does not mean that one gender is necessarily hegemonic in relation to the other, which is an empirical question of dominance. Nor are gender norms hegemonic over other principles of social differentiation, such as caste or class. Rather, by gender hegemony Ortner means the particular gender ideology, the relative dominance of some cultural logics, meanings, and practices related to gender, over others. Whether and how a gender hegemony gives higher prestige to men or to women are empirical questions and vary from case to case. As I interpret Ortner, her discussion of cultural logics and prestige structures includes cultural norms, although she does not state so explicitly. I suggest that one way to analytically apply the concept of gender hegemony is to first identify the set of tacit and explicit cultural norms and rules that regulate gendered social behavior in a society, and next to investigate how people through their social practices relate to these gender norms.

However, "no society or culture is totally consistent. Every society/culture has some axes of male prestige and some of female, some of gender equality, and some (sometimes many) axes of prestige that have nothing to do with gender at all" (Ortner, 1990). In any ethnographic dataset, there are pieces of information that fit poorly into the dominant tendency, pieces of information that indicate something different to, or opposite to, the general trend. Such deviant cases (Gobo, 2004) should not be neglected, but rather addressed by analysing the relationships between deviant cases of social practice and the abstract cultural norms. The next challenge is to analyse the different ways in which people in practice relate to these norms in their daily lives through expressions of agency. Building on Ortner, I do not seek to identify one single, coherent system of gender norms to which everyone must adhere in a deterministic enactment of social roles; people may act in accordance with prevailing cultural norms, but they can also deviate from them and face the expected social sanctions.

A question that Ortner does not address, however, is whether there can be more than one gender hegemony at work simultaneously in a society. If several influential norms are competing so there is no longer one dominating gender hegemony, what would then be the consequences for how people behave and justify their practices?

3. Study area and methods

The study takes place in Kavre and Chhetrapa Rural Municipalities (former Village Development Committees[3]) in Dolakha, Nepal. A local market place named Maina Pokhari functions as the nexus for local trade and transport. For simplicity, I use the name Maina Pokhari for the whole study area. An all-weather road connects Maina Pokhari to the city of Charikot in two hours by car and Kathmandu is reached in seven hours. Terrace cultivation combined with animal husbandry is the dominant farming practice and the major crops are rice, maize, millet, wheat, vegetables and some spices. Cultivation is primarily for subsistence, but over the last ten years it has become common to dedicate approximately 20% of the land to market production (Holmelin, 2017)[4]. Average farm size is 0.5 ha (median 0.4 ha). Some households have additional incomes from trade, tea shops, lodges, casual labor on larger farms, or from migration. The majority of the population is Hindu and belongs to Chhetri/Bahun (68%) and Dalit (11%) castes according to local population censuses. About a fifth of the population (21%) are Buddhists of the ethnic groups Jirel, Newar[5], Sherpa and Tamang. The composi-

[3] On March 10, 2017, Nepal adopted a new administrative structure where Rural Municipalities and Urban Municipalities replaced the former Village Development Committees. A Sherpa settlement in ward no. 3 of Baiteshwar Rural Municipality is included in the study area.

[4] More contextual details on local livelihoods and the farming system are found here.

[5] Newars are sometimes Hindus other places in Nepal, such as in Kathmandu.

tion of castes and ethnic groups is mixed spatially, although specific groups, often extended families, dominate in certain settlements.

Primary data for this study were produced by the author during three periods of fieldwork between October 2012 and November 2013. Qualitative data were obtained through ethnographic methods such as observations and in-depth discussions with informants about those observations, participant observation, and semi-structured interviews. Selected households were visited and interviewed several times and studied as intensive household cases. In addition, a structured quantitative survey (n = 114) was conducted from a purposive sample of households. The sample covered the local variation in variables relevant for the topic of study (Gobo, 2004) such as caste and ethnicity, level of wealth, education, gender composition and size of the household, migration, land holdings, crop diversity, livestock size and composition, farm altitude, and distance to roads and markets. Gendered decision-making was analysed by using quantitative methods such as cross tabulation analysis (Chi^2 tests), while the questions of relations between cultural norms and social practice, and gendered decision-making in this context, were analysed qualitatively.

4. Labor division in agriculture

The agricultural labor division between men and women is quite relaxed with few absolute taboos on which chores women and men can do. Husband, wife and adolescents often help each other, although the main responsibility for each task often lies with either husband or wife. The survey reveals that women generally do much more of the work than men in the fields, forest, and stable, particularly in planting, weeding, collecting fodder, herding, harvesting and milking (see Fig. 1). Both men and women collect fuelwood, manure the fields, and irrigate. Men thresh rice while women thresh millet and maize.

The only task exclusively performed by men is ploughing with oxen, while women feed and herd the livestock more frequently than men do. Women often prepare rainfed or smaller irrigated plots by hoe. Some maize-millet cultivators prepare the land by hoe only, among which there are women who run the whole farm without male assistance.

Women almost exclusively sow and transplant rice, and take on the largest workload in weeding and harvesting. While everyone participates in the rice harvest, women carry out most of the harvesting of millet, maize, potatoes and vegetables. Landowners who hire casual labor prefer to hire women because *"they have faster hands"* and are more thorough than men are. In spite of this, women are paid only half of men's wages for a day's work.

During a normal day, women work much longer hours than men do. While women do the majority of tasks in cultivation, they are also responsible for household chores such as preservation, storage and preparation of food, cleaning, laundry and caring for children and elderly. Furthermore, women are expected to serve food and tea to guests and prepare for festivals, religious ceremonies, and funerals. Such 'hidden work' is important for maintaining social relations and cultural values (Wadel & Wadel, 2007), and for maintaining the social prestige of the family (Papanek, 1979). Girls are taught to help their mothers, while boys are not expected to do the same and have more liberty in deciding how to spend their time. Men chop firewood and slaughter livestock, but the way that men contribute to household chores is currently changing.

> *"Even men cook food now, in my house, the person who has time does the cooking. It doesn't matter if it is a man or a woman. Before, only women were doing laundry, but now I see a lot of men doing it too. Now it has become more equal than before, both men and women do more of the same work."*
>
> [*Man, 77*]

Both men and women state that the labor division is more relaxed today compared to 20–30 years ago as men now sometimes perform some of women's household tasks. However, women refer to it as *"sometimes the men help us"*. The everyday responsibility for the welfare of the family still lies with the women.

5. Gendered patterns of decision-making

The household survey from Maina Pokhari shows that women make farm-management decisions in 45% of the households, while men decide alone in only 25%. In the remaining 30% of the households, husband and wife discuss and decide together (see Fig. 2). There are only small variations among the five decisions: who it is that most often decides over cereal production, vegetable cultivation, livestock, cash-crop investments, and expenditures on chemical fertilizers. The sample includes several migrant households in order to reflect the actual situation in the study area.

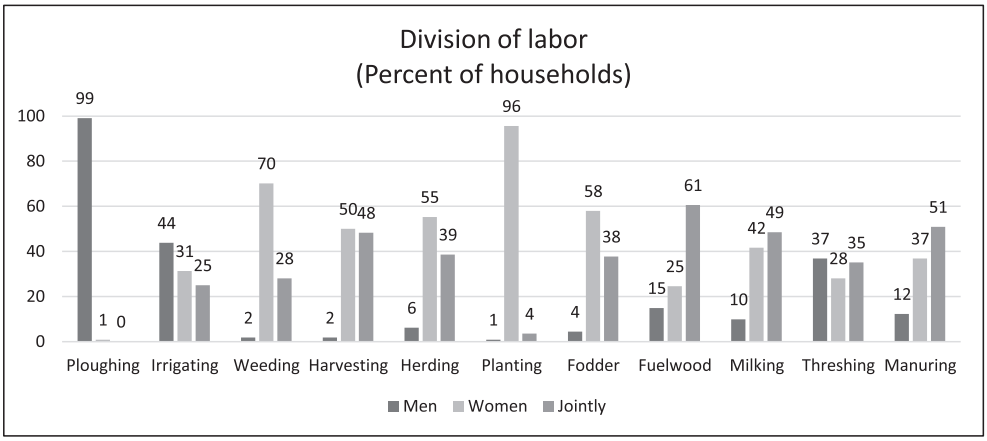

Fig. 1. Division of labor between men and women, percent of households (n = 114).

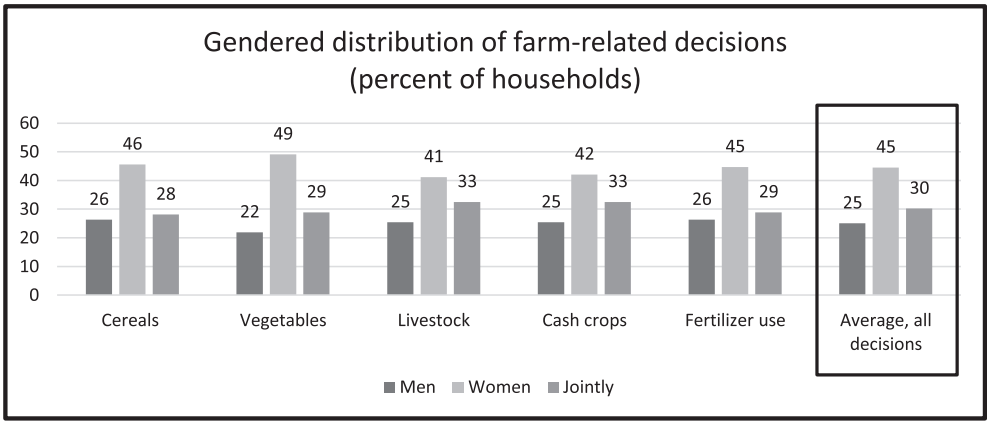

Fig. 2. Gendered distribution of farm-related decisions in Maina Pokhari households (n = 114), in percent. Respondents were 58% women, 35% men and 7% women and men together. The husband was absent (migrated or deceased) in 24% of the households.

Principles of social differentiation such as caste, class, and age may influence gendered patterns of farm management. In this survey, the answers are similar among high-caste (Bahun/Chhetri), middle-caste (Matwali[6]) and low-caste (Dalit) households. Women's decision-making power is just as pronounced in Dalit households as among higher castes, with no significant differences for any of the five decisions. Furthermore, women decide neither more nor less frequently in wealthier households than in poorer ones. While age difference between the spouses can influence decision-making (Halbrendt et al., 2014), in this sample there is no significant difference in answers based on age. Husbands are often older than their wives, but the typical age difference is only a few years.

Answers may vary with gender of respondent. Chi^2 tests are conducted for the variables 'gender of respondent' and 'who makes decisions', for the full sample which includes migrant households, and for a sub-sample of all non-migrant households (both husband and wife present, widow households excluded). There is no significant difference between the answers of men and women in the sub-sample of households where both spouses stay at the farm.

In the 27 households (24%) where the husband is migrated or deceased, all decisions remain with the wife. Decisions are not taken over by the wife's father-in-law or son. No adult men in the sample live without a wife. The widowed men have all married again, while 14 women live alone as widows or unmarried.

In their husbands' absence women decide over the farm, but before and after migration, the married couple often decide together. In the sub-sample where both spouses are present, decisions are made jointly in 38% of the households, men decide alone in 34% and women alone in 28% of the households. Women still decide over vegetable production slightly more often than men do when they are present. There is no significant difference in female decision-making in returned-migrant households as compared to non-migrant households when both spouses stay at home. A man's absence thus leaves the wife temporarily with more decision-making power over the farm.

The lack of significant correlation between the background variables caste, class, and age and gendered decision-making indicates that apart from men's absence, no single variable alone can explain the variation in gendered decision-making. The whole complex of social, economic and cultural structures, including gender norms, must be considered together in order to understand how the gendered pattern of farm management is constituted.

The contention that men make most of the decisions in agriculture while women do most of the work is often repeated and generalized in reports from NGOs and development institutions (OXFAM, 2009; UNEP, GRID-Arendal, 2011; FAO, 2013). Some studies find that rural women are marginalized in decision-making both within and outside the household in Nepal (Boserup, 1989; Khamis, Plush, & Zelaya, 2009; Onta & Resurreccion, 2011) as well as in India (Roy & Venema, 2002; Kerr, 2008; Sidh & Basu, 2011). However, others find that women in Nepal and Indian Himalaya are largely responsible for the farm enterprise in terms of both labor input and farm-management decisions (Acharya & Bennett, 1981; Adhikari, 2008; Gooch, 2014). The results from this case supports the latter conclusion that women take an active part in farm-management decisions within the household, either alone or jointly with their husbands. When the husband is absent on migration, the wife makes all decisions alone.

6. Folk reasons and scientific explanations

The main objective of this article is to analyze how people's practices in farm management and in the community relate to cultural gender norms. The ways that people perform their gender roles have implications for how decision-making is gendered. Ethnographic data resulting from observations and open-ended interviews include quotes from the informants on their own reasons for their actions and practices. This results in two kinds of explanations (Wilk & Wilhite, 1986). First, folk reasons are explanations the informants themselves present in response to direct or indirect questioning; they reflect people's intentions with their actions. Second, the researcher's explanations emerge after thorough analysis of ethnographic data in the light of contextual factors. The folk reasons serve partly as reference points and partly as data for the second kind of explanation, which seeks to analyze deeper social and cultural structures underlying the reasons given by the informants (Wilk & Wilhite, 1986; Aase & Fossåskaret, 2014). Folk reasons for gendered farm management are presented below while the author's analysis is presented in the succeeding section.

The informants' views on how decision-making is gendered crystalize into three main types of reasons:

[6] Matwali refers to the ethnic groups, *janajati*, which are placed in the middle of the Nepali caste system.

1. The husband and wife discuss and reach a joint conclusion. "*We make all decisions together, we discuss and agree. It doesn't depend on men or women, it depends on who is the oldest or most experienced [on the subject matter]. You can't listen to one person only, then you may make mistakes*" (man, 66). The consensus-based decision model is quite common (see Fig. 2) and there are only small variations in which decisions are made by men and women.
2. The wife decides in her husband's absence. "*My husband is abroad, so I decide*" (woman, 56). The wife takes charge of farm management in households where the husband is absent or deceased. In these cases, the wife makes all the decisions even over cash crops and fertilizer use. *"When my husband lived we used to discuss the matters together, but he had the final word. If I wouldn't listen, then what to do? I still had to eat. He was four years older and he knew more than I did, so I listened. This was how it was. But sometimes he went away, and then I ran the farm*" (woman, 62).
3. The oldest or most experienced decide. *"He is the oldest, so I don't go against his will, but if I make a good suggestion then he agrees*" (woman, 50). When the wife is significantly younger than her husband, the custom is to let him decide. However, "*my husband is too old to make decisions*" said a woman (50) who over the years had gradually taken over the farm-related decisions from her much-older husband. *"The one with the most experience decides*" said a man (73), indicating that decision-making reflects the labor division.

The three types of responses outlined above are typical examples of people's different explanations. In practice, decision-making depends on the household situation in general, in a combination of the three types above. One woman (58) who is three years older than her husband, said: *"I decide on the farm, because my husband goes out to work. I tell him that I need this and that, you must get it for me while you are out. He says, 'you take care of the household, I will see what I can do'. It has always been like this.*" The wife decides because she is doing most of the work and is most experienced, her husband works off-farm, and she is the oldest. When either one of a married couple is sick or disabled, the working spouse makes the decisions too.

A son does not take over decision-making from his parents unless he takes over the farm, not even if his father dies. One elderly man (77) who had split the land between himself and each of his two sons, stated; "*My wife and I decide together, equally. My son and his wife decide together too, and they ask my wife and me for advice. In my other son's house his wife decides everything. She does not want our advice*". Variations in decision-making patterns exist even within one family. In sum, people's own perception is that decisions are often made jointly, that the wife decides in her husband's absence, and that experience and age to some extent influence decision-making.

I now turn from analysis of social practice in farm management to cultural gender norms.

7. Competing gender ideologies

Cultural gender norms express the rights, duties, and informal role expectations that constitute the social statuses of men and women, what kinds of behavior that are considered to be socially appropriate for men and for women (Linton, 1936; Aase & Fossåskaret, 2014). Cultural norms do not dictate people's behaviour, but rather demarcate a space for socially acceptable practices. Behaviour that deviates from cultural norms can provoke social sanctions. The ways that people in practice perform their gender roles, how they negotiate their role space (Aase & Fossåskaret, 2014), and how they relate and respond to explicit and tacit gender norms, shape the context for gendered patterns of decision-making. In the following, influential gender norms in Nepal are identified. I argue that in this case there is not one single gender hegemony as suggested by Ortner (1990). Instead there are two competing gender ideologies at work, which I call the traditional ideology and the modern development ideology.

How social practice is related to gender ideologies can be approached in two ways, and the following discussion draws on both. From an actor-oriented perspective, competing ideologies enable people to choose between the two sets of norms to legitimize a certain practice. From a structure-oriented perspective, however, people are embedded in and are carriers of their culture, expressing aspects of it through "learned and shared patterns of behavior" (Seltzer, 1991, p. 86). Cultural norms are often tacit and taken for granted, which makes them difficult to address, oppose, resist or escape. When tacit norms collide, as in the case of two competing gender ideologies, double binds may arise (Bateson, Jackson, Haley, & Weakland, 1956). A double bind is a situation where a person receives two messages that negate each other, so that any response that fulfils one message involves failure to fulfil the other. A double bind often occurs when the dilemma is communicated non-verbally. While Bateson *et al.* originally refer to a situation where two messages at *different* logical levels are in conflict, I here apply the concept to a conflict between two sets of norms at the same level of abstraction.

The traditional ideology (Nepali: *parampara*) is influenced by the historical significance of Hinduism in Nepal, where religion is more related to social practice and collective identities than to individual belief (Gellner & Letizia, 2016). The majority of the Nepali population, 81%, are Hindus, while 9% are Buddhists (CBS, 2011). Until 2007, Nepal was officially a Hindu kingdom as stated in the 1962 Constitution. Buddhist activists, who had long advocated for religious equality, wanted Hinduism to be treated as a religion like any other, not as the "framework for Nepaliness" (Gellner & Letizia, 2016, p. 4). In the 2015 Constitution, Nepal declares religious and cultural freedom and is formally no longer a Hindu state. However, Gellner et al. (2016) argue that secularization has not, or not yet, occurred in Nepal, neither in the personal nor in the public sphere. Changes to formal state documents have not been followed by practice.

Hinduism encompasses a wide variety of deities, principles, and religious texts, and is practiced in diverse ways throughout India as well as Nepal. Still, a common feature across most Hindu communities is the norm that only men should inherit and own property (Allendorf, 2007; Pandey, 2010; Mishra & Sam, 2016), a tradition which is practiced throughout Nepal (CBS, 2014). The patrilineal Nepalese inheritance rules, which can be traced all the way back to the ancient Laws of Manu, also strongly favour men over women (Adhikari, 2008; Pandey, 2010; Mishra & Sam, 2016). To marry within one's own caste is a norm in the Hindu caste system (Subedi, 2011). The norm of virilocality, widely practiced in Nepal (Gartaula, Vissner, & Niehof, 2012), prescribes that the bride moves to her husband's house at marriage and becomes part of his family and clan (*kul*). She also makes the symbolic transition of starting to worship her husband's family gods (*kul deuta*). It is her marital relationship that gives a woman access to the land formally owned by her husband (Allendorf, 2007; Pandey, 2010; Mishra & Sam, 2016). Although changes were made to Nepali property laws in 2002 and 2007 to enhance women's opportunities to own land, lack of awareness of these changes alongside norms of patrilineal inheritance still prevent many rural women from exercising their constitutional rights (Mishra & Sam, 2016). Women in Nepal have historically had little economic independence (Adhikari, 2008). The Nepali expression '*Laxman Rekha*' labels the cultural norm that women should behave in accordance with the status as a house-

wife and not expand into other conflicting statuses (Adhikari, 2013). A traditional norm in Nepal discourages women from working outside the home and state that they should rather confine themselves to household chores (Adhikari, 2008). Women should neither participate in community decision-making processes nor take the role as village leaders (Nightingale, 2002).

In sum, influential norms in the traditional ideology state that men should own and inherit productive resources, women should marry within their caste and make a transition to their husbands' families, marriage gives women access but not ownership to land, women should not work outside of the home, and women should not participate in public matters.

The second set of gender norms that influence local practice and culture in Nepal is here labelled the modern development ideology. Over the last decade, the Nepali state has incorporated principles from international NGOs and human rights conventions that promote women's empowerment towards gender equality. Nepal's official development policy promotes women's rights and empowerment, for instance through targeted microcredit programs (Adhikari & Shrestha, 2013) and combined educational and health programs (Osei et al., 2017) for women. Efforts are made to increase the number of women in high political and governmental offices. Recently 33% of members of parliament were women (Poudel, 2014). Although the Nepali prime minister has never been a woman, the elected president and the newly appointed Governor of Province 3, to which Dolakha belongs, are women. The 2015 Constitution of Nepal includes the goal of "eliminating discrimination based on class, caste, region, language, religion and gender and all forms of caste-based untouchability" (Constituent Assembly Secretariat, 2015, p. 6). Efforts are made to reduce the stigma of marrying a person from a different or a lower caste, and Nepal is among the first countries to acknowledge a third sex in official registers and passports. In the new government structure of 2017, the rural municipalities (*gaunpalika*) must have both a man and a woman represented in the leadership. The dominant normative discourse of Nepal's official development agenda is one promoting various forms of women's empowerment with the goal of achieving full gender equality, including in the traditionally male-dominant spheres such as financial matters, politics and governance.

The two gender ideologies have some conflicting norms concerning gender issues, but also some norms that correspond. How the two gender ideologies are expressed in Maina Pokhari, and how people relate to both tacit and explicit norms through social practice are discussed in the following.

8. Gendered expectations of youths: Housewives and breadwinners

The social expectations that adolescents meet when they make plans and choices for the future are indicators, among others, of the cultural norms in a community. Young people are perhaps even more concerned with behaving according to – or demonstratively opposed to –norms than other age groups are, which makes them particularly sensitive to the opinion of significant others. Lengthy discussions between the author and youths (15–25 years) revealed that they are very concerned with becoming successful in the eyes of their peers and parents. The indicators of success are different for men and women, which points to diverging gender norms.

Young women are very preoccupied with finding the right husband, getting married and having children. They discuss at length the benefits and drawbacks of modern love marriage versus traditional arranged marriage and are curious to learn how love marriage works 'outside' or in 'the West'. According to local marriage traditions, which are in line with the traditional ideology, the groom and bride should be of the same caste or ethnic group, although women can also marry into a higher caste. There are rules for how genetically distant and ethnically close one must be to "fit" each other, and the rules vary between ethnic groups.

Women find the social pressure to marry a man of the same caste or ethnic group to be strong. A young woman (23) stated, "*I want to find someone that I can love, but he must be accepted by my parents. It is not good, but you have to follow the rules*". If a woman opposes the traditional norm of marrying within her caste, she will lose her social security and parental support. "*If the marriage fails and they divorce, she could not return to her parents' house* (maitighar). *Even if her parents said she could return, she would meet so much gossip, it would be very hard for her to get socially accepted after she ran away for a love marriage*" (woman, 29). Several young women stated that although they hoped to find a man they could love, they found the process very complicated and risky and concluded that they would rather their parents help them find suitable candidates and negotiate with the in-laws.

Commom practice is that women marry at the average age of 20 while the men are often two–three years older (Chhetrapa VDC, 2010). Expectations are high to give birth within a few years and a childless wife faces much social pressure from older women and relatives. She even risks being divorced. Worries over not finding a husband, not having children and not becoming a good housewife are strong among young women. Their worries are not unreasonable as some of the very poorest in the community are unmarried women. Without marriage they have not received any dowry, they own very little or no land and have few opportunities for earning an income. Some raise livestock, but without any land, there is a limit to how many animals one person can feed from forest fodder alone. One unmarried woman (42) stated: "*Without help from my neighbours, I would not survive*".

To marry and have children is a norm within both gender ideologies. It is therefore very difficult to deviate from this norm, unless one is prepared to face gossip. Young women generally choose to comply with the traditional norm of an arranged, intra-caste marriage. Love marriage is a modern development ideal, but the picture is mixed as to whether marriage across caste boundaries is encouraged. Although attempts are made to reduce the stigma of inter-caste marriage, the concrete governmental effort involves offering financial support to the middle- and high-caste men who marry a low-caste woman. However, hypergami, the opportunity for women to marry upwards in the caste hierarchy, already exists within the traditional ideology, although it is not free from stigma. People find that a payment only adds additional stigma to inter-caste marriage as the husband is accused of marrying her solely for the money. For a Dalit woman, the good intentions arising from the modern development ideology could actually create a new double bind: If she marries a higher-caste man, she complies with the modern norm of inter-caste marriage but is stigmatized simultaneously with the accusation that he only took her for money. If she marries a Dalit man, she complies with the same set of norms that keeps her at the bottom of the caste system, not seizing the opportunities that modern development offers her. If she does not marry at all, she is economically and socially worse off than in either of these two scenarios. She cannot win in this tacit game of conflicting ideologies.

Social expectations for young men are quite different. Young men are not so preoccupied with getting married, but take it for granted that they will eventually marry and have children, if only they are 'successful' first. Being successful implies earning an income, in one way or another. A young man can stay home and farm, but migration and remittances are regarded much higher. Three in every four (74%) of the surveyed household in Maina Pokhari have one or more migrants and 24% have a migrant abroad, but only two out of the 37 migrants abroad are women. The

domestic migrants typically return home for the main festival and harvest period in the fall and occasionally at other times of the year, while foreign migrants return home at the most once a year and many only every second year. In Nepal, remittances from the 1.9 million migrants abroad amounted to 32% of GDP in 2016 (Fox, 2018), which has contributed to poverty reduction in Nepal (Gartaula et al., 2012) through increased spendings on daily consumption, land acquisition, loan repayment, education, and health expenses (Upreti & Shrestha, 2017).

However, the work conditions abroad can be very challenging. A recent study (Mak, Abramsky, Sijapati, Kiss, & Zimmerman, 2017) on working emigrant men from Dolakha found that 67% of the recently returned migrants had experienced forced labour, defined as unfree recruitment, work and life under duress, and/or impossibility to leave employer. The share was even higher among those who had to take loans prior to departure. In Maina Pokhari one returned migrant and his co-workers had not been paid their salaries for six months, but when they tried to leave their employer and return to Nepal they were imprisoned because the employers were in possession of their passports. When the migrant finally managed to return to Nepal, he was deeply indebted and spent several years repaying the loans. He and his wife kept this story a secret from their neighbors and friends, despite knowing that other families in the community made great efforts to take loans and send their sons abroad. People generally do not ask for details about how money from migration has been made and there is great social stigma attached to returning without any money. Although women do more of the work in agriculture than men, the struggles and drudgery of labor migrants must not be underestimated. Another returned migrant (30) stated: *"If my farming is a success I will stay here with my family, but if I have to, I will go abroad again*". Another man (54) said: "*For me it is better to stay here than to migrate, but the young people have not understood that yet*". The high prevalence of out-migration does not contribute to rural population decline as most of the migrants eventually return to settle with their families and farm in Maina Pokhari, and some invest their earnings from migration in cash crops such as spices and vegetables (Holmelin, 2017).

The modern development ideology strongly promotes higher education. For women, education postpones marriage plans by three years on average (CBS, 2014), but an educated woman still meets strong social expectations to marry and have children. Education is highly regarded, but it does not excuse people from the norm of eventually entering a proper marriage. To be a farming housewife and a mother is so far the only respectable social status for grown-up women in the community. Men have greater liberty in choosing to become a farmer, an educated and skilled worker, a migrant, a trader, or any combination of these options. However, men strongly feel the expectation that they must be successful in earning an income. The norm that men should secure the family a viable income is present in both gender ideologies, which makes it difficult to escape or resist. The stigma is thus great from returning from migration without money, or being unsuccessful in trade and small businesses.

Many women take great pride in being a good housewife, which is rewarded with social prestige and recognition. The space of the housewife is the domestic sphere that people call 'inside' (*bhitra*), which includes the house and fields but not paid work outside the household[7]. In contrast, men are said to dominate 'outside' (*bhaira*) which refers to politics, trade, governance, migration, and non-local matters (see also Acharya & Bennett, 1981). Although women to a large extent take part in decision-making on the family farm, men still make most of the decisions in business and investments that are not related to farming, since these issues lie 'outside' the household. While women's space is 'inside', men have a role both 'inside' and 'outside'. Since the male gender role encompasses all social spheres, and since the two gender ideologies are largely overlapping for men, they are less exposed to double binds from conflicting gender norms[8]. The dichotomy 'inside–outside' distinguishes gendered spheres of operation quite in line with the traditional ideology, according to which women should be confined to the domestic sphere. Spatial restriction of women has historically been practiced in Maina Pokhari. A male farmer (77) stated: *"Before, women were not allowed to study or to travel out too much. Cultivation they did, work in the fields. But they should only stay near to the house*". Some of the older women in Maina Pokhari have never travelled further than a day's walking distance from their house. However, the practice of spatial restriction is changing. Young women today are more educated and travel more than their parents did. Nepal has seen a drastic improvement in basic education over the last 40 years, especially for women. While only one percent of all women were literate in 1971 (CBS, 2012), women's literacy reached 58% in 2011, and 90% of girl and boy adolescents are now literate (CBS, 2014).

People largely comply with the educational goal of the modern development ideology, which for some leads to travel for further studies. Road development has further increased the spatial reach of women. It is now quite common for women as well as men to visit relatives in Kathmandu. It seems that women justify their practices of obtaining more education and increased mobility with reference to the modern development ideology, instead of complying with the traditional norm of being homebound. However, educated women in their twenties say that they are facing a normative dilemma, a cultural double bind: If they want to work in a job that matches their education, they cannot meet their parent's expectations of a local, intra-caste and child-bearing 'proper' marriage. Such jobs rarely exist locally, and are not practically compatible with childcare and farming[9]. They must either choose to enter the role of a farming housewife and mother, or move to Kathmandu. Parents do value education for their children, hoping that it will enable their sons to obtain a good income. But it seems that for daughters, the main purpose of education is not primarily the opportunity for skilled work, but rather the social prestige and benefit it gives in marriage arrangements, similar to what Papanek noted 40 years ago (1979).

9. Negotiating gender roles

It seems that the accepted role space of a housewife is up for negotiation. Men's long-distance migration not only leaves women with greater temporary decision-making power, they have also started to engage in local trade and sell their farm produce in the local market. To profit from selling farm produce, and that women can do it, are quite recent phenomena in Maina Pokhari, as shown by the following case:

A woman (65) who was an only child inherited a quite large land area. When she married her husband (now 71), they deviated from common marriage norms and settled at her farm, not his, because of the large property. They had four sons who have now inherited most of the land, which they farm in cooperation with their parents. This woman is the one who makes all farm-related decisions in her household. Her husband contributes with some labor, but he works mostly off-farm.

[7] Casual labour on neighbouring farms and other traditional forms of labour sharing are categorized as 'inside'.

[8] The remaining discussion will therefore pay more attention to women than men in how they negotiate their gender roles.

[9] See Gooch (2014) for a similar finding from Uttarakhand, India.

About 25 years ago, this woman started to cultivate a variety of vegetables with support from Swiss development agents. Before a local market was established in Maina Pokhari, she had to face gossip and boycott from people who found her greedy because she demanded money for her vegetables instead of payment in-kind. After a while, people noticed that she offered employment, and she paid well. Eventually she managed to establish a network of laborers who returned every season, and she felt obligated to hire them. Today she is a major employer in the community. She experiments with new varieties and introduces new seeds to the area. The family sells vegetables and other farm products for about 15 *lakh* rupees (15,000 USD) per year. She states, "*I still grow my own food. I could sit back and eat from my sons, but I want to work hard for myself and not depend on them*".

This married couple exemplifies an exception to the traditional norm of virilocality. The woman also became a local pioneer in producing vegetables for sale, thereby introducing the concept of cash crops to the area. Initially it was unheard of that a woman could run a local business, which was not appropriate for a traditional, obedient housewife. With the support of development agents, she managed to legitimize her somewhat controversial practice in the name of agricultural progress (*bikas*), in line with the modern development ideology. She met resistance, but since she was also a married, high-caste woman of a wealthy and respected family, she enjoyed a strong social position that enabled her to become an agent of local change.

The fact that she held all decision-making responsibility inside the household supports the earlier conclusion that land ownership makes it easier for women to control farm management including investments, as argued by Agarwal (1994). The case is also in line with the conclusion that agricultural innovation is conditioned by land ownership rather than gender as such (Aase et al., 2017). Furthermore, this woman resisted the traditional gender norm of only doing local barter trade, and negotiated a new position in the community as a market agent. Despite gossip and social sanctions, she was eventually accepted and even respected as an important employer and 'big person' (*thulo manchhe*) in the community, a role that is normally reserved for well-connected men. This deviant case of a pioneer shows how social prestige and position in hierarchies of caste and class influence to what extent a woman can use culturally conflicting norms to expand the accepted role space of women. Since then, several other women have started to produce and sell vegetables and spices.

Microcredit offices exclusively for women have recently been established by development agents across Nepal. There is one women-only microcredit office in Maina Pokhari. It is managed by women and operates as a small bank for saving and lending. Only larger loans demand collateral, for which women often use their dowry gold. A number of women have recently established women's groups for vegetable production, financed by microcredit loans and supported by NGOs. A grown-up son from a rather wealthy, middle-caste family said, *"mother decides everything [on the farm], even if father is home. The women development group is doing many things: Tomato cultivation [which require investments], agricultural training, closed ovens, orange and vegetable cultivation. Mother initiated tomato cultivation in her group*". Another wealthy, high-caste woman took a loan against the wishes of her husband. Microcredit for women challenges the gendered association to the traditional 'inside/outside' distinction, in which financial matters and trade are 'outside' and thus the responsibility of men. Since women invest in activities that take place in kitchen gardens and plots near the house, they can argue that they still operate 'inside'. Alongside the pioneering woman who initiated cash crops, governmental and NGO development projects, and the frequent absence of men, the context in which people negotiate gender roles has changed quite substantially. It is now practically possible for women to join a women's group, take a loan, and cultivate vegetables for sale. Many husbands also encourage them to do so and support their wives' expansion into the financial and market spheres. The spouses often have shared interests (Jackson, 2007) and many men also support women's practices when they act according to modern development norms.

10. Conclusions

Gender relations in Himalayan farming communities are influenced by increasing out-migration of men, women who take over more of the agricultural work, and development interventions. This case study from the Nepali Middle Hills shows that while the labor division between women and men is quite relaxed, women still have the largest labor burden in the fields and house. The generalized statement that men make all decisions in farming is not a valid description of Maina Pokhari. Here, women do take part in decision-making alone or jointly with their husbands in 75% of the surveyed households, even in matters regarding cash crops, livestock and fertilizer use. Women make all decisions when their husbands are absent and joint decision-making is the most common mode (38%) before and after migration.

Decision-making within the household occurs in the context of cultural norms and gender roles. The relative dominance of certain cultural logics, meanings, and practices related to gender is what Ortner (1990) has labelled a gender hegemony. I argue that a gender hegemony can be analyzed by identifying influential gender norms in a society and studying how social practice relates to this set of cultural norms. I find that in Maina Pokhari, there is not one dominant gender hegemony but rather two competing gender ideologies. There are two abstract sets of norms that each demarcate a space of socially appropriate practice for men and for women. The traditional ideology and the modern development ideology have some norms in common, especially regarding marriage and childbirth. Other norms are in conflict, where the modern development ideology largely opposes several traditional norms.

The local concepts 'inside' and 'outside' demarcate gendered spheres of operation in line with the traditional ideology. Farm and fields are part of the 'inside' sphere and under female responsibility, but not theirs alone. Men operate both 'outside' and 'inside', they alternate between the outside spheres of migration, trade, and off-farm income and the inner sphere of the household and farm (see Hastrup, 1989, for a similar finding from Iceland). However, men rarely take over cooking, laundry and childcare, which are women's responsibilities. 'Inside–outside' refer to both spatial areas and gendered spheres of operation, and farming is a sphere where both genders have a role. If 'inside' and 'outside' are seen as prototypes instead of clearly distinguished categories, then farming exists in an overlap zone where women and men both have a socially defined place. A prototypical conception of 'inside–outside' is supported by the fact that people call the market place 'outside' in relation to the home, but it is 'inside' relative to larger cities. Although women are responsible for household chores and take part in farm management, they are not necessarily free to expand into spheres 'outside' the farm. The negotiation over socially accepted practices in the light of the two gender ideologies concerns not whether a woman can make farm-related decisions, but whether and how she, as a farming housewife, can expand into 'outside' spheres and activities.

Differences in caste/ethnicity, class, or age do not correlate with differences in gendered patterns of decision-making in Maina Pokhari. However, these principles of social differentiation are important determinants of social influence and prestige in the community. High-caste, wealthy, well-connected and 'properly' married individuals have a strong social position that makes them

capable of negotiating what the role of a farming housewife entails. They may therefore actively use the conflict between the two gender ideologies to expand the socially accepted role space for women. Low-caste, poor, unmarried women and adolescents do not have a strong enough social position to alter local gender roles and are more likely to be caught in double binds when facing conflicting gender ideologies. Men are less exposed to double binds because they already have a culturally defined role both 'inside' and 'outside' and because the two gender ideologies to a large extent are overlapping for men.

In order to understand gender relations in farm management, the broader social and cultural context in which men and women operate must be considered. An analysis of cultural norms, and how people relate to them through social practice, demonstrates how conflicting gender norms simultaneously enable and constrain people's practices. An individual's ability to alter gender roles in the community depends not on gender, but on caste/ethnicity, class, age and marital status, as these principles of social differentiation determine a person's social position in the community.

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The author declares no conflicts of interest.

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IV

Appendices

Date:

Altitude (khet/bari):

Distance to market:

Place:

Household survey HICAP (Nepali – Extended)

Household no._____

VDC_____ Settlement _____

Caste _____

1) Household map (gender, age, activity of all hh members)

2) Land

How much khet owned? ____ ropani How much khet cultivated ____ ropani

How much bari owned? ____ ropani How much pakho land owned? ___ ropani

Do you own land that was cultivated before that is not cultivated now? _____ ropani

3) Livestock

Buffalo ___nos Cow __ nos Ox _____ nos Goat____ nos Chicken _____ nos

4) Winter fodder: Which sources are most important?

Rank (1 most important – 6 least important; not used=0)

Cultivated fodder (alfalfa etc.)	
Crop residues (straw etc.)	
Government forest	
Community forest	
Private forest	
Buy fodder from market/neighbours	

5) Chemical fertilizer, total amount used:_____kg

Use chemical fertilizer on own land for paddy? _____ kg/ropani

Use chemical fertilizer on sharecropped land for paddy? _____ kg/ropani

Use chemical fertilizer on vegetables? _____ kg/ropani

6) What is needed in order to produce more crops on the land you cultivate?

Rank (1 most important – 6 least important)

More water	
More labour	
More manure	
More chemical fertilizer	
Better seeds	
Better extension service	

7) Have you planted some new crops or vegetables during the last 10 years?

No □ Yes □

If yes, which crops/vegetables? _____

8) Have you started to use new agricultural utensils last 10 years?

No □ Yes □

If yes, which kinds? _____

9) Do any children/son in the family want to take over the farm?

No □ Yes □

If no, what will you do with the land? _____

10) Did you produce enough food for the household last year?

Surplus □ Just enough □ Deficit □

Did you sell any agricultural products last year? No □ Yes □

If you sold any agric products, for how many Rupees?_____ Rs

Which kind of agricultural products did you sell? _____

For how many months are you self-sufficient (all crops)? _____months

In which crops are you normally self-sufficient? _____

11) Who is mostly doing what? (if fifty-fifty, mark both boxes)

	Men	Women		Men	Women
Ploughing	□	□	Collecting fodder	□	□
Irrigating	□	□	Collecting fuelwood	□	□
Weeding	□	□	Milking	□	□
Harvesting	□	□	Threshing	□	□
Herding	□	□	Manure fields	□	□
Planting	□	□			

12) Who decides:

	Men	Women
Which cereals to sow?	□	□
Which vegetables to grow?	□	□
Which livestock/chicken to keep?	□	□
Which cash crops to grow?	□	□
Amount of chemical fertilizer?	□	□

13) Do some of your household collect wild plants from forest?

Medicinal plants: Men □ Women □

Most used species_____

Edible herbs/fungi: Men □ Women □

Most used species_____

Did you sell wild plants last year? No □ Yes, for Rs_____

14) Do you use canal water to irrigate your khet? _____% of khet land

Is canal water sufficient whenever you need it? No □ Yes □

15) 5 most important crops this year: 1)_____2)_____3)_____4)_____5)_____

5 most important crops 10 ys ago: 1)_____2)_____3)_____4)_____5)_____

16) What do you do if your harvest fails? _____

_____

17) Sources of cooking/heating:

Rank (1 most important – 6 least important; not used=0)

Firewood from community forest	
Firewood from private forest	
Firewood from Government forest	
Kerosene	
Gas	
Other (specify)	

18) Other comments/information:

19) Wealth ranking of household (interviewer's evaluation):

Wealthy □□ Middle □ Poor □

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Statement of co-authorship
describing the independent research contribution of the candidate

When submitting a PhD thesis with co-authored articles, a statement of co-authorship must be enclosed. The statement of co-authorship must describe the independent research contribution of the candidate of each co-authored article (problem formulation and research design, data collection, analysis and interpretation, and writing etc.)

It is the evaluation committee that evaluate whether the independent effort of a PhD candidate is of sufficient extent and satisfactory quality for the thesis to be publicly defended. Therefore, it is very important that the candidate state his or her individual contribution to the joint publication as clearly as possible in this statement.

For each article the declaration should be filled in and signed by the candidate, then circulated to the most important co-authors for signatures (three at most).

Article no: 1
Authors: Nina Holmelin and Tor Halfdan Aase
Stipulated total contribution of the candidate (%): 80%
Title: Flexibility of Scope, Type and Temporality in Mustang, Nepal. Opportunities for Adaptation in a Farming System Facing Climatic and Market Uncertainty. *Sustainability* 2013, 5, 1387-1405; doi: 10.3390/su5041387

The independent contribution of the candidate
Problem formulation and research design[1]: The article is based on Nina Holmelin's MA thesis, which was supervised by Tor H. Aase. Problem formulation and research design for the article was developed by Nina Holmelin and commented on by Tor H. Aase.
Data collection: All fieldwork and data collection were conducted by Nina Holmelin.
Analysis and interpretation: Data analysis, interpretation and theoretical development was done by Nina Holmelin, under guidance and supervision by Tor H. Aase.
Writing/presentation: Nina Holmelin wrote the full article and completed the peer review process. An advanced draft of the manuscript was commented on by Tor H. Aase.

[1] Including methodology design, selection of methods and method development

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Nina Bergan Holmelin Signature of the candidate Name (bold letters): NINA B. HOLMELIN	T. H. Aase Signature of co-author 1 Name (bold letters): TOR HALFDAN AASE
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