**CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE**

**Faculty of Tropical AgriSciences**


# Factors Influencing the Adaptation towards Climate Change among Smallholder Tea Farmers in Ilam, Nepal

MASTER'S THESIS

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# Declaration

I hereby declare that I have done this thesis entitled "*Factors influencing the adaptation towards climate change among smallholder tea farmers in Ilam, Nepal*" independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague, 25th April 2019

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Steffen Münch

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# Abstract

The government of Nepal is currently setting focus on enhancing the domestic production and export of tea (*Camellia sinensis*). Climate change has a large impact on Nepalese agriculture, which employs 74% of Nepal's population. The identification of factors influencing the adaptation behaviour towards climate change among tea farmers in Nepal is hence a critical aspect for the economic success of the tea export strategy. This thesis focused on the adaptation behaviour of 91 smallholder tea farmers in the Ilam district, which is one of Nepal´s main tea producing areas. 86.8% of the respondents were aware of climate change and the average number of applied adaptation strategies was three out of six proposed options. Crop diversification and soil conservation were applied by most farmers, while irrigation related strategies were used by only a few respondents. Agroforestry and climate resilient tea cultivars had a balanced share of whether being deployed as coping strategy. By applying basic statistic tests and binary logit models, factors of influence in adaptation towards climate change were identified. While no socio-demographic variables were revealed as significant, information sources (other tea farmers, internet and trainings) as well as institutional factors (membership in cooperative and credit access) appear to positively influence the level of adaptation among the sample. The biggest perceived climate change impacts were extended drought periods and intense rainfall. The perceived main constraints to climate change adaptation were a lack of governmental support, not enough information as well as no access to credits. An improved interaction between the government and the tea farmers is thus necessary to successfully increase production and export of Nepalese tea. In addition, easier credit access and the provision of effective extension services could support the farmers to better adapt to climate change. Most participants expressed high concern towards their future as tea farmer. Therefore, the need for further researching this climate vulnerable industry is becoming inevitable.

**Keywords:** climate change impacts, adoption of coping strategies, constraints and concerns, Nepalese tea industry, tea export strategy

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| | |
|---|---|
| **BLM** | Binary Logit Model |
| **CC** | Climate Change |
| **CIA** | Central Intelligence Agency |
| **FAO** | Food and Agriculture Organization |
| **GDP** | Gross Domestic Product |
| **HH** | Household |
| **ITC** | International Trade Center |
| **LDC** | Least developed country |
| **MNL** | Multinomial Logit |
| **NTCDB** | National Tea and Coffee Development Board |
| **OR** | Odds Ratio |
| **SPSS** | Statistical Package for the Social Sciences |

# 1.Introduction and Literature review

## 1.1. Introduction

The unpredictability of climate shifts and the observation of related impacts particularly to the agricultural sector are increasingly becoming evident (Duncan et al. 2016). Research has been conducted among stakeholders involved in agricultural value chains towards their perceptions and opinions on the impact of climate change (CC). Shifts in climate have a dramatic influence on global agriculture through more extreme weather, like droughts or floods (Tate 2001). Particularly climate sensitive high value cash crops such as wine, coffee and tea are sensitive towards environmental changes (Mozell & Tach 2014). Consequently, a full understanding of a crops´ production and value chain is essential (Schultz 2010). Despite different research approaches, application of different objectives and analysis methods, numerous studies reveal a correlation between the impacts of changing climate and the effectiveness of an agricultural sector. However, research is often focusing on globally significant economies. At the same time, seemingly insignificant countries appear to be somewhat overlooked in this context.

### *1.1.1. Nepal, CC and agriculture*

Being geographically locked between India and China, the two highest populated countries on earth (CIA 2018), Nepal appears to be such a case. In compare to its neighbouring countries, Nepal is proportionally small in terms of inhabitants and economic strength. According to the United Nations (2018), Nepal still belongs to the least developed countries (LDC´s) in the world. This indicates a low degree of self-sufficiency. Because of that, a decreased resilience towards unexpected disturbances such as extreme weather can be observed. Looking at the country's GDP development and its relation to the agricultural sector, the available data shows a steady decline in the share of agricultural activities towards the overall GDP (World Bank 2018). Nevertheless, with approximately 33% (as of 2016) of Nepal´s GDP being generated through agricultural activities, the reliance on this economic sector becomes undoubtedly clear. Approximately 74% of domestic employment is generated through agricultural activities (CBS 2014). Taking Germany as counterpart example, agriculture only constitutes approximately 0.6% towards the overall GDP (World Bank 2018). Hence, a high degree of relative agricultural dependency can be derived. In an elaborate report regarding the cost of

CC in South Asia, Ahmed and Suphachalasai (2014) pointed out, that regional climate in Nepal could face a temperature increase of 1.6°C–2 °C by 2030, 2.3°C–2.9 °C by 2050, and 3.4°C–5.0 °C by 2080. As a logical consequence, the productivity of the domestic agricultural sector and thus the economic situation of many households is jeopardized by the ongoing changes in climate.

### *1.1.2. Nepal´s tea sector*

Taking a closer look at the complexity of Nepal´s domestic agricultural sector, one branch appears to continuously gain in economic significance: The tea producing and processing industry. With tea *(Camellia sinensis)* being the second most consumed beverage after water (Szenthe 2015), global demand increased by more than 60% within the past two decades (ITC 2016).

The International Trade Center (ITC) conducted a study concerning the domestic tea sector in Nepal including an elaborate strategic export plan for the years 2017-2021. National tea production increased remarkably, particularly within the past decade. A production growth of more than 60% between 2004 and 2014 could be observed. This is proof for an increasing share of regional livelihood income being generated through tea production (Figure 1).

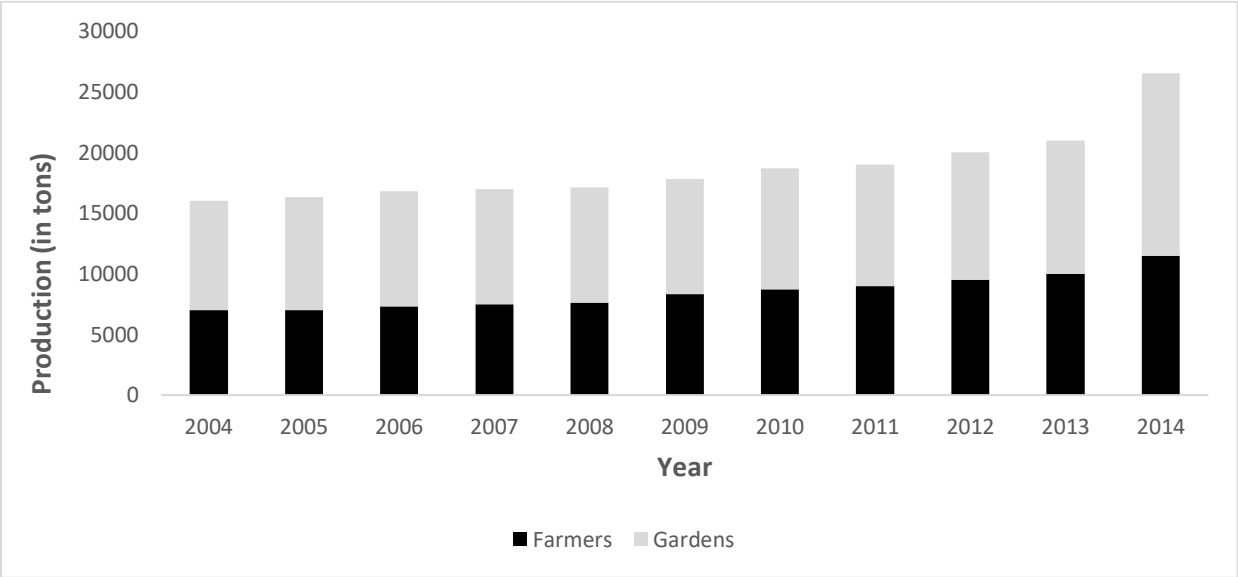


**Figure 1: Production of tea divided by commercial gardens and smallholder farmers 2004-2015 (compiled with Data from NTCDB)**

Furthermore, this study provides a particularized analysis of the overall value chain of tea and potential strategic recommendations. These should eventually help to continuously enhance the size of the domestic tea sector. This information is significant, because it exhibits the growing importance and future perspective of this industry and justifies the imperative of applying contemporary research issues towards the tea farming sector of Nepal.

As in most other agricultural fields around the globe, Nepal´s tea industry is as well highly influenced by the effects of CC (Chalise et al. 2017). It is mostly the smallholder and subsistence-based farmers being particularly vulnerable to any disasters caused by CC due to financial dependency on the crops they are growing. As the ITC (2016) pointed out, the average farm size of a tea farmer in the tea producing areas of Nepal equals to 0.78 hectare with a total of 14898 tea farmers in the country (as of 2016). A large share of domestic tea production is therefore carried out by smallholder farmers whose livelihoods are largely depending on selling the harvested tea leaves.

### *1.1.3. Research gaps*

More studies dedicate their focus on the farmers´ awareness level and strategies to cope with a changing climate. At the same time, Mertz et al. (2009) mentioned that traditionally such topic related studies always focused more on the opinion and perception of public organizations or field experts and not so much on the farmers themselves. An obvious yet crucial observation in this context was made by Wheeler and Tiffin (2009): Farmers were always adjusted to cope with seasonal changes in climate, yet unpredictability and speed of global CC makes it crucial to accelerate and diversify these coping strategies.

While the apparent intention lies in a steady growth of Nepal´s domestic tea industry, it should be a natural deliberation to gain insight into the adaptation behaviour of tea farmers towards CC. This is not only important from a commercial point of view, but foremost for filling a knowledge gap. This should eventually allow direct comparisons between other agricultural industries and similar research conducted in various parts of the world. A lack of awareness regarding CC and wrong or no adoption of strategies among farmers not only leaves them more exposed to any potential losses, but generally lowers the overall productivity of an agricultural sector (Woods et al. 2017).

In terms of available scientific literature, several insights were obtained:

1. There is an increasing number of studies focusing on CC adaptation and how the international tea industry is affected by its consequences. As mentioned earlier however, those studies are largely focused on more significant countries in the global tea trade such as India (Biggs et al. 2018a), China (Ahmed et al. 2014), Vietnam (Nguyen & Mitsumasu 2016), Japan (Ashardiono & Cassim 2014), Kenya (Ochieng et al. 2016) and Sri Lanka (Gunathilaka et al. 2018).

2. Socio-economic research has been conducted in Nepal regarding the impact of CC. Yet so far, no study has focused on the direct relation between tea farming practises in Nepal and the farmers´ perceived influence of a shift in climate. The research gap in the revelation of the perception and awareness of tea farmers in Nepal towards this topic could be a barrier to higher efficiency of the domestic tea export strategy set from 2017-2021 (ITC 2016).

3. CC poses a significant threat to the agricultural sector around the world and particularly the LDC´s are prone to be confronted with disasters (e.g. food crisis). Adding knowledge within this frame is unquestionably necessary to counteract negative consequences such as humanitarian crises.

CC is currently becoming an incremental topic in scientific research. Combined with the suspicion, that no studies focusing on the awareness and adaptation towards CC among tea farmers in Nepal have been carried out so far, lead to the intrinsic motivation to focus on this issue more in depth.

## 1.2. Literature review

In order to appropriately analyse the current state of scientific knowledge, it is pivotal to see which studies were published in connection to CC adaptation and Nepalese agriculture. Nevertheless, it is crucial to comprehend this issue from a global perspective as well to identify broader topic patterns and issues. Additionally, it is of importance to analyse CC adaptation in the context of tea farming. The available literature is thus reviewed in correspondence to these categories and systematically examined within various sub-chapters.

### *1.2.1. CC adaptation in Nepalese agriculture*

#### *1.2.1.1. Current situation*

With Nepal being classified as LDC, Adger et al. (2003) claimed that in such cases it is particularly the responsibility of policy makers to diminish negative CC effects on the domestic agricultural sector. Vij et al. (2018) conducted an elaborate study regarding climate policy paradigms in Nepal and Bangladesh. The basis of these policies is a focus on disaster response and relief, followed by disaster risk reduction and campaigns to increase awareness of CC adaptation. At the same time, farmers in particularly poor regions frequently do not feel a high degree of governmental support. This raises the question, if Nepalese tea farmers are subjectively perceiving implanted policy measures as supportive towards improved CC adaptability. Chetri et al. (2012) revealed the relation between institutional and technological innovation and the level of adaptation in agriculture towards the change of climate. Nepal´s farmers do have an ever-improving access to up to date knowledge and technology. This eventually helps them to decrease negative impacts caused by unexpected natural disturbances (e.g. intense rain periods). Particularly the ingress to more precise weather forecasts and the availability of improved and more resistant crop varieties supports a decline of harvest losses due to extreme weather. Climate data provided by Harris et al. (2014) uncovered temperature and precipitation development between 1910 and 2010. The findings indicated an increase in average temperature while simultaneously a steady decrease in overall precipitation.

Remarkably, these long-term changes in climate appeared to have a perceived positive effect on domestic agriculture until around 2010. From this year onwards, the perceived negative impacts outweighed the positive ones (Paudel et al. 2019). This raises the suspicion, that the transformation of the perception towards CC is only happening slowly in Nepal. It would also be a possible explanation for a potentially low degree of adaptation among smallholder tea farmers.

#### *1.2.1.2. Impacts of CC on agriculture*

Chalise and Naranpanawa (2016) analysed the change of land usage patterns in Nepal due to a change in climate. A computable general equilibrium model has been developed for these purposes. The study simulated, by working with different data scenarios, how land usage is potentially changing with an increasing exposure to CC effects. The farmers in Nepal tend to reallocate their land to less climate sensitive crops. Recommendations included the focus on appropriate policy measures such as the provision of climate smart rice paddy aiming to support the local farmers. This goes in line with findings of an up to date study by Paudel et al. (2019). Their research concentrated on perceived drivers influencing the changes of agricultural land use in Nepal. Next to sociodemographic factors and aspects such as policy measures, a strong connection with changing climate was identified.

In a similar study by Chalise et al. (2017), a general equilibrium assessment has been used in connection to the loss of productivity in the agricultural sector due to CC. Within the three scenarios presented, even the least dramatic one did indicate a significant negative influence on all major crops grown in Nepal. With that, losses in farming output, farming wages and GDP are to be expected. The ultimate effects are eventually leading to rising food prices and potential insecurities in this respect. While this study mostly focused on the effect on food crops such as rice, wheat and maize, the tea farming sector is prone to be equally confronted and threatened through these changing climate patterns. In addition, Malla (2008) noted that Nepal's climate frequently suffers from a late or pre-monsoon and increasingly unpredictable weather which again has a negative impact on all farm related activities in the country.

*1.2.1.3. Factors influencing CC adaptation in Nepal*

As Hossain et al. (2016) confirmed, the biggest shifts due to CC can be expected through an increase in temperature and less predictable rainfall patterns. In a study particularly focused on rural households in Nepal, Ensor et al. (2019) however critically question the purpose of attempting to identify adoption of strategies towards these changes, if the wider socio-cultural context is largely ignored. In order to comprehend the CC adaptation of Nepalese farmers, it is thus necessary to identify which other factors play a role in their overall way of thinking. Next to labour and market availability, it is also the aspect of information search behaviour and socio-demographic factors causing changes in that regard. The epistemology of CC adaptation should hence focus more on including such aspects (Ensor et al. 2019).

In a similar research layout, Khanal et al. (2018) identified the adoption of strategies towards CC among Nepalese rice farmers in connection to the impact on the rice yield. As academic literature indicates, it is crucial to enhance a farmer's ability to adapt to CC by effective policy measures. This supports the ability to counteract negative effects of a changing climate accordingly (Huq et al. 2004). On the other hand, Khanal et al. (2018) claimed, it is as well important for policy makers to take the farmers´ perception and existing knowledge into consideration. This allows a more tailored and effective approach in the implementation of supportive actions. Based on the conducted household survey among 422 rice farmers, the findings included access to credits, the farmer´s level of education, attendance in trainings and access to information on CC issues have a significant influence on the degree of CC adaptation. Without a question, these discoveries appear to be relevant and the feasibility of comparing these factors with the findings among tea farmers in Nepal becomes undeniable.

*1.2.1.4. Research on tea farms in Nepal*

Research on Nepal´s tea farming sector has been conducted in the past, however without a direct link to CC. Karki et al. (2011), identified factors influencing the conversion to organic farming among small holder tea farmers. While the topic itself is not necessarily of high pertinency in this context, the methodology applied was of a similar nature as intended for this thesis. By having short interviews with around 180 farmers in the Ilam district, the

respondent's socio-demographic characteristics have been identified and were used to carry out a regression analysis. This offers evidence on conducting a similar type of exploration being feasible. Mohan (2015) focused on global value chains and how Nepalese smallholder tea farmers could benefit from an improved inclusion through so called "upgrading". Again, this issue is not directly related to CC. Nevertheless, it displays the increasing awareness on Nepal´s domestic tea sector and the prerequisite to gain more insight in this regard.

### *1.2.2. CC adaptation in global agriculture*

The previous subchapter aims to provide insight into the current state of CC effects, perceptions and adaptive strategies in Nepal. With CC being a global phenomenon however, a relevant element in this context is to also investigate these concerns not only domestically but also internationally. The aim of this subchapter is thus an analytical display of scientific research connected to CC perceptions and adaptation strategies in various agricultural fields around the world. The primary intention lies in the identification of broader patterns and potential similarities with the tea farming sector.

#### *1.2.2.1. CC adaptation in Asian agriculture*

A recent study regarding adaptation strategies towards CC of smallholder farmers in Vietnam by Trinh et al. (2018) pinpointed that socio-demographic aspects such as education, training participation, age, gender and access to credit did have an influence on which extend CC adaptation was practised. This goes in line with the findings of the previously mentioned research conducted by Khanal et al. (2018). Adaptation strategies such as crop diversification, following the weather forecast and soil cultivation were significantly affected by those variables. The authors concluded that the creation of more trainings focusing on CC as well as CC policy integration in regional organizations could lead to an increased awareness and eventually to a higher degree of resilience towards negative impacts for smallholder farmers. Sahu and Mishra (2013) carried out an investigation with similar objectives among 150 farmers in rural India. 98% of the respondents did feel a change in climate through a shift in rainfall patterns or a difference in temperature. However, out of this sample only 59% made use of one or more adaptation strategies. This raises the question why the awareness seems to be

high but the level of adaptation relatively low. As in related research projects, farm land size, access to credits and annual income had a significant effect on adaptive capabilities.

Menike and Arachchi (2016) provided related scientific evidence from Sri Lanka. Again, the focus consisted of identifying which factors play a role in the adaptation practises towards CC among smallholder farmers. All 125 participating farmers were aware of a change in climate. Among the following significant factors of influence towards the probability of CC adaptation have been identified: household size, level of education, income, access to credits, being member of a cooperative and access to climate information. Interestingly, farmers who primarily use television and internet for weather updates, had a significantly higher probability of adaptation to CC than farmers using other or no sources. As Sri Lanka is one of the worlds key producers of tea (ITC 2016) and the research design of the study has the same centre of attention as this thesis, the applicability to the context of Nepal would be a logical consequence.

A study with an almost identical focus was conducted among 1500 Chinese farmers by Shi-yan et al. (2018). For the analysis of the acquired data, a multinomial logit model (MNL) was applied. As Rosenzweig and Tubiello (2007) noted, the decision making-process of a farmer´s adaptation mind-set is difficult and complex. By asking them about their perception on CC using a five-point Likert-Scale (lowest: no change – highest: very obvious), it has been uncovered that close to 90% of the respondents at least perceived a change in climate to some extent. In addition, most farmers made use of at least one adaptation strategy. The three highest ranked strategies were improved irrigation, more crop varieties and increasing input of fertilizers. As in numerous comparable studies, sociodemographic factors such as age, income, education and farming experience have been identified as significant predictors. The question of which factors were keeping the farmers from adapting to CC constituted to be another interesting aspect. Not enough information and a lack of funds were the responses with the highest frequency, which goes in line with the findings of Deressa et al. (2009). Fahad and Wang (2018) analysed adaptation strategies towards CC and their perceived constraints among farmers in rural Pakistan. As in the study of Shi-yan et al. (2018), the most common adaptation strategies included a change of crop type as well as adjustments in usage of fertilizers, pesticides and irrigation. Also, agroforestry was a common approach among the respondents. Perceived constraints towards CC adaptation are crucial to understand in order

to improve the farmers´ situation (Bryan et al. 2013). The main perceived constraints in this case included poverty, lack of support from the government, no access to credits and a lack of knowledge. Similar findings in other studies add credibility to the broader patterns (Deressa et al. 2009; Shi-yan et al. 2018; Sahu & Mishra 2013). As the Nepalese government is actively working on boosting the domestic tea industry (ITC 2016), it should be a logical consequence to support the tea farmers accordingly. The question remains to what extend the farmers perceive being supported.

This paper also had an overlap with earlier research conducted in Pakistan by Ali and Erenstein (2017). Pakistan is prone to be strongly affected by CC with a worsening outlook for the future. Positive associations between adaptation and variables such as education, access to credits and trainings, wealth and farm size could be identified. Particularly farm size appears to have a varying effect on adaptation behaviour. While Sahu and Mishra (2013) came to the same conclusion, Bedeke et al. (2018) as well as Deressa et al. (2009) revealed a negative relationship. This raises the question what effect these two variables have among tea farmers in Nepal. Regarding the remaining variables however, the results go in accordance with other research (Fahad &Wang 2018; Trinh et al. 2018; Khanal et al. 2018; Menike & Arachchi 2016). Focusing on a different angle, Islam and Nursey-Brey (2017) studied the importance of formal institutions and governments connected to the farmers ability to adapt to CC in Bangladesh. In addition, they as well tried to identify the awareness level of CC among farmers in rural areas and concluded, that all respondents were aware of changing weather patterns.

#### *1.2.2.2. CC adaptation in African agriculture*

Many farmers in Sub-Saharan Africa do face more extreme weather such as droughts and higher temperatures while at the same time their adaptability remains low due to a high degree of poverty (Kotir 2011). Bedeke et al. (2018) focused on the perception and response towards CC of maize farmers in rural Ethiopia. Their hypothesis centred around the following assumption: farmers who strongly perceive CC also adapt to it accordingly. The findings could confirm this supposition. Next to the adjustment of cropping dates, the usage of more resilient crop varieties, irrigation through ponds and agroforestry, also off-farm income diversification and seasonal migration were playing a crucial role in the farmers´ adaptation mind-set. Interestingly, the assumption of more farmland having a positive relationship with CC

adaptation could not be confirmed in this case. This outcome is opposed to the results of other studies such as from Sahu and Mishra (2013). However, Deressa et al. (2009) also revealed a negative relationship between farm size and CC adaptation in an earlier study as well based in Ethiopia. That on the contrary uncovers potential deviations of such factors in different geographic settings.

A study conducted by Mertz et al. (2009) gained insight in farmers´ CC perceptions in rural Sahel. As this part of the world is frequently ridden by extreme weather events, research suggests a strong opinion of the local farmers towards climate (Elmqvist & Olsson 2006). Within this frame, a lack of rain was mentioned as major impact. The subsistence-based farmers´ adaptation strategies were relatively limited. Next to replacing draught horses with kettle and the usage of manure, it was mostly the switch to less climate sensitive vegetable crops.

By asking smallholder farmers of different age and wealth groups in central Zimbabwe, Makuvaro et al. (2018) identified the respondents' future perceptions and suggestions towards CC effects on their farms by the year 2050. Particularly in this part of the world, the agricultural sector does not have high adaptive capabilities (Gandure et al. 2013). Interestingly, elderly farmers (> 70 years of age) came up with the least potential strategies despite mostly having more experience than younger farmers. Nevertheless, all participants acknowledged that CC had a significant influence on their farming activities. Other factors, such as a lack of governmental support, were perceived as equally severe threats.

As Dilling et al. (2015) pointed out, the decision-making process of CC adaptation has not been a strong empirical focus in the past. Using a structured mental methods protocol among grain farmers in South Africa, Findlater et al. (2018) found out that despite a generally high degree of awareness of CC impacts, this pertaining issue was not included in the farmers mental models of everyday risks. That made them less flexible in developing effective counter measures and adaptation strategies. So particularly on a broader outlook and long-term perspective, the lack of CC adaptation could potentially lead to substantial losses.

*1.2.2.3. CC adaptation in European agriculture*

Woods et al. (2017) focused on the perception and response to CC among farmers across Denmark. As the FAO (2016) noted, CC impacts are increasingly studied, particularly on how they affect global agriculture. At the same time, it is unquestionable that effects of CC are varying in various parts of the world (Glantz et al. 2009). This assimilation can be confirmed by the Danish study, as most respondents did not express a high concern towards CC. In contrary, a significant share of the farmers believed in a change in climate could even have positive effects on their farming activities. What made this study innovative is that not only a focus on the negative impacts of CC has been drawn, but also its potential benefits. The results indicate, that barriers to adapt to CC are perceived as too high. Next to policy regulations, a potential economic loss and uncertainty regarding the development of CC were among the reasons for not adapting.

Aguiar et al. (2018) critically analysed the general level of adaptation to CC at a regional level in Europe. Most severe weather impacts are experienced on a local scale (Hunt & Watkiss 2011). While this awareness is leading to more regionalized adaptation strategies such as policies and other supportive measures, the balance between regional, national and international attempts to diminish the negative effects of CC appear to be difficult to maintain. As this research has been concentrated on countries such as Germany and Portugal, it can only be assumed that LDC´s are struggling with an effective implementation of related policies even more.

Focusing on short- and long-term perceptions of CC among farmers in Italy, Menapace et al. (2015) noted that respondents who strongly believe in CC were also more concerned about their future (e.g. in terms of harvest losses). What is innovative in this study is the application of the exchangeability method. Within this process, farmers were rather asked about expected harvest losses in contrary to directly questioning them on their perception towards CC. The aim was more precise and accountable data. Out of 195 respondents, 83 % were aware of CC. This goes in line with relatable research, in which equally (or higher) awareness rates have been identified. Asking these farmers about the potential cause of a shift in climate, approximately 58% believed in a combination of human activities and natural events. They also revealed mixed perceptions on a changing climate among farmers in various agricultural fields and regions of the world. The share of farmers perceiving such changes varies greatly.

Nevertheless, if risk perception and plans to adapt are directly compared, in most cases a positive relationship could be defined. According to Lobell et al. (2006) however, perennial crops (such as tea) are especially challenging when it comes to appropriate adaptation due to their relatively long lifecycles.

Through in-depth focus group discussions among agricultural experts in Sweden, Neset et al. (2018) confirmed, that the balance between CC perception and adaptation is difficult to maintain. One of the reasons is again regional differences of effects and impacts, which can largely deviate even within one country. This goes in line with the findings of Aguiar et al. (2018). While governments and other policy makers in LDC´s seem to generally struggle with providing any support to the agricultural sector at all (Gandure et al. 2013), the seemingly effective strategies in European countries are often questioned as well.

#### *1.2.2.4 CC adaptation in Central and North American agriculture*

As in previous research performed among farmers in Asia, Africa and Europe, De Sousa et al. (2018) identified how knowledge and sociodemographic aspects influence CC adaptation among farming households across Central America. The awareness rate towards CC among the respondents was 90%, which proofs that also in this part of the world the apprehension is quite high. Similar observations have been made in Italy (Menapace et al. 2015), South Africa (Findlater et al. 2018), Sri Lanka (Menike & Arachchi 2016), China (Shi-yan et al. 2018) and India (Sahu & Mishra 2013) where the awareness rate levelled between 83% - 100%. Crop diversification, improved soil cultivation and reforestation were identified as main coping strategies. As pointed out by Ashardiono and Cassim (2014), these appear to be common strategies among tea farmers as well. Moreover, this study also revealed a significant difference of adaptation preference in dependence of the land size and the respondents´ level of education.

Capturing this situation from a slightly different angle, Arbuckle Jr. et al. (2013) asked farmers in Iowa (USA) about their opinion on mitigation of CC effects and compared them with their attitudes towards this topic. Farmers who do believe in human activity being responsible for CC, showed a more positive attitude towards mitigation than farmers who believe in it being a purely natural phenomenon. The methodology in use contained three different CC

adaptation option models (protect, drain and mitigate) and among the following independent variables: age, education and the degree of concern. All of them were identified as significant predictors for at least one of the three models. Particularly age and education appear to be a factor of influence in all reviewed and topic-related research so far.

Similar outcomes were observed among farmers in rural California in a study by Haden et al. (2012). Their hypothesis claimed, that the degree of adapting to CC is strongly related to the farmers global beliefs about it. Additionally, it is also the direct consequences (e.g. a lack of water) increasing the likeliness to adapt accordingly. Within this research, most of the respondents expressed a moderate or high concern towards the future development of a changing climate.

### *1.2.3. Impact of CC and adaptation in the global tea industry*

Tea as commercially grown crop is undoubtedly being influenced by shifts in climate. Ochieng et al. (2016) identified the perceived impact in the case of smallholder tea farmers in Kenya. Temperature variations can have a positive effect on tea while having negative effects on other crops. On the other hand, intensive rainfall supposedly has a negative impact on tea farming. Those findings were gathered by comparing available weather data (rainfall, average temperature) with harvested quantities of tea and maize. The data was analysed with a regression model. In this case, tea reacted particularly sensitive towards an increased amount of rainfall.

In a similar study by Ashardiono and Cassim (2014), CC adaptation strategies of tea farmers in Japan were uncovered. Within this framework, it was once more emphasized on the significant impact of an increasing temperature for the tea industry. Extreme weather events are on a rise and due to their partial unpredictability, these impacts can cause serious harvest losses as well. Additionally, a correlation between average temperature and harvested amount of tea has been identified. A strong focus was laid on the so-called terroir concept, which includes following aspects: climate, soil, topography and the cultivar. Most respondents were taking each of those aspects into consideration.

The tea sector in India is significant for the domestic economy and being one of the world's largest tea exporters (ITC 2016), a steady increase in production and export quantities can be observed (Arya 2013). By analysing the change of livelihoods among involved stakeholders of tea plantations in Assam, Biggs et al. (2018a) additionally uncovered the perception of local farmers towards CC and their suggestions of how the situation could be improved by adaptive farming approaches. Next to the creation of awareness programmes and stricter control towards the usage of pesticides and fertilizers, their responses included improved irrigation, soil conservation, the prevention of deforestation and the reduction of air pollution.

Within the same research framework, Biggs et al. (2018b) published a paper on the production characteristics of tea farmers in Assam (in 4 different districts), differentiating between large- (> 10ha) and smallholders (< 10 ha). Between 59% and 76% of the smallholder´s farmland was used for tea production, which indicates that crop diversification was a common strategy for the farmers. Duncan et al. (2016) focused on Assam as well, which itself constitutes to almost 17% of the world tea production alone (Dikshit & Diskhit 2014). A correlation between increased monthly temperature and a decreased tea yield could be observed. This contrasts with what was found by Ochieng et al. (2016) in Kenya.

Adaptation to CC can be defined as the process of searching for better alternatives to changing conditions (Smit et al. 2000). Within this context, Gunathilaka et al. (2018) conducted interviews with tea farmers in Sri Lanka, asking them about strategies to adapt to the changing climate. By applying an MNL model, the preferred adaptation strategies were defined as dependent variable and factors such as size of the farm, information access to CC, elevation of the tea farm and intensity of rain or increased temperature were set as predictors. This approach was also common in studies focusing on other regions with various agricultural production systems. In terms of factors influencing the willingness to adapt to CC, the level of available information, farm size and elevation of the farm were among the factors of influence. The most relevant constraints towards adaptation were a lack of capital as well as information but foremost also the perceived insufficient support from the government.

Nguyen and Mitsumasu (2016) focused on improvement of irrigation as CC adaptation strategy among tea farmers in Vietnam. Water use efficiency of the respondents was relatively low. Factors such as gender, training participation, awareness about water shortage and soil conservation all had a significant influence on how farmers made use of irrigation.

Going in line with the findings of Menapace et al. (2015), CC can also have positive effects on tea production. Particularly an increased temperature in higher latitudes can lead to higher yields in some cases (Ewert et al. 2005). Next to the quantitative element in tea production, it is also of importance to focus on the effect of CC towards the quality. This has been done in a study by Ahmed et al. (2014) in which the quality of tea in China has been analysed in different seasons and weather patterns. While the tea harvest during the monsoon period (more rainfall) increased by up to 50%, the quality of produced tea during the same period also decreased by up to 50%. Faster growth leaves less time for the development of important flavonoids in the tea leaves. The lack of quality and poorer sensory properties of this tea lead to a decreased price and ultimately to less farm income. In addition, the increased harvest in relation to more rainfall contradicts the discoveries of Ochieng et al. (2016).

These findings are a good example of how complex, particularly towards agriculture, the issue of CC is. The necessity for further research is therefore undeniable. Next to potential threats to the tea farmers and other involved stakeholders, it is also the consumers being directly affected through a decreased availability of quality tea (Ahmed et al. 2014). Once more this supports the core idea of this thesis.

### *1.2.4. Summarized literature findings*

The previous information should provide the reader with a possibly broad and elaborate insight to the topic of this thesis. Figure 2 displays the most relevant findings from the literature review. Next to commonly used adaptation strategies in agriculture and particularly tea farming, factors influencing the level of adaptation have been summarized. In addition, the literature derived constraints towards adaptation in agriculture have been identified. These discoveries were used as basis for further analysis.

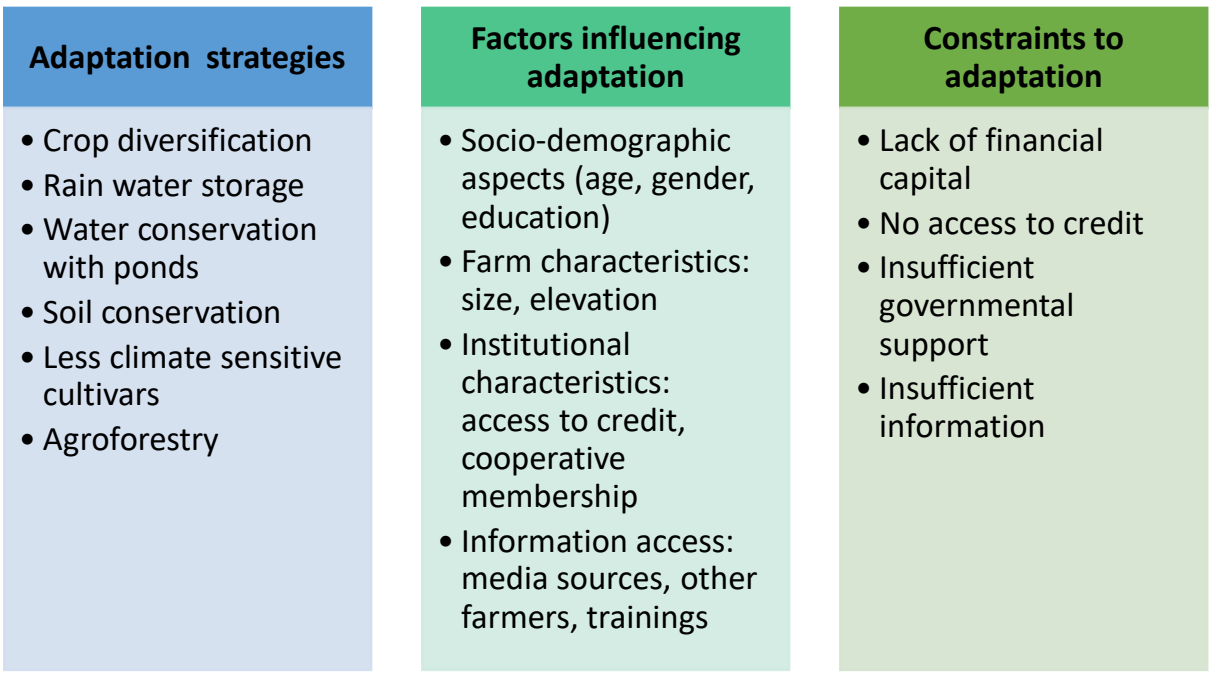


**Figure 2: Key aspects from literature review**

# 2. Research objectives

**Main objective:**

The main objective of this thesis was an analysis of the factors influencing the degree of CC adaptation among smallholder tea farmers in Ilam, Nepal.

**Specific objectives:**

As the main objective is defined in rather broad terms, a set of more specific objectives has been developed:

1. Revelation of the respondents´ CC adaptation behaviour in terms of how many strategies and which specific strategies are applied.
2. Identification of which demographic, institutional and information source factors are likely to influence the choice and extend of applying specified adaptation strategies towards CC.
3. Uncovering the adaptation constraints and the perceived effects of CC to the tea farms.

**Research questions**

The research questions do all have a direct or indirect link to the theoretical framework of this thesis and had the goal to find answers to the set of objectives:

1. *Which CC adaptation strategies are perceived as most important and most frequently used by the farmers?*
2. *How do demographic, institutional factors and information sources influence the adaptation behaviour of tea farmers towards CC?*
3. *Which sources do farmers use to educate themselves about climate and tea farming?*
4. *Which constraints do have a negative impact on the degree of CC adaptation and future concern of the farmers?*
5. *How do farmers evaluate CC impacts and other environmental factors towards tea cultivation?*

# 3. Methodology

## 3.1. Data collection

The data for this thesis consisted of two main elements: Secondary and primary data. While the secondary data framed the theoretical element, primary data could be perceived as the logical consequence based on the topic related theory reviewed.

### *3.1.1. Secondary data*

Secondary data was mainly acquired through an extensive literature review. The sources of information were several academic databases. However, most of the relevant papers and related literature have been searched for within the following databases: *Science Direct, Web of Science and Google Scholar*. These databases included many topic related papers published in specific scientific journals. Mentioning each journal would exceed the frame of this sub-chapter but among the following journals constituted to be highly relevant regarding the particular topic of this thesis**:** *Environmental science and policy, Global environmental challenge, International journal of climatology, PLOS one, Climate change, World development, Climate risk management, Land use policy, Economic modelling.* Furthermore, databases such as from the *World Bank, FAO, CIA, UN, NTCDB and ITC* primarily served for useful background information to address the issue from a broader perspective. From a methodological point of view, several sources were considered. In terms of research layout and methods, the book of Bryman (2008) on social research methods allowed in-depth insights. Elaborate explanations about econometric modelling and statistical evaluation of data was partially derived from Gujarati (2006), Greene (2003), Cramer (2003), Landau and Everitt (2004) as well as Bryman (2008).

### *3.1.2. Primary data*

The primary data element of this thesis consisted of a questionnaire, which was developed in accordance to the findings of the secondary data. The quantitative tool served as main source of acquiring desired data directly from the selected respondents. Due to the lack of digital infrastructure and communication barriers in the study area, there was no option of

distributing the questionnaire digitally. Despite the data tool used being primarily of a quantitative nature, a qualitative element has been included because all farmers haven been visited and interviewed personally. This aspect allowed to have personal discussions on an informal basis and not solely the responses given in the questionnaire. The language barrier however did not allow to fully record, translate, transcribe and code these discussions.

### *3.1.3. Layout of the questionnaire*

Serving as the main tool for the primary element of data collection, the questionnaire was carefully developed in accordance to the secondary data and previously set objectives. To allow a possibly deep insight into the characteristics, perceptions and adaptation strategies, the questionnaire was divided into four categories with a total of 41 questions of various nature (Likert scale, dichotomous, continuous, etc.). The following divisions were made (full questionnaire in English: Appendix 4; in Nepali: Appendix 5):

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***1. CC perceptions and adaptation strategies**: awareness, perceived impact on farming performance, adaptation strategies, constraints of adaptation*

***2. Financing and information access:** use of loans, sources of weather and tea cultivation information, participation in trainings, awareness of tea export strategy, member of cooperatives, relevance of information*

***3. Economic performance:** harvest quantity, average price and perceived profitability for the past 3 years, usage of fertilizers/pesticides, certification according to international standards, harvest losses, further processing of the tea*

***4. Socio economic aspects:** education, age, experience in tea farming, farm size & elevation, HH size, work force distribution, other crops on the farm*

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Due to language barriers, the questionnaire was thoroughly translated to Nepali ahead of the field research. The questionnaire was reviewed before the field trip through personal contacts with Nepali origins in order to assure that the translated version is understandable. Once the research area was reached, further piloting was made among three local contacts with expertise in tea farming and knowledge on the research population. Based on their feedback, minor changes have been made to the questionnaire retrospectively.

### *3.1.4. Respondent selection*

The intended type of selecting the respondents was based on random sampling as stated by Bryman (2008). Due to the lack of a complete list of all farmers in the targeted study area as well as the remoteness and inaccessibility of some of the municipalities however, the respondents could not be selected on an entirely random base. Another challenge constituted to be the cultural context and social connectivity as according to local contacts, it was not recommended to ask personal and sensitive questions without having any referral.

Based on the situation, the choice was made to focus on an **exponential non-discriminative snowball sampling method.** According to Dudovsky (2018), this method has following advantages: it allows to get access to hidden populations and has a high cost and time efficiency. After close interaction with the main contact in the study area, several contacts were provided in other municipalities in order to still gain a representative image of the Ilam district. As connectivity among the local population in Nepal is high, a wider range of contacts to tea farmers was established. This supported the collection of the primary data. Despite efforts to complete at least 150 questionnaires, the final number of respondents was 91. These were spread among three municipalities of the Ilam district (further details in Chapter 3.2.).

A designated research assistant from a local university was hired as well as a personal driver in order to help with translation, logistics and general issues encountered during the field research.

## 3.2. Study area description

### *3.2.1. General characteristics*

As the government of Nepal (2018) pointed out, Nepal currently has around 26.5 Million inhabitants and a total area of 147,181 $km^2$. The country consists of a complex mixture of ethnicities and has 13 officially recognized languages. The main religions are Hinduism with 81.3%, Buddhism around 9% and 4.4% Islam. The Human Development Index (HDI) of Nepal has a value of 0,574 (as of 2018). It indicates the level of development of a country by the following dimensions: long and healthy life, knowledge and a decent standard of living (United Nations 2018). This value is classified as “low” HDI being one of the lowest in whole Asia and on position 149 out of 189 countries worldwide. Relating this fact to the high dependency on agriculture, the fragility of Nepal´s domestic economy becomes once more evident. Looking at the statistics released by the National Tea and Coffee Development Board of Nepal (NTCDB), it becomes apparent that the biggest tea producing district of Nepal is Jhapa. However, this district is mostly focused on larger scale farming by tea gardens. The total output compared between Jhapa with around 18.3 million kg and Ilam with around 4.15 million kg reveals, that Jhapa is the most significant tea producing district in quantitative terms (NTCDB 2018). On the other hand, Ilam is the district with the highest number of smallholder farmers (6985) (Appendix 2). As this thesis has a focus on smallholder and subsistence-based farmers, Ilam district hence constituted to be the most feasible one in terms of research population as well as accessibility. Figure 3 illustrates the geographic position of Nepal including the minor and major tea producing areas of the country. It also visualizes where Ilam district is located, which is shown in more detail in Figure 4.

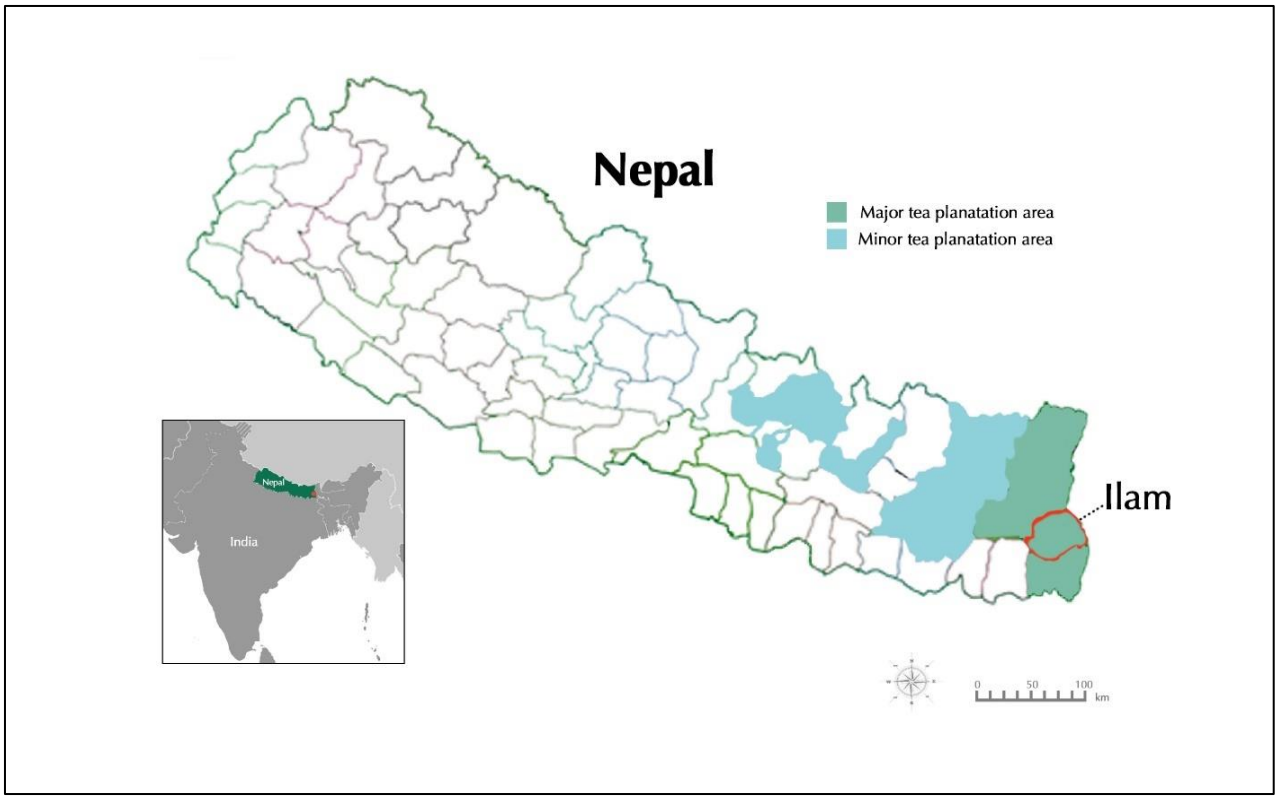


**Figure 3: Map of Nepal with tea plantation areas**

### *3.2.2. Ilam district*

Ilam district has a total size of 1,703 km$^2$ and a population of around 303,000 (City Population 2017). It is divided into a total of ten municipalities, including Ilam municipality (Figure 4). After informal discussions with local contacts, the decision was made to focus on three out of the ten municipalities, namely: Ilam, Saryoday and Deumai. The reasons for this decision were time constraints not allowing to visit all municipalities as well logistical issues (accessibility). At the same time, these municipalities covered a large share of the overall district from west to east and supposedly allowed to get representative data for the whole district. As mentioned earlier, the total number of respondents was 91. 28 respondents were interviewed in the Ilam municipality, 20 in the Deumai municipality, and 43 in the Saryoday municipality.

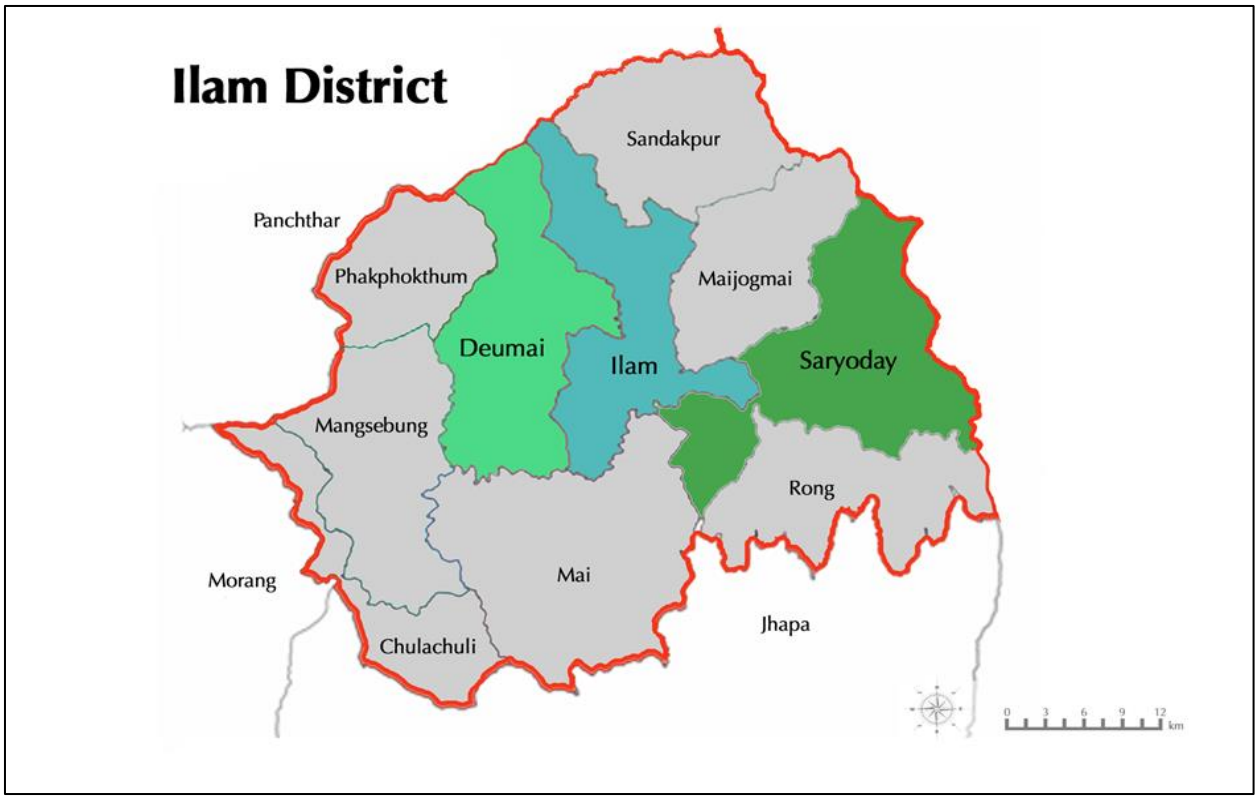


**Figure 4: Map of Ilam district with municipalities and specific study areas**

### *3.2.3. Climate in Ilam district*

Due to the large variation in altitude within the district, Ilam experiences big differences in weather according to the climate zones (Appendix 2). The most present climatic conditions can be defined as subtropical with an elevation between 1,000 to 2,000 meters. This range covers approximately 40.1% of the total area of Ilam district. It is noteworthy that between 1,000 to 2,000 meters was also the elevation range of all tea farms participating in this study.

Nevertheless, climate data of Ilam uncovers that a large part of the annual precipitation occurs during the months June, July, August and September (Climate data 2019) (Appendix 2). The data reveals a strong influence of the yearly monsoon season. As mentioned earlier, Malla (2008) identified a shift and higher unpredictability of the monsoon in Nepal. This leaves the tea farmers more exposed to these shifting climate patterns.

## 3.3. Time frame

The process of this thesis was broadly divided into five stages (Figure 5). The overall project had a duration of around 13 months (March 2018 – April 2019), from the initial tasks to the finalization and submission.

***Phase 1:*** In the initial stage, the focus was primarily laid on the identification of an appropriate topic. This was achieved by in-depth discussions with the thesis supervisor as well as personal research. Based on the broad topic formulation, an elaborate literature research has been conducted. This served as the theoretical frame for revealing potential research gaps as well as for the definition of objectives and research questions.

***Phase 2:*** The goal was to develop an appropriate methodology as how to perform the planned field research. This process included logistic and planning related activities. Furthermore, the outcomes during Phase 1 were used to develop a feasible and purposeful questionnaire, which served as the basis for data acquisition among Nepalese tea farmers.

***Phase 3:*** The third phase was exclusively focused on data collection. It was done through personally visiting tea farmers in the designated research area and by commissioning a personal assistant and interpreter as support. Next to onsite visits of tea processing factories and informal discussions with local stakeholders, the previously developed questionnaire served as primary tool for data acquisition.

***Phase 4:*** After returning from the field research, the printed questionnaires were all converted into a data-set in MS-Excel. In addition, the data has been appropriately coded in order to analyse it with SPSS. The literature review and objectives served as basis for the data analysis.

***Phase 5:*** The last phase of the thesis process mainly consisted of the interpretation of the analysed data. This included a contextual discussion as well as conclusions, limitations and recommendations. In addition, final changes have been made to the document to enhance a coherent and useful structure and layout.

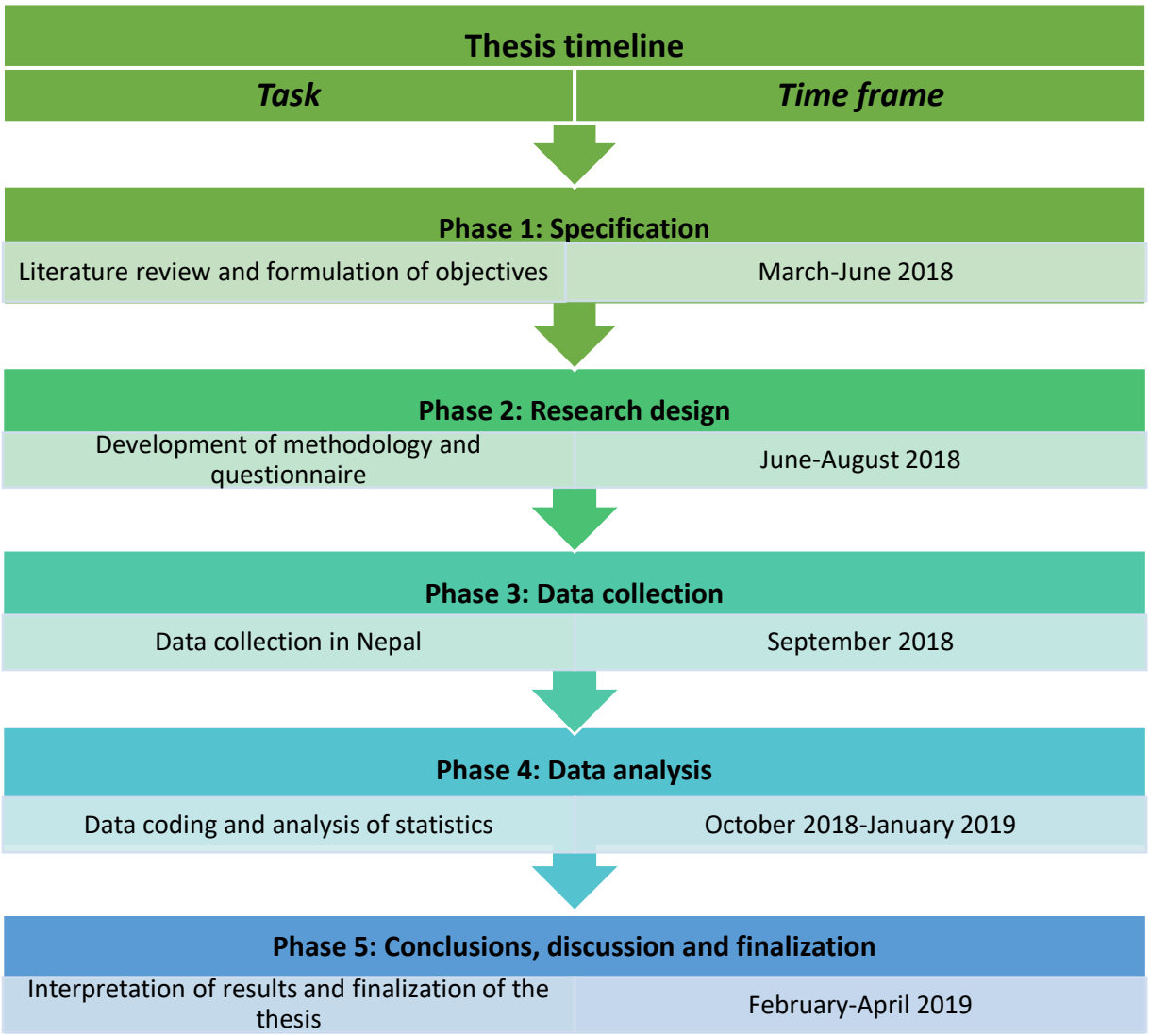


**Figure 5: Thesis timeline**

## 3.4. Data analysis methods

Due to the nature of the data and the intended presentation of the results, the data analysis of this thesis consisted of various elements. The analysis was mostly performed with the statistical software SPSS Version 25. Three main analysis methods were of relevance:

*1. Descriptive statistics:* Particularly the sample characteristics and used information sources were analysed on a descriptive base. In addition, the perceived constraints and impact factors of CC towards tea cultivation were revealed by using descriptive statistics.

*2. Basic statistical testing:* In order to see a potential relationship between the defined independent variables and adaptation strategies applied by the farmers, basic statistic tests have been conducted. Due to the different nature of the predictors, Independent Sample T-Tests as well as Spearman Correlation Tests were applied.

*3. Application of a Binary Logit Model (BLM):* The most important element of the data analysis constituted to be the estimation of a Binary Logit Model (BLM), in which two specific CC adaptation strategies were used as dependent variables and literature derived factors used as predictors to estimate any possible effects.

### *3.4.1. Independent Sample T-Test and Spearman correlation*

In order to reveal which explanatory variables have an influence on the number of adaptation strategies used, two basic statistic tests have been included. The Independent Sample T-Test allowed to gain insight in the mean difference of the binary predictors. The Spearman Correlation Test is a non-parametric way of measuring the strength of a relationship among ranked and/or continuous variables, which made it a suitable alternative for some of the included variables (Landau and Everitt 2004).

### *3.4.2. Binary Logit Model (BLM)*

The BLM is a feasible analysis method when the outcome of the dependent variable is of a binary nature (Lemeshow 2000; Greene 2003; Cramer 2003). In such a case, the endogenous variable can take only two outcomes coded with the value 0 or 1. By involving potential factors

of influence as independent variables, the logit model reveals which of these factors do affect the likeliness of the outcome of the dependent variable. It is noteworthy that next to the continuous predictors in the model, the ordinal predictors were converted into dummy variables. This allowed them to be included in the analysis as well. The dependent variables were selected based on the outcome of which strategies have been used in which frequency by the tea farmers. In this case, two models were estimated based on two dependent variables:

***1. Agroforestry as CC adaptation (1=yes/0=no)***

***2. Switching to less climate sensitive cultivars (1=yes/0=no)***

Further details regarding the applied variables will be provided during Chapter 3.4.3.

Based on Hosmer and Lemeshow (2000) as well as Greene (2003) and Cramer (2003), the basic binary logit equation can be described in the following way:

$$\boldsymbol{log\left(\frac{p}{1-p}\right) = \beta_0 + \beta x}$$

In this equation, the dependent variable y can have the outcome of 1 or 0 based on the logarithm (*log*) of probability p. $\beta_0$ constitutes to be the intercept while *X* is the vector of all independent variables included in the model (all variables are shown in Table 1). The coefficients of the independent variables are expressed through $\beta$. In theory, the probability of y=1 with a given value of the vector *X* of all independent variables can be calculated in the following way:

$$\boldsymbol{p(y = 1) = \frac{e\beta_0 + \beta x}{1 + e\beta_0 + \beta x}}$$

In addition to the intercept, coefficient and variable vectors in the original equation, *e* symbolises the natural logarithm used for calculation.

**Odds Ratio (OR):**

One important element for interpreting the results of a BLM is the OR (Maxwell 2009). As the resulting coefficients cannot be interpreted the same way as in an ordinary regression due to the binary nature of the dependent variable and the non-linear relationship, the OR (or alternatively the log odds) is a feasible way of interpreting the effect of the predictors towards the dependent variable. The OR can be calculated in the following way:

$$OR = \left(\frac{\pi_1}{1-\pi_1}\right)\left(\frac{1-\pi_2}{\pi_2}\right)$$

It compares the probability of y=1 if a factor is present (or not present) with the probability of y=0 if the factor is present (or not present). If the OR>1 it can be assumed that the presence (or increase) of a certain factor has a positive influence on the dependent variable.

### *3.4.3. Selection of variables*

Table 1 presents the literature derived independent variables which had a significant influence on the adaptive capabilities of famers in various agricultural sectors. In addition, the two dependent variables for the models have been identified. The reason for why specifically those adaptation strategies have been selected will be further explained in chapter 4.2.2.

**Description of independent variables:**

*1.Institutional variables*

This group of variables is focusing on whether a farmer had access to a credit/loan within the past five years as well as if there was a membership in at least one cooperative. As literature indicates, having access to a loan and being member of a cooperative both appear to have a positive effect on the degree of CC adaptation.

*2.Sociodemographic variables*

In this case, the sociodemographic variables with potential influence could be divided into respondent characteristics with gender, age and education and farm characteristics with farm size, farm elevation and farming experience. Related research revealed the potential explanatory power of each of these variables towards the usage of adaptation strategies.

*3.Information source variables*

As the available sources and level of information to the farmers appear to play a significant role in the behaviour towards adaptation practises, it was unquestionable to include these variables in the analysis. Particularly information sources and degree of attending trainings (extension services) were defined as important factors of influence in similar research. Within this questionnaire, the farmers have been asked about their preferred information channels with numerous possible alternatives. To not exceed the number of exogenous variables, only the most preferred information channels haven been included (internet and other tea farmers).

**Table 1: Dependent and independent variables used for statistical tests**

| *Variables* | *Type/Label* | *Mean* | *References* |
|---|---|---|---|
| ***Dependent Variables*** | | | |
| Agroforestry | dichotomous/no, yes | .45 | Bedeke et al. (2018)<br>De Sousa et al. (2018) |
| Climate resistant cultivars | dichotomous/no,yes | .42 | Biggs et al. (2018a) |
| ***Independent Variables*** | | | |
| *Institutional variables* | | | |
| Access to credit | dichotomous/no, yes | .26 | Khanal et al. (2018)<br>Trinh et al. (2018)<br>Sahu & Mishra (2013)<br>Menike & Arachchi (2016)<br>Ali & Erenstein (2017)<br>Gunathilaka et al. (2018) |
| Cooperative member | dichotomous/no, yes | .52 | Trinh et al. (2018)<br>Menike & Arachchi (2016)<br>De Sousa et al. (2018) |
| *Socio-demographic variables* | | | |
| Age | continuous/years | 45.41 | Trinh et al. (2018)<br>Shi-yan et al. (2018)<br>Makuvaro et al. (2018)<br>Sousa et al. (2018)<br>Arbuckle Jr. et al. (2013) |
| Gender | dichotomous/male,fem. | .82 | Trinh et al. (2018)<br>De Sousa et al. (2018) |
| Education | continuous/years | 9.55 | Khanal et al. (2018)<br>Menike & Arachchi (2016)<br>Shi-yan et al. (2018)<br>Ali & Erenstein (2017)<br>De Sousa et al. (2018)<br>Arbuckle Jr. et al. (2013) |
| Farm size | continuous/hectare | 1.17 | Sahu and Mishra (2013)<br>Ali and Erenstein (2017)<br>Bedeke et al. (2018)<br>Gunathilaka et al. (2018) |
| Farming experience | continuous/years | 18.86 | Shi-yan et al. (2018) |
| Farm elevation | continuous/meters | 1553 | Gunathilaka et al. (2018) |
| *Information source variables* | | | |
| Attendance in trainings | ordinal/never-frequently | 2.84 | Khanal et al. (2018)<br>Trinh et al. (2018)<br>Shi-yan et al. (2018)<br>Ali & Erenstein (2017)<br>Gunathilaka et al. (2018)<br>Nguyen&Mitsumasu(2016) |
| Information source: Internet | ordinal/never-frequently | 2.54 | Menike & Arachchi 2016 |
| Information source: Other farmers | ordinal/never-frequently | 3.30 | Menike & Arachchi 2016 |

**Note: ordinal variables have a scale from 0=never – 4=frequently; dichotomous variables: 0=no,1=yes; 1=male,0=female**

# 4. Results

## 4.1 Sample description

The respondents´ demographic characteristics were presented in Table 2. Most respondents were male with a share of approximately 82.4%. Interestingly, the literacy rate of the respondents was at 91.2 %. According to Index Mundus (2018), the current literacy rate average for Nepal lies at around 64%. Hence the portion of literate respondents was significantly higher than the average for Nepal. The share of married respondents with 95.6% is high, too. The average size of a family in this sample equalled to 5.14. The UNDP (2017) published a HH survey of Nepal in which the average family size on a national level was 4.6. At the same time, the sizes of the families in this sample varied significantly on an individual base. The youngest respondent was 25 years of age while the oldest 73 with an overall average of 45.41. Noteworthy is that the average years of schooling of the respondents equalled to 9.55. This is considerably higher than the average years of schooling in whole Nepal with around 3.3 years (UNDP 2017).

The mean farming experience of the respondents was 18.9 years (with a min. of 7 years and a max. of 40 years). The farm size ranged between 0.2 and 10 hectares with an average of 1.2 hectare per farm. As previous data from ITC (2016) revealed, the average farm size of smallholder farmers in Ilam district is 0.71 hectare. Hence, the farm size of this sample was significantly larger than the one of the overall research population. The share of cooperative members with 51.6% and non-members with 48.4% was relatively balanced. Only around 26.4% of the respondents have made use of a loan or credit in the past years. At the same time, 66% of the farmers frequently participated in trainings (at least once per year) while only around 5.5% did not attend any trainings at all. Worth to mention is also the average share of the farm dedicated to tea production was 75.4%. All farmers had additional crops on their farm, mostly vegetables grown for own consumption (e.g. Potatoes, Maize and Garlic). A more detailed overview of the farm characteristics can be found in Appendix 1.

**Table 2: Demographic characteristics**

| *Variable* | *Total (%)* | *Min.* | *Max.* | *Mean* |
|---|---|---|---|---|
| **Gender** | | | | |
| Male | 75 (82.4%) | - | - | - |
| Female | 16 (17.9%) | - | - | - |
| **Literacy** | | | | |
| Literate | 83 (91.2%) | - | - | - |
| Illiterate | 8 (8.8%) | - | - | - |
| **Marital status** | | | | |
| Single | 2 (2.2%) | - | - | - |
| Married | 87 (95.6%) | - | - | - |
| Divorced | 0 (0.0%) | - | - | - |
| Widow | 2 (2.2%) | - | - | - |
| **HH members** | | | | |
| to 15 years | - | 0 | 3 | 1.02 |
| 16-59 years | - | 0 | 10 | 3.35 |
| 60+ years | - | 0 | 3 | 0.77 |
| Total average | - | - | - | 5.14 |
| **Age (years)** | - | 25 | 73 | 45.41 |
| **Education (years)** | - | 0 | 15 | 9.55 |

## 4.2. Factors of influence in CC adaptation

One essential element of this thesis was the analysis of which factors do have a potential influence on CC adaptation strategies of tea farmers. This included how many adaptation strategies were used but also which specific strategies were applied to which extend and how the determined factors (Table 1) might influence this process. Being one of the most rudimentary yet crucial questions of this research, the farmers have been asked if they were generally aware of CC. With 86.8%, most of the respondents do have an awareness regarding CC while 13.2% never heard about this term before.

### *4.2.1. Number of adaptation strategies applied*

Figure 6 shows the average number of adaptation strategies used by the tea farmers (min.=0, max.=6). The mean for all respondents in the application of adaptation strategies was 3.00. Most farmers made use between two and four adaptation strategies, 34 (37.4%) were applying three adaptation strategies. There were no farmers not making use of any adaptation

strategies and only four respondents (4.4%) applying one. On the other end, merely two respondents (2.2%) did make use of all six strategies.

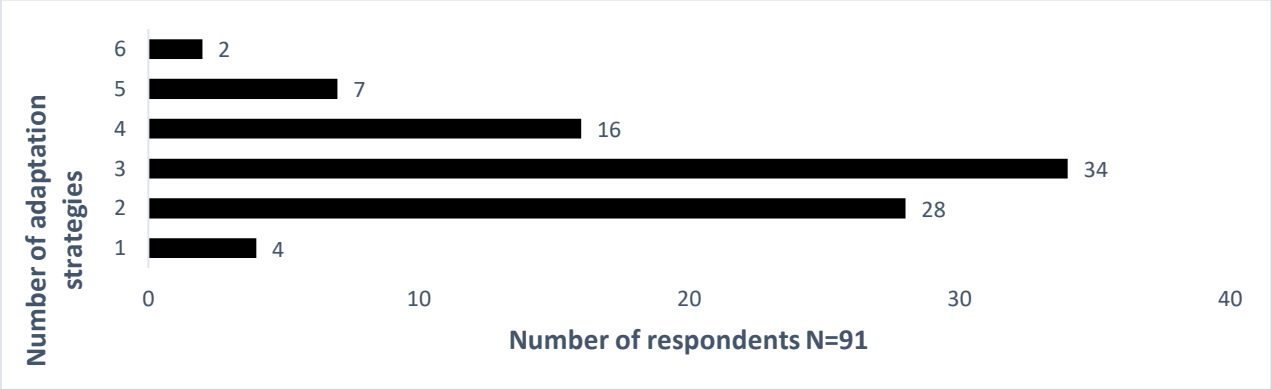


**Figure 6: Number of adaptation strategies applied by respondents**

Table 3 illustrates the factors of influence based on an Independent Sample T-Test. It allows to compare scores of one variable (number of adaptation strategies) for groups with two different outcomes (e.g. access to credit vs. no access to credit). This is suitable because the number of adaptation strategies could be defined as ratio variable and the included independent variables as dichotomous. According to Bryman (2008), such cases allow the application of an Independent Sample T-Test. Running the Shapiro-Wilk Test (testing normal distribution) revealed, that data of the dependent variable was not perfectly distributed. However, as Khan and Rayner (2003) mentioned, the T-Test is relatively robust towards non-normal distribution. Nevertheless, a Mann-Whitney U Test has been performed additionally. This is a common non-parametric alternative for the T-Test. Results showed the same statistical significances as the T-Test. For the sake of expressive power of the means (instead of the mean rank) however, the outcomes of the T-Test have been used for further interpretation. Significant differences in the average means of having access to credit, being aware of CC and being a member of a cooperative were identified. If a farmer had access to credit in the past five years, the mean difference in the number of adaptation strategies applied lies at 0.51 and for the awareness of CC at 0.77. Particularly the membership of a cooperation appears to have a large statistically significant mean difference with 1.14 compared to not being a cooperative member. Institutional factors do have an impact on what extend CC adaptation is applied.

**Table 3: Mean difference of dichotomous variables in number of adaptation strategies used**

| *Variable* | *Group 0* | *Group 1* | *p-value* | *mean difference* |
|---|---|---|---|---|
| **Access to credit** | **2.87** | **3.38** | **.048** | **0.51** |
| **Aware of CC** | **2.33** | **3.10** | **.022** | **0.77** |
| Gender | 3.00 | 3.00 | 1.00 | 0.00 |
| **Cooperative member** | **2.41** | **3.55** | **.000** | **1.14** |

**Note: groups according to coded variables (Group 0=no; Group 1=yes).**

To compare the number of adaptation strategies applied with other identified explanatory variables, Spearman´s Correlation Test was used (Table 4). The interpretation deviates from the T-Test, however it is still possible to see if there is a relationship between the tested variables.

**Table 4: Spearman´s correlation of continuous and ordinal variables**

| *Variable* | *Correlation Coefficient ($r_s$)* | *p-value* |
|---|---|---|
| Age | 0.000 | 0.999 |
| Education | 0.000 | 0.693 |
| Farm size | -0.083 | 0.436 |
| **Farm elevation** | **0.291** | **0.005** |
| Farming experience | -0.016 | 0.882 |
| **Inf. source: Internet** | **0.206** | **0.050** |
| **Inf. source: Other farmers** | **0.255** | **0.015** |
| **Attendance in trainings** | **0.466** | **0.000** |

Next to farm elevation and the frequency of attending trainings, it was also the information sources having a significant positive relationship with the number of strategies used. The $r_s$-value has a range between -1 and 1 where 0 expresses no relationship. Since all significant coefficients do have a positive value, it can be derived that an increase in training attendance, in usage of internet and other tea farmers as information sources as well as in farm elevation do lead farmers to apply a greater variety of adaptation strategies.

### *4.2.2. Specific adaptation strategies*

Figure 7 displays the farmers´ share of whether each of the six adaptation strategies were applied. These strategies were as well obtained from literature findings such as from Biggs et al. (2018a) or De Sousa et al. (2018). Interestingly, crop diversification with 83 respondents (91.2%) and soil conservation with 85 respondents (93.4%) were both applied by most tea farmers. On the contrary, strategies focused on irrigation like making use from water dams with 12 respondents (13.1%) and water conservation with 13 respondents (14.3%) were not used frequently among the sample.

This leaves agroforestry with 50 respondents (54.9%) and switching to less climate sensitive cultivars at 38 respondents (41.8%) with a relatively balanced share between farmers who do apply and who do not apply. Given the number of the overall sample size (N=91) and the frequencies of the usage of each adaptation strategy, further analysis was most purposeful with whether farmers apply agroforestry and switching to less climate sensitive cultivars as coping strategies.

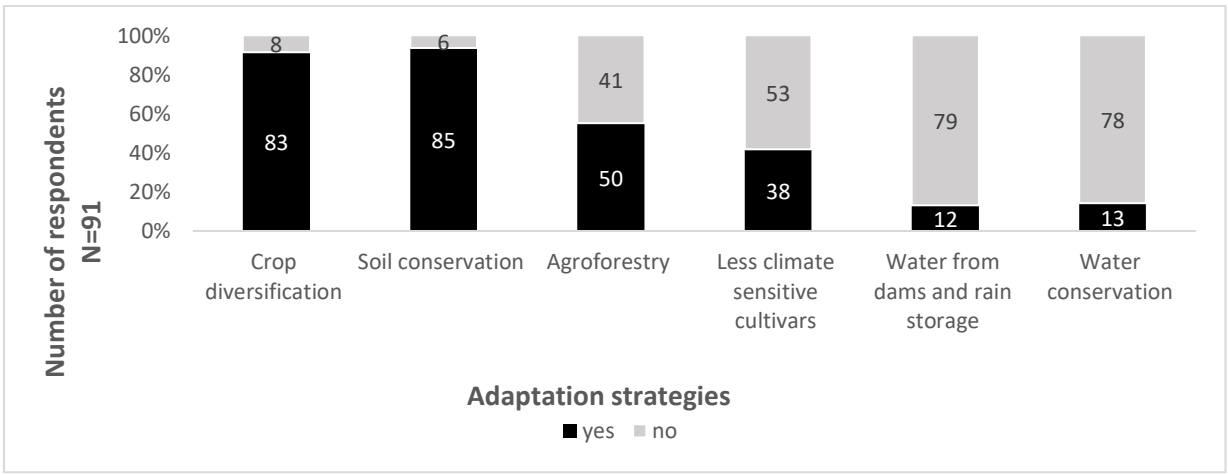


**Figure 7: Application of specific adaptation strategies**

### *4.2.3. Information sources*

Within this sample, the respondents have been asked to rank the usage of a set of sources of information for tea cultivation and weather information separately.

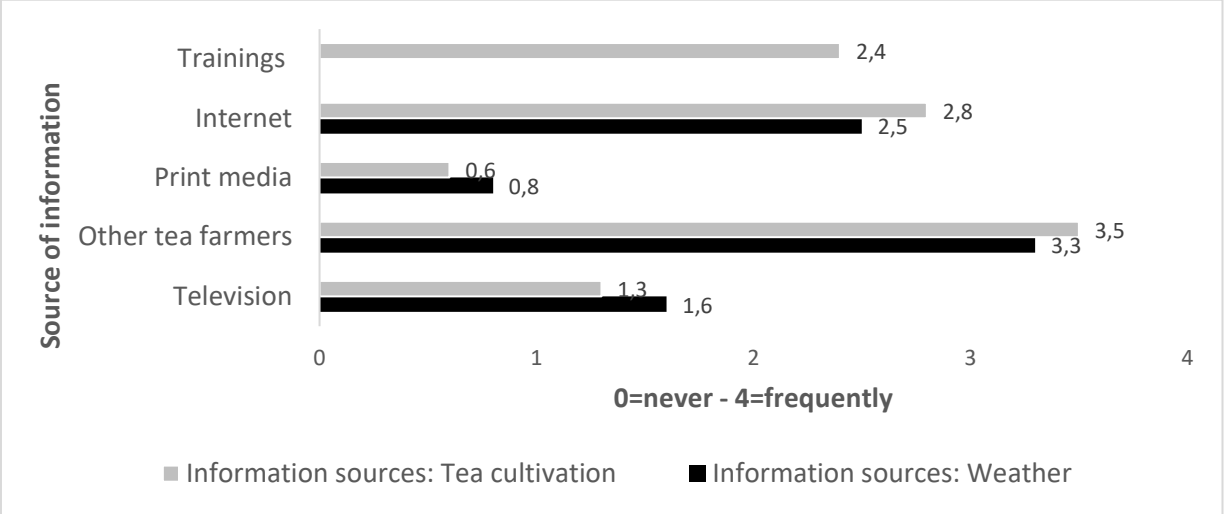


**Figure 8: Information sources for tea cultivation/weather information**

As Figure 8 indicates, the differences between information sources for tea cultivation and weather did not vary to a large degree. Trainings as information source has only been given as an option for tea cultivation. Internet and other tea farmers were the two mostly used sources regarding information access while print media (e.g. Newspapers) and television appear to be not of high relevance in this context. Particularly other tea farmers were the most important source of information. As literature indicates, the sources of information can also have an influence on the likeliness to make use of CC adaptation practises (Menike & Arachchi 2016). Therefore, the two most relevant information sources (internet and other tea farmers) were defined as predictors as well.

While elaborating on the sources of information, it is noteworthy to identify to which extend the respondents were participating in trainings (Figure 9). While only 5 (5.5%) farmers never participated in any trainings, the share of farmers who at least attended a training on a frequent base (once per year) was around 60 (66%). 35 farmers (38.5%) even participated in trainings very often (several times per year).

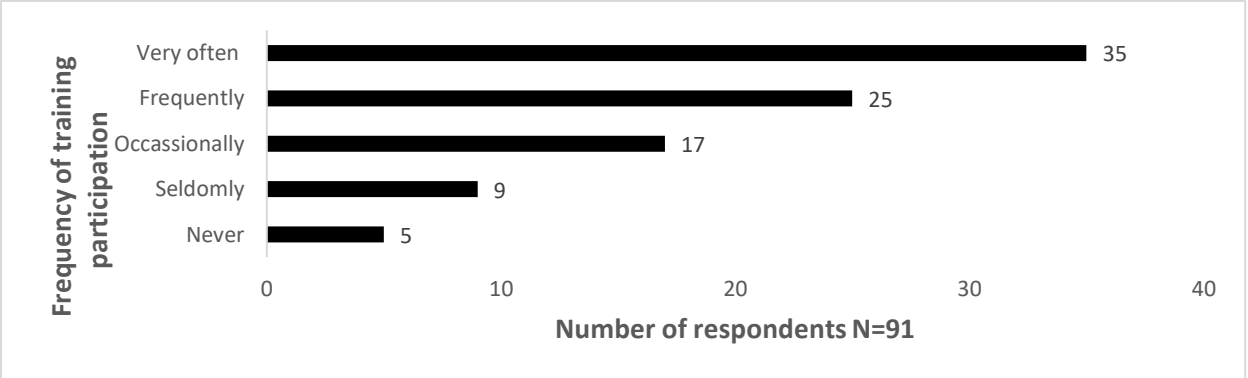


**Figure 9: Frequency of training participation**

Asking the farmers about their perceived level of knowledge regarding tea farming, only around 23 (25.3%) responded with feeling very well informed. This leaves 68 (74.7%) discern their level of knowledge as moderate or not well informed. As mentioned earlier, the intention of sophisticating the Nepalese tea industry is embedded in the National Tea Export Strategy 2017-2021 (ITC 2016). However, it seems that 58 (63.7%) of the farmers never heard about this strategic plan and only 7 (7.7%) were aware about its content. Pie charts regarding the perceived level of knowledge and awareness of the export strategy can be found in Appendix 3. Figure 10 indicates the most relevant types of information for the farmers. The rating shows, that all options were at least somewhat important. Particularly the information about farming techniques and the market (e.g. prices, certifications) are perceived as highly relevant. Since the awareness rate of the Export Strategy 2017-2021 (ITC 2016) has a relatively low rate, it raises the suspicion of a lack of communication among stakeholders in the regional tea industry.

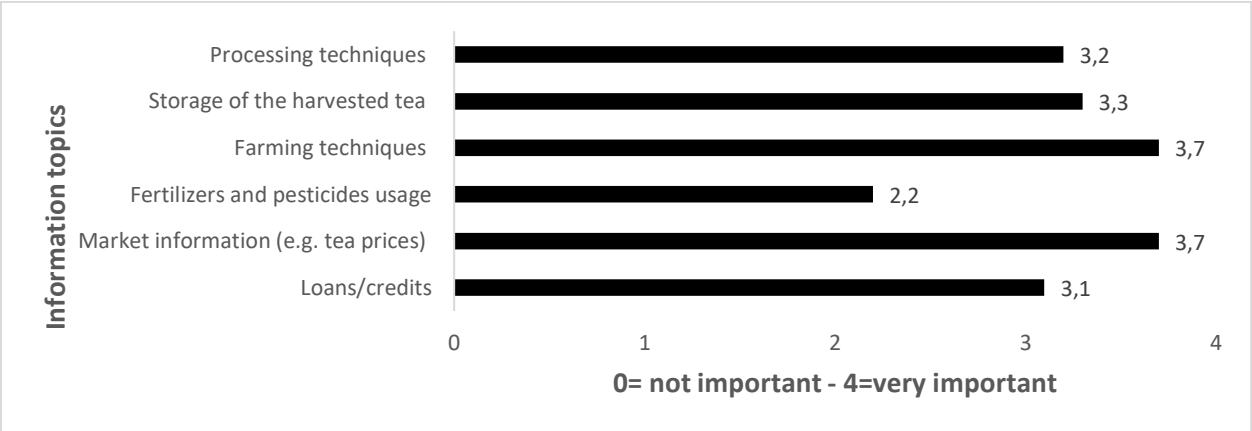


**Figure 10: Most relevant information topics**

### *4.2.4. Binary Logit Model*

Table 6 shows the results of BLM´s for the two selected strategies agroforestry and switching to less climate sensitive cultivars. One condition of the BLM is no multicollinearity among the independent variables (Cramer 2003). For that, all independent variables have been tested by the variance inflation factor (VIF). As O´Brien (2007) states, the most widely applied limit for an acceptable VIF is 10. In this case, all variables stayed within a VIF-range between 1.5 and 3.2. It can be claimed, that there was no significant multicollinearity between the predictors.

**Table 5: Fit of the Models**

| *Indicators* | *Model 1 (Agroforestry)* | *Model 2 (Cultivars)* |
|---|---|---|
| *Omnibus Test* | | |
| Chi-square | 48.347 | 22.510 |
| Df | 11 | 11 |
| Sig. | 0.000 | 0.021 |
| *Classification of Models* | | |
| Overall percentage | 78.0 | 70.3 |

**Note: Df=Degrees of freedom; Overall percentage: Predictive power of the model in (%); Sig.=p-value**

Table 5 provides insight into the fit of the estimated models. Model 1 is significant at the 1% level and has an accuracy predicting 78% of the values correctly compared to the observed values whereas Model 2 is significant at the 5% level and has an accuracy of predicting 70.3% correctly. According to Greene (2003) these results allow the assumption, that the values based on the models including the predictors are significantly different from the observed values.

The results of both BLMs can be found in table 6. For agroforestry (Model 1) access to credit, being a cooperative member and other tea farmers as information source do have a statistically significant effect on whether this strategy is applied. Looking at the value of the OR and the significance levels, having access to a credit has the biggest influence. If all other factors remain unchanged, the OR indicates a more than eight times higher probability to use agroforestry than if no credit was utilized. Members of a cooperative were almost six times as likely to make use of agroforestry and respondents who frequently use other tea farmers as information sources over four times more likely.

**Table 6: Results of the Binary Logit Models**

| | *Agroforestry (1)* | | | *Less climate sensitive cultivars (2)* | | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***p-value*** | ***odds ratio*** | ***S.E.*** | ***p-value*** | ***odds ratio*** | ***S.E.*** |
| *Institutional variables* | | | | | | |
| Access to credit | **0.008** | **8.104** | **0.783** | 0.430 | 6.710 | 0.646 |
| Cooperative member | **0.012** | **5.804** | **0.700** | **0.012** | **4.923** | **0.632** |
| | | | | | | |
| *Socio-demographic variables* | | | | | | |
| Age | 0.830 | 0.992 | 0.039 | 0.158 | 1.050 | 0.034 |
| Gender | 0.237 | 3.602 | 1.085 | 0.620 | 0.681 | 0.775 |
| Education | 0.226 | 0.877 | 0.108 | 0.194 | 1.117 | 0.085 |
| Farm size | 0.942 | 0.980 | 0.279 | 0.797 | 0.946 | 0.217 |
| Farming experience | 0.587 | 0.970 | 0.057 | 0.276 | 0.949 | 0.048 |
| Farm elevation | 0.491 | 1.001 | 0.002 | 0.446 | 1.001 | 0.002 |
| | | | | | | |
| *Information source variables* | | | | | | |
| Attendance in trainings | 0.197 | 0.959 | 0.321 | **0.041** | **1.705** | **0.272** |
| Inf. source: Internet | 0.166 | 1.659 | 0.365 | 0.170 | 0.638 | 0.328 |
| Inf. source: Other farmers | **0.027** | **4.128** | **0.642** | 0.194 | 0.590 | 0.406 |

**Note: Odds ratio=Exponential of coefficient; S.E.= Standard Error**

Model 2 (less climate sensitive cultivars) showed that being a cooperative member increases the chance to make use of this strategy by almost five times. Higher frequency in use of internet as information source lead to higher probability of switching to less climate sensitive cultivars by around 1.7 times per scale unit (0=never-4=frequently). Both predictors were significant at the 5% level. Interestingly, access to credit had a high OR value too, however with no statistical significance. Nevertheless, it is obvious that both, institutional as well as information source variables do have an influence on the application of these strategies.

Remarkably, no socio-demographic predictors were of statistical significance which goes in contrary to what other publications proposed.

## 4.3. Constraints, concerns and perceived CC impact

While identifying the factors of importance when it comes to CC adaptation, the exposure of perceived constraints and impact of specific changes in climate constituted to be of equally high interest.

### *4.3.1. Constraints*

As can be derived from Figure 11, respondents have been asked which constraints towards CC adaptation and success as tea farmers they are confronted with. As all potential constraints have a value above three (=relevant), it is a combination of insufficient governmental support, a lack of information and a lack of financial capital. However, insufficient governmental support obviously has the biggest impact. During informal discussions with the farmers, it was frequently mentioned that the government of Nepal attempts to export only high-quality tea while at the same time there is a lack of policy measures supporting high-quality tea production from the farmers point of view. As 73.6% of the respondents did not make use of a credit in the past five years, the lack of financial capital as constraint only becomes a natural deliberation.

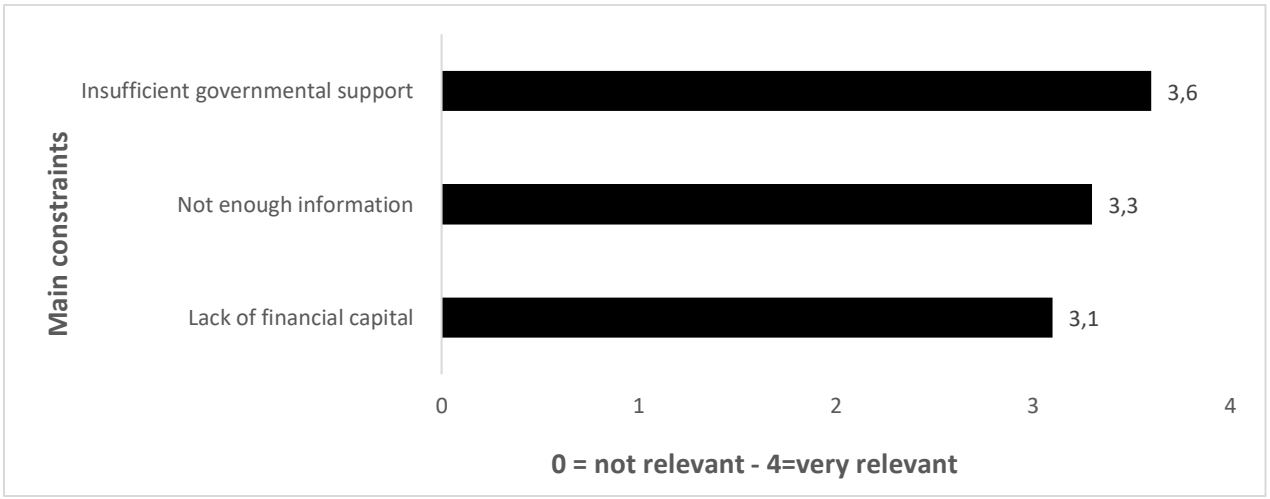


**Figure 11: Main constraints to adaptation**

### *4.3.2. Perceived CC impact*

To better comprehend the complexity of CC adaptation among the respondents, they were asked to mention the perceived impact of changes in climate and which environmental factors play the biggest role in tea cultivation. Figure 12 reveals the perceived impact of a set of CC effects derived from related literature. Again, all effects appear to have an at least moderate impact to the tea farmers. Particularly the changes in intensity of rainfall patterns and increased drought periods seem to have a high perceived impact on the farming activities. This goes in line with findings of predicted changes of climate in Nepal (Ahmed & Suphachalasai 2014).

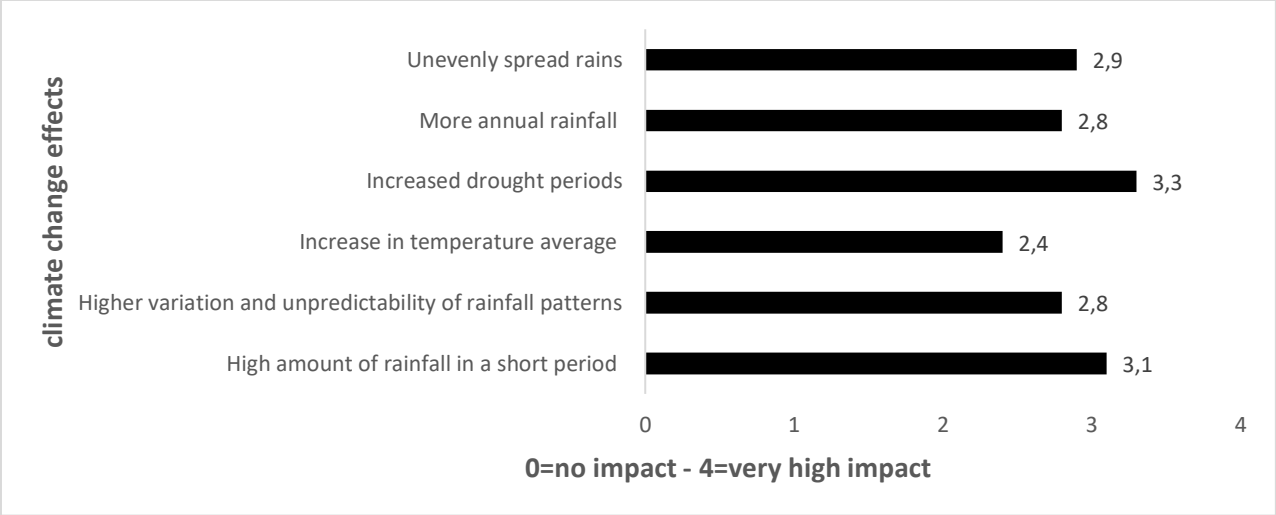


**Figure 12: Perceived impact of CC effects**

Based on the terroir concept discussed by Ashardiono and Cassim (2014), it was primarily the cultivar as well as the quality of the soil playing a crucial role in tea production from an environmentally point of view. Nevertheless, Figure 13 shows that none of these elements were considered as not important. With climatic conditions being perceived as relevant environmental factors, the necessity of appropriate adaptation is becoming even more apparent.

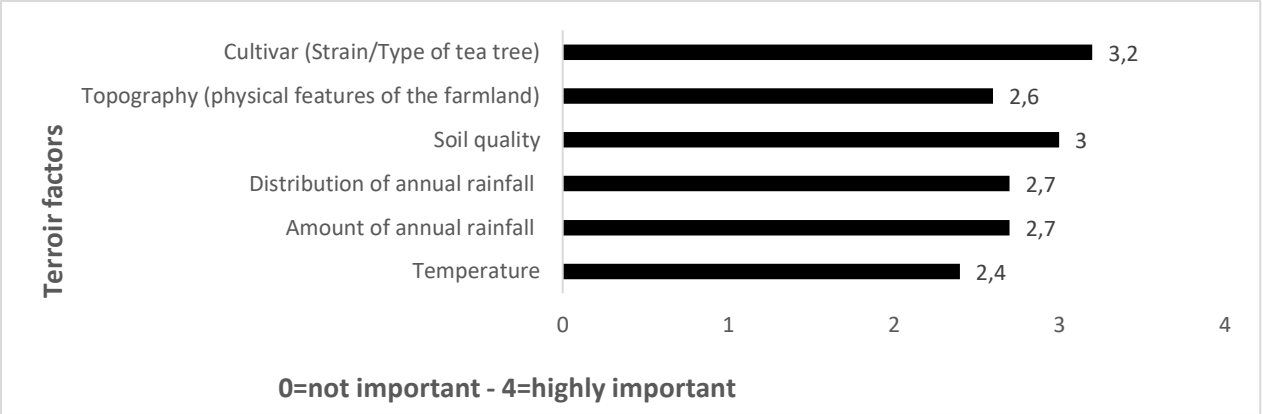


**Figure 13: Importance of terroir factors in tea farming**

In addition to these aspects, the analysis of the farmers responses revealed a strong consensus towards the statement of CC being an ongoing and impacting issue for them. At the same time there was only moderate agreement with the claim, that tea plantations do contribute to CC as well through decreasing biodiversity, soil erosion and usage of pesticides (Appendix 3).

### *4.3.3. Concerns of the tea farmers*

In connection to CC adaptation and its consequences, respondents have been asked to express their degree of concern towards their future as tea farmer (Figure 14). Most tea farmers (64.8%) do feel highly concerned. Furthermore, farmers have been asked to reflect on their perceived economic performance of the previous years (Appendix 3). Almost half of the sample (49.5%) believes in making profit with tea is becoming increasingly difficult. On the contrary, a positive economic development was perceived by 19.8% of the farmers. While the level of concern was high, 83.3% of the respondents would not replace tea with other crops.

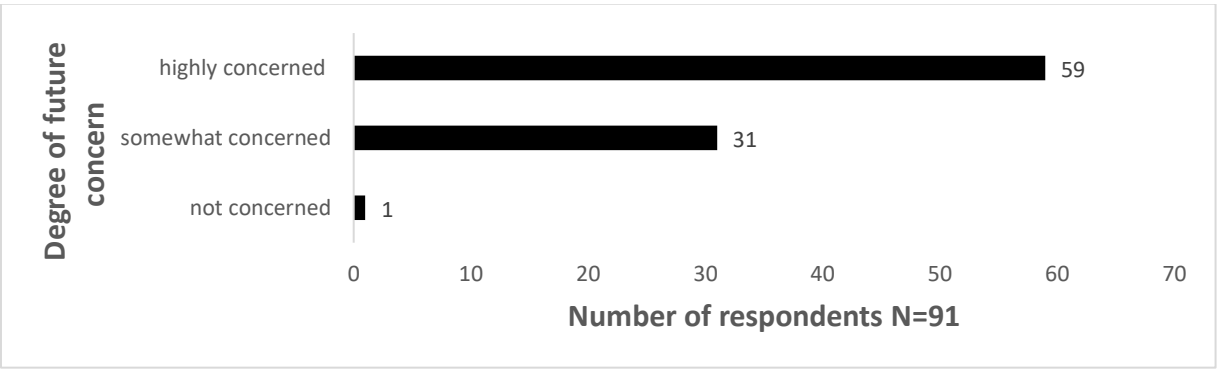


**Figure 14: Degree of concern towards the future as tea farmer**

# 5. Discussion

## 5.1 CC adaptation of Nepalese tea farmers

The awareness rate towards CC among the sample of tea farmers was 86.8%. This is within the mean of previous findings among farmers in various countries such as Italy (Menapace et al. 2015), South Africa (Findlater et al. 2018), Sri Lanka (Menike & Arachchi 2016), China (Shi-yan et al. 2018) and India (Sahu & Mishra 2013). In these studies, the awareness levelled between 83% - 100%. On the other hand, it is a proof that some farmers were not aware of CC taking place. This leaves them even more exposed to potential impacts. The most common adaptation strategies among tea farmers identified by Ashardiono and Cassim (2014) in Japan and by Biggs et al. (2018a) in India were applied by the Nepalese farmers as well. While there was no farmer not making use of at least one of the six proposed strategies, only a small share (2.2%) was applying all of them. Unlike the findings of Sahu and Mishra (2013), where the farmers awareness rate to CC (98%) was much higher than the adaptation rate (59%), all respondents adapted at least partially to the changing conditions. However, it appears that sometimes this is happening unknowingly. A possible explanation for the deviance between awareness and adaptation is the lack of including CC threats into the farmers mental models of everyday risks as identified by Findlater et al. (2018).

Looking at the responses given to the application of specific adaptation strategies, several revelations are worth to scrutinize. Firstly, crop diversification and soil cultivation were both applied by most farmers. As the share of farm size dedicated to tea was on average 75.4%, all farmers had farm land devoted to vegetables and other crops used for their personal consumption. This goes in line with the findings from Biggs et al. (2018b), whom also identified that smallholder tea farmers never used the whole farm solely for tea production. Hence, crop diversification appears to be a natural coping strategy not only connected to CC. Nevertheless, it was unexpected to see that the adaptation of irrigation strategies was not high among the sample. Particularly as increased droughts were perceived as one of the main CC threats. It raises the suspicion, that farmers did not have much knowledge about irrigation methods in general.

The adaptation strategy switching to less climate sensitive cultivars was applied by less than half of the respondents (41.8%). This could be connected to what was mentioned by Lobell et

al. (2006): perennial crops (such as tea) are especially challenging when it comes to appropriate adaptation due to their relatively long lifecycles. According to the farmers, the introduction of more climate resilient tea cultivars can only be done gradually as it takes three to five years for tea trees to reach maturity. Adapting by protecting the tea from wind and sun exposure (agroforestry) is, next to other factors, also depending on the specific location of the tea farm.

### *5.1.1. Effect of socio-demographic and farm aspects on CC adaptation*

In contrary to the results of studies with a similar focus, no statistically significant influence of socio-demographic factors could be identified. Menike and Arachchi (2016), Trinh et al. (2018) and Ali and Erenstein (2017) all noted that a higher degree of education and gender (being male) leads to an improved adaptation behaviour. In this case, education and gender did firstly not influence the overall number of adaptation strategies used, secondly not the application of agroforestry and usage of climate resilient cultivars. It might be assumed that more experience in farming will positively influence the rate of adaptation (Shi-yan et al. 2018), but it did not seem to influence the choices made by Nepalese tea farmers. Age did not have a significant effect either. This is disparate to the outcomes of Bedeke et al. (2018) whom connected decreased abilities to CC adaptation with increasing age among farmers in Ethiopia. A possible explanation could be the partial homogeneity of the sample (e.g. mostly male and literate respondents).

The farm size did not show any statistically relevant influence on the level of adaptation. Previous literature argued about its effect, with Sahu and Mishra (2013) identifying a positive relationship and Bedeke et al. (2018) as well as Deressa et al. (2009) a negative relationship between farm size and CC adaptation rate. Nevertheless, it needs to be considered that the target sample were smallholder farmers. The size of most farms was between 0.5 and 1.5 hectare. The relatively small difference in farm size could be a possible explanation for the insignificance of this factor within the sample.

Matching with the results of Gunathilaka et al. (2018), the elevation of the farm did have a positive effect on the number of adaptation strategies applied. At the same time, it did not show influence on the two specified strategies agroforestry and climate resilient cultivars. A

natural deliberation is that higher elevation would lead to increased exposure to extreme weather (e.g. strong wind). But particularly agroforestry as protective measure was not influenced by the farm elevation, which leaves the effect of this predictor questionable within the framework of this study.

Overall it can be said, that homogeneity and limited size of the sample had an influence on the outcomes. In addition, these findings are interesting because socio-demographic aspects are largely fixed. Policies and other supportive measures do not have much influence on these variables respectively.

### *5.1.2. Effect of information sources on CC adaptation*

Other farmers and internet were the most common sources of accessing information about weather and tea cultivation. Menike and Arachchi (2016) confirmed the importance of these channels, however their study concluded with television and radio having the biggest positive influence on adaptation behaviour. Both, internet and other tea farmers as information source had a positive effect on the number of adaptation strategies applied. This relationship was also identified by Gunathilaka et al. (2018) among tea farmers in Sri Lanka. Sourcing information from other tea farmers had an impact on the likeliness to make use of agroforestry. The lack of using other ways of information gathering would allow policy makers to diversify information access to the farmers. If farmers attended trainings more frequently, they were also more likely to apply more adaptation strategies and had a higher probability of using climate resilient cultivars. Khanal et al. (2018) uncovered similar outcomes based on a study among Nepalese rice farmers and Nguyen and Mitsumasu (2016) among Vietnamese tea farmers. Supportive findings were derived from Deressa et al. (2009) whom identified a lack of access to trainings as one of the main constraints towards adapting to CC. This offers clear evidence of how important training and extension service provision is. However, the FAO (2010) revealed weaknesses of agricultural extension in Nepal. It concluded that a lack of planning, inappropriate technical expertise, weak motivation and poor commercialization are hindering the effectiveness of domestic training programmes for farmers. While results indicate the importance of these measures, farmers should not only be encouraged to attend trainings, but the quality of trainings should be improved overall with a focus on CC education.

### *5.1.3. Effect of institutional variables on CC adaptation*

Both institutional variables, credit access and cooperative membership, indicated a statistically significant effect on the number of adaptation strategies applied as well as the application of agroforestry and climate resilient cultivars. In agreement with Trinh et al. (2018), Ali and Erenstein (2017) as well as Menike and Arachchi (2016), access to credit and cooperative membership have a positive impact on adaptation behaviour of farmers. Nevertheless, given the share of cooperative members in this sample (51.6%), it could be argued that CC adaptation among Nepalese tea farmers is far from reaching its full potential due to almost half of the respondents not being member of a cooperative. Taking into consideration, that other tea farmers are the most popular source of information, the necessity of encouraging farmers to join cooperatives could lead to improved information exchange, a higher degree of adaptation and eventually better economic performance. Related research as from Nguyen and Mitsumasu (2016) and the ITC (2016) had a similar point of view. Agricultural research on CC adaptation behaviour concluded with having access to credit being one of the main drivers (Sahu & Mishra 2013; Trinh et al. 2018; Khanal et al. 2018; Fahad & Wang 2018). The Nepal Rastra Bank (2014) confirmed this by analysing the effect of micro credits on the Nepalese agricultural sector. It was found that improved credit access has a positive effect on agricultural efficiency. However, Nepalese credit institutions are increasingly reluctant to give credits particularly to smallholder farmers. The conditions can often not be fulfilled and the high interest rates make it less appealing for farmers to apply for a credit. This appears to be the case for tea farmers too, as the majority (73.6%) did not have credit access in the past five years. Most farmers emphasized on the importance of financial liquidity towards the farm operation as well as the high barriers to have access to credits. Given the fact, that credits positively influence the farmers´ capabilities, private and public institutions should lower the barriers of credit acquisition.

## 5.2. Constraints, perceived CC impact and future concerns

### *5.2.1. Constraints to CC adaptation*

The main constraints to CC adaptation among Nepalese tea farmers were insufficient information, financial limitations and foremost the lack of governmental support. According to Gunathilaka et al. (2018), tea farmers in Sri Lanka faced similar constraints. While Khanal et al. (2018) emphasized on the importance of taking the farmers perception into account, the farmers themselves felt a big gap between the government's expectation towards quality and the level of support provision. Additionally, not only a lack of policies can hinder adaptation but also legal barriers and obligations. The crucial role of governments and policy makers is thus undeniable (Woods et al. 2017). The tea export strategy (ITC 2016) undermines the governmental plans of producing higher quality as well as quantity, but as most farmers (63.7%) never even heard about this plan, insufficient communication among stakeholders becomes apparent. The lack of financial capital can also be linked to the difficulties for the farmers to acquire a credit. With limited information being perceived as constraint too, the necessity of improved extension services becomes evident.

### *5.2.2. Perceived CC impact*

Increased droughts and a high amount of rainfall in a short period had the highest perceived climate impact among the sample. This goes in line with the predicted weather extremes for Nepal in the study from Ahmed and Suphachalasai (2014). Also, Malla (2008) noted that the yearly monsoon is shifting, resulting in increased unpredictability of rains and droughts. Interestingly, Ochieng et al. (2016) mentioned that intense rain periods negatively influence tea harvest quantities while Ahmed et al. (2014) came to an opposite conclusion. As research revealed contradicting effects, the specification of impacts to tea harvests in Nepal could be an interesting angle for future research. The environmental factors (terroir concept) derived from the study among Japanese tea farmers by Ashardiono and Cassim (2014) all had a perceived moderate to high importance for the participants of this study. Despite regional differences in climatic conditions, the terroir concept thus appears to be valid for tea farmers in Nepal as well.

### *5.2.3. Future concerns of tea farmers*

Looking at the respondents´ degree of concern towards their future as tea farmer, it was found that 64.8% expressed high concerns. As pointed out by Menapace et al. (2015), being aware of CC leads to a higher degree of future concern. With 86.8% being aware of CC, the high degree of future concern among the sample is not surprising. On the contrary, 83.3% of the respondents would still not give up tea farming and hence not switch to other crops instead. The main argument was the long lifecycles of tea and that a replacement would result in no farm income for an extended period which goes in line with the findings of Lobell et al. (2006). Paired with the negative economic outlook perceived by 49.5% of the sample, the complexity of the issue and struggles of the tea farmers is unquestionable.

# 6. Conclusions

## 6.1. General remarks

This thesis has uncovered the current perception and factors influencing the adaptation towards CC among smallholder tea farmers in Nepal. Unlike the outcomes of other studies, no socio-demographic aspects played a significant role in the level of adaptation among the farmers. On the other hand, information sources and institutional variables did positively influence the degree of adaptation. While there were no farmers not applying at least one adaptation strategy, there was only a small share making use of all proposed options. Irrigation related coping strategies were least applied.

Particularly information exchange with other tea farmers, participation in trainings and access to credits affected the adaptation behaviour of Nepalese tea farmers. These factors have been identified as significant in other publications as well. Despite the governments´ goal to boost the domestic tea exports (ITC 2016) however, most farmers were not aware of those elaborate strategic plans. The lack of communication is an obvious barrier for the Nepalese tea sector to thrive in its full potential. While many farmers frequently attended trainings, the quality of these extension services is often poor (FAO 2010). Particularly the lack of governmental support was perceived as one of the main barriers to appropriate adaptation. This fact emphasizes on the necessity to focus on more efficient policy implementation. Connected to that are the difficulties for farmers to access credits and the barriers set by involved financial institutions.

Although Nepal dramatically increased its spending towards CC mitigation (Nepali Sansar 2017), the outcomes of this study indicate the need for further investments and primarily an improved interaction with the tea farmers. With Nepal being prone to be hit by natural disasters caused through CC, it is not only the tea export strategy being at stake. Due to the high dependency on agriculture, potential disasters could result in humanitarian crises. Understanding the perception and adaptation towards CC of the population depending on agriculture as a source of living, is thus vital and essential for Nepal´s future perspective.

## 6.2. Recommendations

As a logical consequence, following recommendations can be given:

- The Nepalese government should educate tea farmers more about the plans embedded in the national tea export strategy (ITC 2016). Without close cooperation to the producers, the aim of improving quantity and quality will be a difficult task. This could be carried out by preparing specific trainings and education of cooperative representatives helping to transfer the knowledge.

- Cooperative memberships should be encouraged. The membership rate of only 51.6% among the sample is a proof for the potential to convince more farmers to join cooperatives. Due to the close social interaction in Nepalese society, specific "cooperative ambassadors" could be nominated who could promote the benefits of a membership to other tea farmers.

- Access to trainings should be facilitated and CC specific information should be provided. In addition, it is important to also focus on the quality of such trainings as the FAO (2010) revealed weaknesses in that regard.

- Being a relatively small player in the global tea trade, Nepalese officials should gain insight in best practises of tea producing areas being researched more in-depth (e.g. India, Sri Lanka, Japan).

- The restrictions and barriers towards the ability of tea farmers to have credit access should be reduced. Farmers having access to credit were more likely to adapt to CC. This can only be supportive towards the governments goals of expanding the tea industry.

- As adaptation strategies related to irrigation were not applied frequently, yet increased droughts were perceived as main impact factor of CC, attention should be set on providing more elaborate information regarding irrigation of tea plantations.

## 6.3. Limitations

*Methodological limitations:*

- The sample size (N=91) was smaller than anticipated and given the number of smallholder tea farmers in Ilam district (6985), the applicability of the results to the overall research population is limited.
- Due to the lack of address lists of farmers, random sampling was not possible.
- The involvement of comparing results among the three chosen municipalities was not feasible due to an uneven number of respondents in each municipality.

*Logistical limitations:*

- Language barriers and cultural complexities made any interaction with the respondents challenging and difficult. Misunderstandings could arise easily. Being mostly dependent on an interpreter allowed only minor influence of discussions and explanations.
- The limited time frame for this study (app. 1 month) restricted the level of sophistication in accessing the population. Despite having planned at least 150 respondents, only 91 could eventually be obtained.
- The research area was difficult to access and remote. Some tea farms could only be reached by 4WD vehicles which took a substantial amount of time. This turned any field data acquisition into a logistical challenge.
- Due to the Monsoon season, heavy rains did not allow to travel at all for some days.
- Most farmers have been busy as the time of the research was during autumn harvest.

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# Appendices

Appendix 1: Table – Farming and economic characteristics

Appendix 2: Tea producing districts Nepal & climate conditions Ilam

Appendix 3: Additional Figures – Information and Concerns

Appendix 4: Questionnaire – English version

Appendix 5: Questionnaire – Nepali version

## Appendix 1: Table – Farming and economic characteristics

| *Variable* | *Total (in %)* | *Min.* | *Max.* | *Mean* |
|---|---|---|---|---|
| **Farm features** | | | | |
| Size (Hectar) | - | 0,2 | 10 | 1,2 |
| Size (Ropani) | - | 4 | 200 | 23,7 |
| Share used for tea production (%) | - | 30 | 95 | 75,4 |
| Elevation (meter) | - | 1100 | 1900 | 1554 |
| **Farm employment** | | | | |
| Total | - | 2 | 34 | 7 |
| Male (total) | - | 0 | 7 | 2 |
| Female (total) | - | 1 | 32 | 5 |
| Family (male) | - | 0 | 3 | 1,1 |
| Family (female) | - | 0 | 3 | 0,8 |
| Family (total) | - | 1 | 12 | 2 |
| Paid (male) | - | 0 | 4 | 0,9 |
| Paid (female) | - | 0 | 30 | 4,1 |
| Paid (total) | - | 0 | 30 | 5,1 |
| **Farming experience (years)** | - | 7 | 40 | 18,9 |
| **Fertilizer usage** | | | | |
| Never | 3 (3,3%) | - | - | - |
| Sometimes | 84 (92,3%) | - | - | - |
| Frequently | 4 (4,4%) | - | - | - |
| **Pesticide usage** | | | | |
| Never | 79 (86,8%) | - | - | - |
| Sometimes | 12 (13,2%) | - | - | - |
| Frequently | 0 (0,0%) | - | - | - |
| **Usage of loan (credit)** | | | | |
| Yes | 24 (26,4%) | - | - | - |
| No | 67 (73,6%) | - | - | - |
| **Organic certification (international)** | | | | |
| Yes | 34 (37,4%) | - | - | - |
| No | 57 (62,6%) | - | - | - |
| **Perceived economic performance within 5 years** | | | | |
| Positive economic development | 18 (19,8%) | - | - | - |
| No significant changes | 28 (30,8%) | - | - | - |
| Negative economic development | 45 (49,5%) | - | - | - |
| **Cooperative member** | | | | |
| Yes | 47 (51,6%) | - | - | - |
| No | 44 (48,4%) | - | - | - |
| **Training participation** | | | | |
| Never | 5 (5.5%) | - | - | - |
| Seldomly (<once every 5 years) | 9 (9.9%) | - | - | - |
| Occasionally (once every 2-3 years) | 17 (18.7%) | - | - | - |
| Frequently (around once per year) | 25 (27.5%) | - | - | - |
| Very often (several times a year) | 35 (38.5%) | - | - | - |
| **Aware about CC** | | | | |
| Yes | 79 (86.8%) | - | - | - |
| No | 12 (13.2%) | - | - | - |

# Appendix 2: Tea producing districts Nepal & climate conditions Ilam

## 1. Climate zones of Ilam district, Nepal

| Climate zone | Elevation | Area Coverage (%) |
|---|---|---|
| Lower Tropical | below 300 meters | 15.5% |
| Upper Tropical | 300 to 1,000 meters | 33.5% |
| Subtropical | 1,000 to 2,000 meters | 40.1% |
| Temperate | 2,000 to 3,000 meters | 10.6% |
| Subalpine | 3,000 to 4,000 meters | 0.3% |

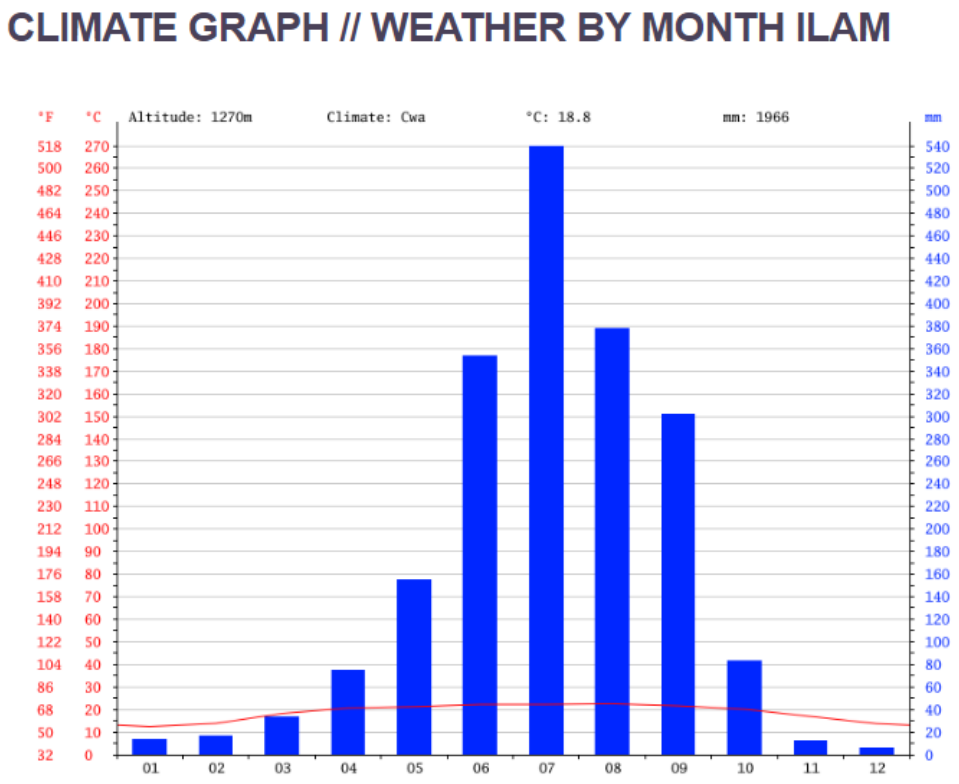
Source: Lillesø et al. (2005)

## 2. Major tea producing districts in Nepal

| Main tea producing districts | Number of smallholder farmers | Average production per farm/kg | Average farm size/ ha |
|---|---|---|---|
| **Ilam** | **6985** | **380** | **0.71** |
| Jhapa | 2952 | 2315 | 1.26 |
| Panchathar | 1131 | 176 | 0.46 |
| Terathum | 662 | 85.5 | 0.37 |
| Dhankuta | 482 | 204 | 0.96 |
| Others | 2686 | 29.3 | 0.62 |
| Total | 14898 | 666 | 0.78 |

Source: NTCDB

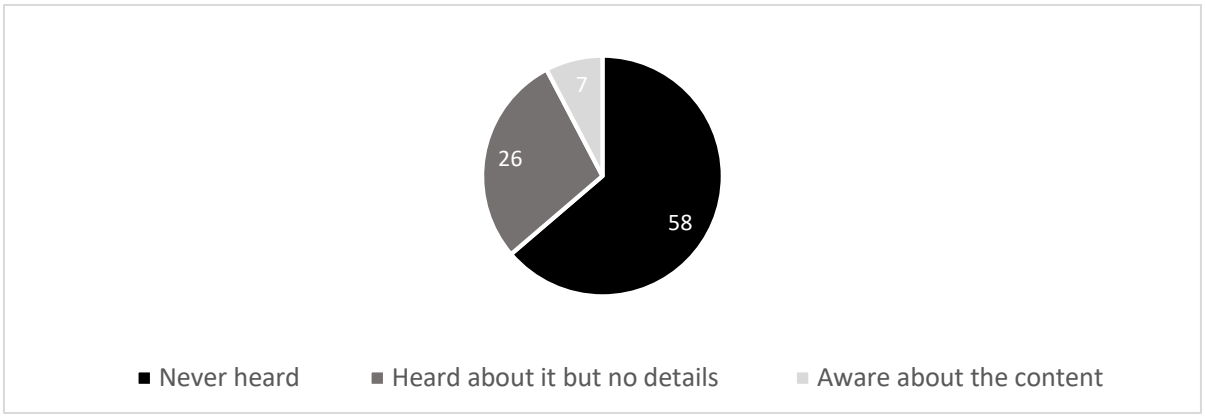
3. Rainfall distribution of Ilam district



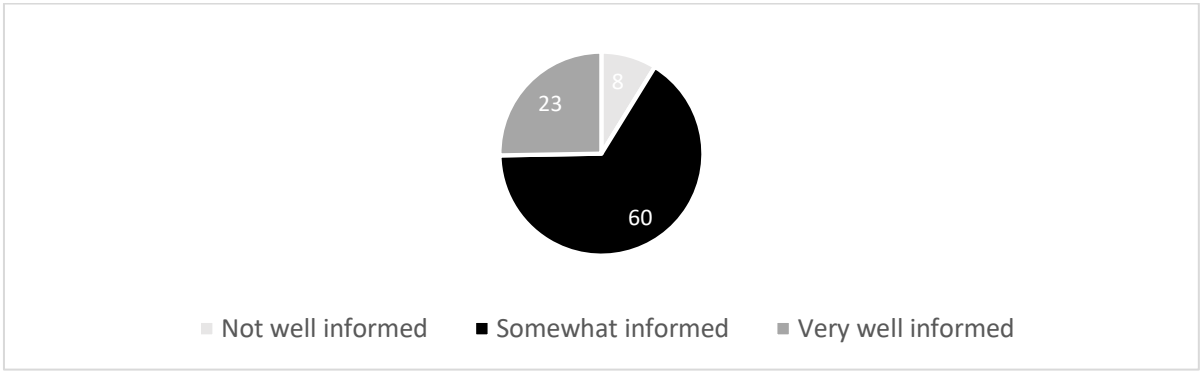

Source: Climate data (2019)

## Appendix 3: Additional Figures – Information and Concerns

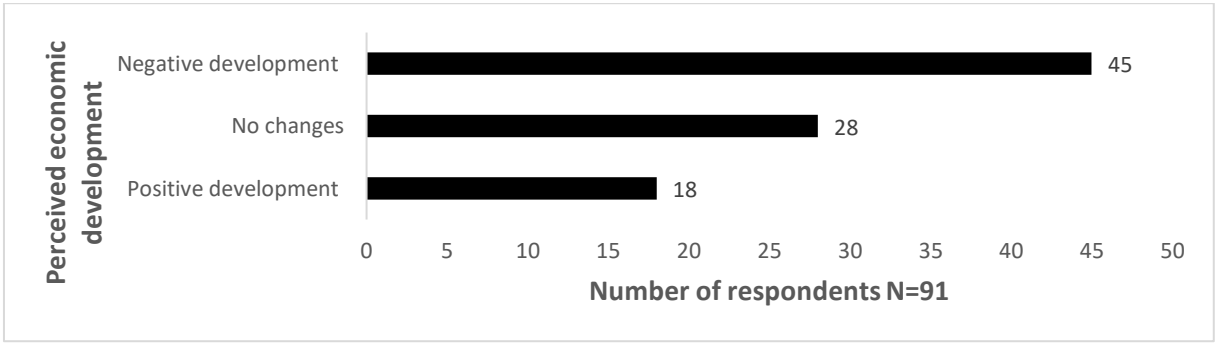
### 1. Awareness of "National Tea Export Strategy 2017-2021" by ITC (2016)



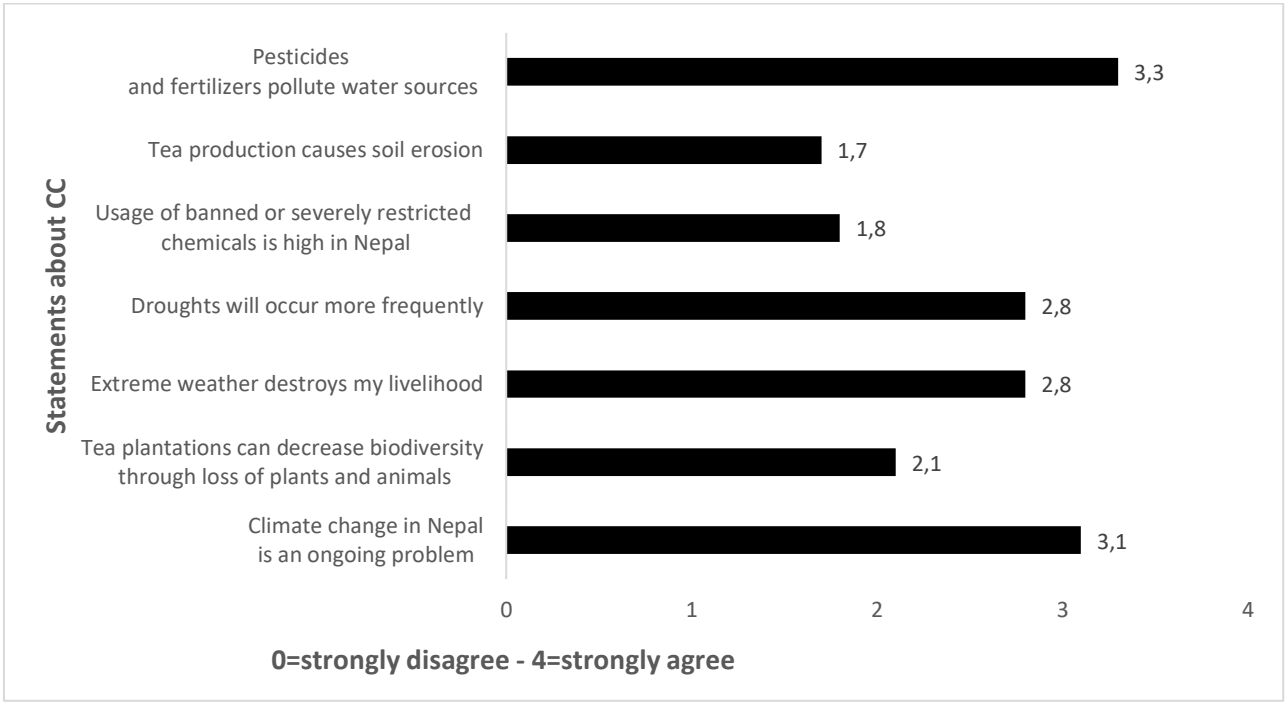

### 2. Perceived level of feeling informed about tea cultivation



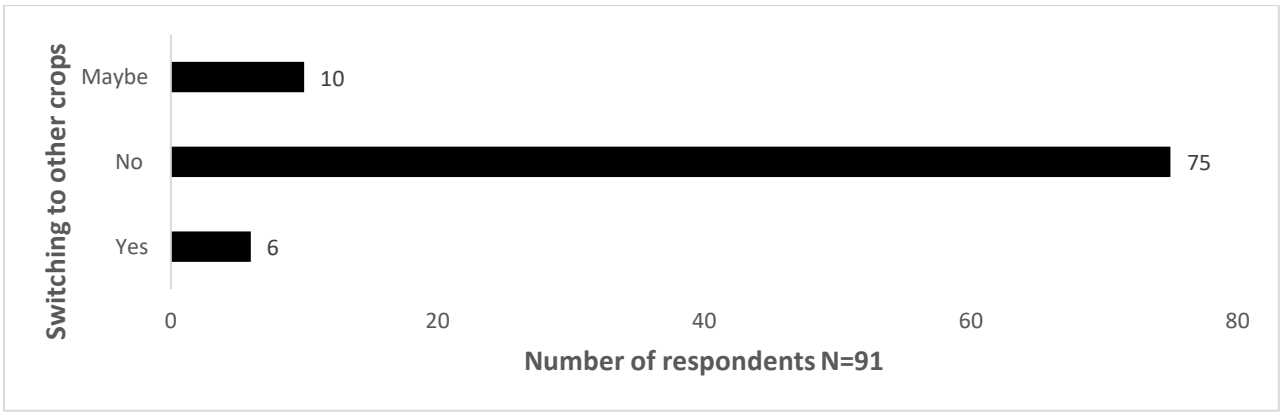

### 3. Parmers perceived economic development in the past 3 years



4. Degree of agreement towards statements about CC




5. Consideration of switching to other crops than tea in the future



Appendix 4: Questionnaire – English version

## Survey - Farmers perceived impact of CC

### *1.CC perception and adaptation strategies*

| **1.Did you hear about the term "CC" before?** | |
|---|---|
| Yes | No |

| **2.If yes, how often do you hear about this topic?** | | |
|---|---|---|
| Rarely | Sometimes | Frequently |

| **3. Considering the following changes in weather, what is the perceived impact on your economic performance as tea farmer?** | | | | | |
|---|---|---|---|---|---|
| | **No impact at all – 0** | **1** | **2** | **3** | **4 – Very high impact** |
| High amount of rainfall in a short period | 0 | 1 | 2 | 3 | 4 |
| Higher variation and unpredictability of rainfall patterns | 0 | 1 | 2 | 3 | 4 |
| Increase in temperature average | 0 | 1 | 2 | 3 | 4 |
| Increased drought periods | 0 | 1 | 2 | 3 | 4 |
| More annual rainfall | 0 | 1 | 2 | 3 | 4 |
| Unevenly spread rains | 0 | 1 | 2 | 3 | 4 |
| Other: | 0 | 1 | 2 | 3 | 4 |

| **4.Please indicate to which extend you agree:** | | | | | |
|---|---|---|---|---|---|
| | Strongly agree | Agree | Neutral | Disagree | Strongly disagree |
| CC in Nepal is an ongoing problem | | | | | |
| Tea plantations can decrease biodiversity through loss of plants and animals | | | | | |
| Extreme weather destroys my livelihood | | | | | |
| Droughts will occur more frequently | | | | | |
| Usage of banned or severely restricted chemicals is high in Nepal | | | | | |
| Tea production causes soil erosion | | | | | |
| Chemicals, such as pesticides and fertilizers pollute water | | | | | |

| **5.Please indicate how important the following strategies would be for your tea plantation in terms of adopting to a changing climate in the future:** | | | | | | |
|---|---|---|---|---|---|---|
| | **Unimportant – 0** | **1** | **2** | **3** | **4 – Very important** | |
| Crop diversification (e.g. different cultivars) | 0 | 1 | 2 | 3 | 4 | |
| Reduced soil cultivation | 0 | 1 | 2 | 3 | 4 | |
| Agroforestry (Shade and wind protection) | 0 | 1 | 2 | 3 | 4 | |
| Switch to less climate sensitive cultivars | 0 | 1 | 2 | 3 | 4 | |
| Making use of water from rain storage, pumps or dams | 0 | 1 | 2 | 3 | 4 | |
| Water conservation and storage through rain water harvesting using ponds | 0 | 1 | 2 | 3 | 4 | |
| Other: | 0 | 1 | 2 | 3 | 4 | |

| **6.Which of these adaptation strategies do you already make use of?** | | |
|---|---|---|
| | | |
| Crop diversification (e.g. different cultivars) | Yes | No |
| Soil conservation | Yes | No |
| Shade management | Yes | No |
| Switch to less climate sensitive cultivars | Yes | No |
| Making use of water from rain storage, pumps or dams | Yes | No |
| Water conservation and storage through rain water harvesting using ponds | Yes | No |
| Other: | Yes | No |

| **7.Do you consider switching to other, less climate sensitive crops in the future? (e.g. food crops such as rice)** | | |
|---|---|---|
| Yes | I do not know/ maybe | No |
| If yes, please indicate which crops: | | |

| **8.While thinking about the changing climate, are you concerned about your future as tea farmer?** | | |
|---|---|---|
| Not concerned | Somewhat concerned | Highly concerned |

| **9.How high is the impact of the following factors on your tea yield? (terroir concept: all environmental factors having an influence on the crop):** | | | | | |
|---|---|---|---|---|---|
| | **No impact at all – 0** | **1** | **2** | **3** | **4 – Very high impact** |
| Temperature | 0 | 1 | 2 | 3 | 4 |
| Amount of annual rainfall | 0 | 1 | 2 | 3 | 4 |
| Distribution of annual rainfall | 0 | 1 | 2 | 3 | 4 |
| Soil quality | 0 | 1 | 2 | 3 | 4 |
| Topography (physical features of the farmland) | 0 | 1 | 2 | 3 | 4 |
| Cultivar (Strain/Type of tea tree) | 0 | 1 | 2 | 3 | 4 |

| 10.Which constraints do make it particularly difficult for you as tea farmer to appropriately adopt to CC? | | | | | |
|---|---|---|---|---|---|
| | Not relevant-0 | 1 | 2 | 3 | 4-Very relevant |
| Lack of financial capital | 0 | 1 | 2 | 3 | 4 |
| Not enough information | 0 | 1 | 2 | 3 | 4 |
| Insufficient governmental support | 0 | 1 | 2 | 3 | 4 |

## *2.Financing and information access*

| 11.Did you make use of a credit or loan to support your farm within the past 5 years? | |
|---|---|
| yes | no |

| 12.How often do you make use of the following information channels regarding weather information? | | | | | |
|---|---|---|---|---|---|
| | Never – 0 | 1 | 2 | 3 | 4 – Frequently |
| Internet | 0 | 1 | 2 | 3 | 4 |
| Television (e.g. weather forecast) | 0 | 1 | 2 | 3 | 4 |
| Other tea farmers | 0 | 1 | 2 | 3 | 4 |
| Print media (e.g. newspaper) | 0 | 1 | 2 | 3 | 4 |
| Mobile phone | 0 | 1 | 2 | 3 | 4 |
| Other (please indicate): | 0 | 1 | 2 | 3 | 4 |

| 13.How often do you make use of the following information channels regarding tea cultivation? | | | | | |
|---|---|---|---|---|---|
| | Never – 0 | 1 | 2 | 3 | 4 – Frequently |
| Internet | 0 | 1 | 2 | 3 | 4 |
| Television | 0 | 1 | 2 | 3 | 4 |
| Other tea farmers | 0 | 1 | 2 | 3 | 4 |
| Print media (e.g. newspaper) | 0 | 1 | 2 | 3 | 4 |
| Participation in trainings | 0 | 1 | 2 | 3 | 4 |
| Mobile phone | 0 | 1 | 2 | 3 | 4 |
| Other (please indicate): | 0 | 1 | 2 | 3 | 4 |

| 14.Have you participated in trainings and workshops regarding tea farming? | | | | |
|---|---|---|---|---|
| Very often (several times per year) | Frequently (around once per year) | Occasionally (around once every 2-3 years) | Seldomly (less than once in 5 years) | Never |

| 15.Are you aware of the "National Tea Export Strategy 2017-2021" commissioned by the Nepalese government and the international trade centre? | | |
|---|---|---|
| Never heard | Heard about it but do not know details | Aware about the content |

| **16.Do you believe, that you are well informed about current trends in the tea cultivation practises in Nepal?** | | |
|---|---|---|
| Not well informed | Somewhat informed | Very well informed |

| **17.How many tea farmer cooperative(s) are you currently a member of?** |
|---|
| Number: |
| Please mention which cooperative(s): |

| **18.Please evaluate the importance of the following types of information for you as tea farmer:** | | | | | | |
|---|---|---|---|---|---|---|
| | **Least important-** | **0** | **1** | **2** | **3** | **4 -Most important** |
| Loans/credits | | 0 | 1 | 2 | 3 | 4 |
| Market information (e.g. tea prices) | | 0 | 1 | 2 | 3 | 4 |
| Fertilizers and pesticides usage | | 0 | 1 | 2 | 3 | 4 |
| Farming techniques | | 0 | 1 | 2 | 3 | 4 |
| Storage of the harvested tea | | 0 | 1 | 2 | 3 | 4 |
| Processing techniques | | 0 | 1 | 2 | 3 | 4 |
| Other: | | 0 | 1 | 2 | 3 | 4 |

## *3.Economic performance*

| **19.Please estimate the quantity (in kg) of all your harvested tea in the past 3 years for each year individually:** | |
|---|---|
| **Year:** | **Tea harvest (kg):** |
| 2015 | |
| 2016 | |
| 2017 | |

| **20.Please estimate the average price you sold your tea for (per kg) for the past 3 years:** | |
|---|---|
| **Year:** | **Selling price in NPR (per kg):** |
| 2015 | |
| 2016 | |
| 2017 | |

| **21.How would you evaluate the profitability of your tea farm in the past 3 years?** | |
|---|---|
| **1=No profit at all; 2=Low Profit; 3=Average Profit; 4= High Profit; 5= Very High Profit** | |
| 2015 | |
| 2016 | |
| 2017 | |

| **22.Considering your economic performance in the past 5 years, which of the following statements would you most agree with?** |
|---|
| 1. Positive economic development |
| 2.No significant changes |
| 3. Making money by producing tea is increasingly difficult |

| **23.How often did you make use of fertilizers within the last 12 months?** | | |
|---|---|---|
| Never | Sometimes (less than 5 times) | Frequently (more than 5 times) |
| If yes, please indicate which fertilizers: | | |
| **24.How often did you make use pesticides within the last 12 months?** | | |
| Never | Sometimes (less than 5 times) | Frequently (more than 5 times) |
| If yes, please indicate which pesticides: | | |

| **25.Is your tea farm currently certified according to international organic standards?** | |
|---|---|
| Yes | No |
| If yes, please indicate which certifications: | |

| **26.Is your tea farm currently certified according to Nepalese organic standards?** | |
|---|---|
| Yes | No |
| If yes, please indicate which certifications: | |

| **27.Please indicate where further processing of your harvested tea takes places?** |
|---|
| At my own farm |
| Processed by a small private processing factory |
| Processed by a cooperative, larger processing unit |

| **28.Please estimate how much of your average annual tea harvest (in %) is lost (not usable) because of issues such as mould and insufficient quality** |
|---|
| |

| **29.Do you know for which type of tea processing your harvested leaves are used?** | | |
|---|---|---|
| CTC (Crush Tear Curl) | Orthodox Tea | I do not know |

## *4. Socio demographic profiling*

| **30.Please indicate your gender:** | |
|---|---|
| Male | Female |

| **31.Please indicate your current age:** |
|---|
| |

| **32.How long have you been working as a tea farmer? (years)** |
|---|
| |

| **33.Would you consider yourself to be…?** | |
|---|---|
| Able to write and read (literate) | Unable to write and read (illiterate) |

| **34.Please indicate the number of years of your education:** |
|---|
| |

| **35.What is your marital status?** | | | |
|---|---|---|---|
| Single | Married | Divorced | Widow |

| **36.How many people do live in your household?** | | |
|---|---|---|
| Children (-15 years): | Adults (16-59 years): | Elderly (60+ years): |

| **37.Please indicate how many people are working on your farm and which gender they have:** | | |
|---|---|---|
| Total number: | Number of male workers: | Number of female workers: |
| Family members: | Male: | Female: |
| Paid workers: | Male: | Female: |

| **38.Please indicate the size of your farm (in ha):** |
|---|
| |

| **39. What is the share (in %) of your farmland size used for tea production only?** |
|---|
| |

| **40.What is the elevation (altitude) of your tea plantation plots? (in meter)** |
|---|
| |

| **41.Do you currently grow only tea or other crops (e.g. rice) too? If yes, please indicate which crops** | |
|---|---|
| Yes | No |
| Other crops: | |

Appendix 5: Questionnaire – Nepali Version

# सर्वेक्षण – जलवायु परिवर्तन प्रभावको किसानहरुमा अनुभव

## *1. जलवायु परिवर्तनको विचार धारणा र सामनाको रणनीतिहरु*

| **1. तपाईंले "जलवायु परिवर्तन" शब्दको बारेमा पहिले सुन्नुभएको थियो ?** | |
|---|---|
| हो | होइन |

| **2. यदि हो भने, तपाईं यस विषयको बारेमा कति पटक सुन्नुभयो ?** | | |
|---|---|---|
| कदाचित | कहिलेकाहीं | अक्सर |

| **3. मौसममा निम्न परिवर्तनहरू विचार गर्दै, तपाईको चिया किसानीको अनुभवमा तपाईंको आर्थिक लाभमा कस्तो असर परेको छ?** | |
|---|---|
| | **कुनै प्रभाव छैन – 0 1 2 3 4 – अति उच्च प्रभाव** |
| छोटो अवधिमा वर्षाको उच्चतम मात्रा | 0 1 2 3 4 |
| उच्च भिन्नता र वर्षाको ढाँचाको अप्रत्याशितता | 0 1 2 3 4 |
| तापमान औसतमा वृद्धि | 0 1 2 3 4 |
| सूखा समय बढ्यो | 0 1 2 3 4 |
| थप वार्षिक वर्षा | 0 1 2 3 4 |
| असमान रूपमा वर्षा | 0 1 2 3 4 |
| अन्य: | 0 1 2 3 4 |

| **4. कृपया संकेत गर्नुहोस्, तपाईं यी कुन कुरामा सहमत हुनुहुन्छ:** | | | | | |
|---|---|---|---|---|---|
| | कडा सहमत | सहमत | तटस्थ | असहमत | कडा असहमत |
| नेपालमा जलवायु परिवर्तन एक निरन्तर समस्या हो | | | | | |
| चिया खेतीले बिरुवाहरू र जनावरहरूको कमीगरि जैबिक-विविधतामा कमि गर्छ | | | | | |
| चरम मौसमले मेरो जीविकालाई नष्ट गर्दछ | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| सूखे/अनावृष्टि धेरै पटक देखा पर्नेछ | | | | | |
| नेपालमा प्रतिबन्धित वा गम्भीर प्रतिबन्धित रसायनहरूको उच्च प्रयोग हुन्छ | | | | | |
| चिया उत्पादनले माटोको कटाईको (क्षरणको) कारण बनाउँछ | | | | | |
| रसायन जस्तै कीटनाशक र उर्वरकले पानी प्रदुषण गर्दछ | | | | | |

| **5. कृपया संकेत गर्नुहोस्, तपाईंको चिया खेतीको भविष्यमा जलवायु परिवर्तनको लागि सामना/अनुकूल गर्ने सन्दर्भमा निम्न रणनीतिहरू कसरी महत्त्वपूर्ण हुनेछ:** | |
|---|---|
| **महत्त्वपूर्ण छैन – 0 1 2 3 4 – धेरै महत्त्वपूर्ण** | |
| खेती विविधता (जस्तै विभिन्न**खेती** खेतीहरू) | 0 1 2 3 4 |
| माटो खेतीमा कमी | 0 1 2 3 4 |
| अग्रोफोरेस्त्री (छाया र हावा संरक्षण) | 0 1 2 3 4 |
| मौसम परिबर्तन अनुकुल कम संवेदनशील खेतीमा बदल्ने | 0 1 2 3 4 |
| वर्षाको भण्डारण, पम्प वा बांधबाट पानी प्रयोग | 0 1 2 3 4 |
| तालाबहरू प्रयोग गरेर वर्षा पानीको संग्रह माध्यमबाट जल संरक्षण र भण्डारण | 0 1 2 3 4 |
| अन्य: | 0 1 2 3 4 |

| **6.यी कुन लागु रणनीतिहरु को तपाईं पहिले नै उपयोग गर्नु भएको छ?** | | |
|---|---|---|
| | | |
| खेती विविधता (जस्तै विभिन्न किसानहरू) | हो | होइन |
| माटो संरक्षण | हो | होइन |
| छाया व्यवस्थापन | हो | होइन |
| मौसम परिबर्तन अनुकुल कम संवेदनशील खेतीमा बदल्ने | हो | होइन |
| वर्षाको भण्डारण, पम्प वा बांधबाट पानी प्रयोग | हो | होइन |
| तालाबहरू प्रयोग गरेर वर्षा पानीको संग्रह माध्यमबाट जल संरक्षण र भण्डारण | हो | होइन |
| अन्य: | हो | होइन |

| **7. के तपाई भविष्यमा अन्य, कम जलवायु संवेदनशील बाली मा बदल्ने सोच राखनु हुन्छ ? (जस्तै चामल रूपमा उदाहरण खाद्यान्नलाई)** | | |
|---|---|---|
| हो | मलाई थाहा छैन / शायद | होइन |

| |
|---|
| यदि हो भने, कृपया कुन बालीहरु हो संकेत गर्नुहोस्: |

| **8. परिवर्तनशील जलवायुको बारेमा सोच्दै गर्दा के तपाईं चिया किसानको रूपमा आफ्नो भविष्यबारे सजग (चिन्तित ) हुनुहुन्छ?** | | |
|---|---|---|
| सजग छैन | केहि हद सम्म सजग छु | धेरै सजग छु |

| **9. तपाईंको चिया उपजमा निम्न कारकहरु को प्रभाव कति उच्च छ? (टेर्रो अवधारणा: सबै पर्यावरणीय कारकहरू बलिमा प्रभाव पार्छन्):** | |
|---|---|
| **सबै मा कुनै प्रभाव छैन – 0 1 2 3 4 – अति उच्च प्रभाव** | |
| तापमान | 0 1 2 3 4 |
| कुल वार्षिक वर्षा | 0 1 2 3 4 |
| वार्षिक वर्षाको वितरण | 0 1 2 3 4 |
| माटोको गुणस्तर | 0 1 2 3 4 |
| टोपोग्राफी (खेतीको भौतिक विशेषताहरू) | 0 1 2 3 4 |
| संस्कृति (तनाव / चियाको बोटको प्रकार) | 0 1 2 3 4 |

| **10. चिया किसानको रूपमा तपाईंको लागि कुन अबरोद्यले उचित जलवायु परिवर्तन अपनाउन कठिन छ?** | |
|---|---|
| | **सान्दर्भिक छैन -0 1 2 3 4- धेरै सान्दर्भिक** |
| आर्थिक पूंजीको कमी | 0 1 2 3 4 |
| पर्याप्त जानकारी छैन | 0 1 2 3 4 |
| अपर्याप्त सरकारी समर्थन | 0 1 2 3 4 |

***2.* लगानी र सुचनाको पहुँच**

| **11. तपाईंको खेतको सहायता गर्नको लागि गत 5 सालभित्र तपाइँले कति पटक क्रेडिट वा ऋणको प्रयोग गर्नुभएको छ ?** |
|---|
| |

| **12. मौसम जानकारीको सन्दर्भमा निम्नलिखित सूचना च्यानलहरु लाई तपाइँ कति पटक प्रयोग गर्नुहुन्छ?** | |
|---|---|
| **कहिल्यै होइन – 0 1 2 3 4 – बारम्बार** | |
| इन्टरनेट | 0 1 2 3 4 |
| टेलिभिजन (जस्तै मौसम पूर्वानुमान) | 0 1 2 3 4 |
| अन्य चिया किसानहरू | 0 1 2 3 4 |
| प्रिन्ट मिडिया (जस्तै समाचार पत्र) | 0 1 2 3 4 |
| मोबाइल फोन | 0 1 2 3 4 |

| | |
|---|---|
| अन्य (कृपया संकेत गर्नुहोस्): | 0 1 2 3 4 |

| **13. तपाईं प्राय कति पटक चिया खेती सन्दर्भमा निम्न जानकारी च्यानलहरू प्रयोग गर्छन्?** | |
|---|---|
| | **कहिल्यै होइन – 0 1 2 3 4 – बारम्बार** |
| इन्टरनेट | 0 1 2 3 4 |
| टेलिभिजन | 0 1 2 3 4 |
| अन्य चिया किसानहरू | 0 1 2 3 4 |
| प्रिन्ट मिडिया (जस्तै समाचार पत्र) | 0 1 2 3 4 |
| प्रशिक्षणमा सहभागी | 0 1 2 3 4 |
| मोबाइल फोन | 0 1 2 3 4 |
| अन्य (कृपया संकेत गर्नुहोस्): | 0 1 2 3 4 |

| **14. के तपाईंले चिया खेती सम्बन्धी प्रशिक्षण र कार्यशालाहरूमा सहभागी गर्नुभएको छ ?** | | | | |
|---|---|---|---|---|
| प्राय: (धेरै पटक प्रति वर्ष) | प्राय: (एक पटक प्रति वर्ष) | कहिलेकाँही (प्रत्येक 2-3 वर्षको एक चोटीमा) | शायद नै (5 वर्षमा एक पटक भन्दा कम) | कहिल्यै होइन |

| **15. के तपाईं नेपाली सरकार र अन्तर्राष्ट्रिय व्यापार केन्द्र द्वारा आयोजित "नेशनल चिया एक्सपोर्ट नीति 2017-2021" को बारे मा सजग हुनुहुन्छ?** | | |
|---|---|---|
| कहिल्यै सुनेन | यसको बारेमा सुने तर विवरण थाहा छैन | सामग्री बारे सचेत |

| **16. के तपाईंलाई विश्वास छ , कि तपाइँ नेपालको चिया खेती प्रथाहरुमा हालको प्रवृतिको बारेमा राम्रो तरिकाले सूचित हुनुहुन्छ?** | | |
|---|---|---|
| राम्रो जानकारी छैन | केही हदसम्म जानकारी | धेरै राम्रो जानकारी |

| **17. तपाईं हाल कति चिया किसान सहकारीहरुको सदस्य हुनुहुन्छ?** |
|---|
| संख्या: |
| कृपया कुन सहकारी (हरू) उल्लेख गर्नुहोस्: |

| **18कृपया तपाईंलाई चाय किसानको रूपमा निम्न प्रकारको जानकारीको महत्वको मूल्यांकन गर्नुहोस्:** | |
|---|---|
| | **कम महत्त्वपूर्ण - 0 1 2 3 4 - अति महत्त्वपूर्ण** |
| ऋण / क्रेडिट | 0 1 2 3 4 |
| बजार जानकारी (जस्तै चिया मूल्यहरु) | 0 1 2 3 4 |
| मल र कीटनाशक प्रयोग | 0 1 2 3 4 |

| | |
|---|---|
| खेती प्रविधिहरू | 0 1 2 3 4 |
| खेती गरिएको चियाको भण्डारण | 0 1 2 3 4 |
| प्रविधी प्रक्रिया | 0 1 2 3 4 |
| अन्य: | 0 1 2 3 4 |

***3. आर्थिक प्रदर्शन***

| **19. कृपया गत 5 वर्षभित्रमा प्रत्येक वर्षको अलग - अलग आफ्नो सबै चिया बालि को मात्रा (किलोग्राम मा) अनुमान गर्नुहोस :** | |
|---|---|
| **वर्ष:** | **चिया बालीनाली (किलो):** |
| *2013* | |
| 2014 | |
| 2015 | |
| 2016 | |
| 2017 | |

| **20. कृपया पछिल्लो 5 वर्षमा बेचेको चियाको (प्रति किलो) औसत मूल्य अनुमान गर्नुस** | |
|---|---|
| **वर्ष:** | **NPR मा मूल्य बिक्री (प्रति किलो):** |
| 2013 | |
| 2014 | |
| 2015 | |
| 2016 | |
| 2017 | |

| **21. पछिल्लो 5 बर्षमा तपाईंको चिया खेतीको लाभप्रदता तपाईं कसरी मूल्यांकन गर्नुहुन्छ?** | |
|---|---|
| **1= कुनै पनि लाभ छैन; 2= कम लाभ; 3= औसत लाभ; 4= उच्च लाभ;5= धेरै उच्च लाभ** | |
| 2013 | |
| 2014 | |
| 2015 | |
| 2016 | |
| 2017 | |

| **22. गत 5 वर्षमा तपाईंको आर्थिक प्रदर्शनलाई ध्यान दिँदै, निम्न कथन मध्ये तपाइँ कुन कुरामा सहमत हुनुहुन्छ?** |
|---|
| 1. सकारात्मक आर्थिक विकास |
| 2. कुनै महत्त्वपूर्ण परिवर्तनहरू छैनन् |
| 3. चिया उत्पादन गरेर पैसा बनाउन झन् गाह्रो हुदै छ |

| **23. तपाइँले पछिल्लो 12 महिना भित्र मलखादको प्रयोग प्राय कति पटक गर्नुभयो?** |
|---|

| | | |
|---|---|---|
| कहिल्यै होइन | कहिलेकाहीं (5 पटक भन्दा कम) | प्राय: (5 पटक भन्दा बढी) |
| यदि हो भने कृपया कुन मलखाद संकेत गर्नुहोस्: | | |
| **24. तपाइँले पछिल्लो 12 महिना भित्र कीटनाशको प्रयोग प्राय कति पटक गर्नुभयो?** | | |
| कहिल्यै होइन | कहिलेकाहीं (5 पटक भन्दा कम) | प्राय: (5 पटक भन्दा बढी) |
| यदि हो भने कृपया कुन कीटनाश संकेत गर्नुहोस् | | |

| | |
|---|---|
| **25. के तपाईंको चिया खेत वर्तमान अन्तर्राष्ट्रिय अर्गानिक स्तर अनुसार प्रमाणित छ?** | |
| हो | होइन |
| यदि हो भने कृपया कुन प्रमाणपत्र संकेत गर्नुहोस् | |

| | |
|---|---|
| **26. के तपाईंको चिया खेत वर्तमान नेपाली अर्गानिक स्तर अनुसार प्रमाणित छ?** | |
| हो | होइन |
| यदि हो भने कृपया कुन प्रमाणपत्र संकेत गर्नुहोस् | |

| |
|---|
| **27. कृपया संकेत गर्नुहोस, आफ्नो चिया बलि कटाई गरिसकेपछि थप प्रक्रिया कुन स्थानमा हुन्छ ?** |
| मेरो आफ्नै खेतीमा |
| एउटा सानो निजी प्रशोधन कारखानामा |
| सहकारी, ठूलो प्रशोधन एकाइमा |

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| **28. कृपया अनुमान गर्नुहोस्, कि तपाईंको औसत वार्षिक चिया बलि (% मा) मोल्ड र अपर्याप्त गुणस्तर जस्ता मुद्दाहरूको कारण खेर जान्छ (प्रयोग योग्य हुदैन )** |
| |

| | | |
|---|---|---|
| **29. के तपाईलाई थाहा छ, कुन किसिमको चिया प्रसोधनको लागि तपाई को चियाको पातहरु प्रयोग गरिन्छ ?** | | |
| सीटीसी (क्रश टियर कर्ल) | आर्थोडक्स चिया | मलाई थाहा छैन |

***4.* सामाजिक डेमोग्राफिक रूपरेखा**

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| **30. कृपया तपाईंको लिङ्ग संकेत गर्नुहोस्:** |
| पुरुष महिला |

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|---|
| **31. कृपया आफ्नो वर्तमान उमेर संकेत गर्नुहोस्:** |
| |

| **33. के तपाई आफैलाई यी कुरा सक्षम सोच्नु हुन्छ.....?** | |
|---|---|
| लेख्न र पढ्न सक्षम (साक्षर) | लेख्न र पढ्न असमर्थ (अनपढ) |

| **34. कृपया तपाईंको शिक्षा कति वर्षको थियो संकेत गर्नुहोस्:** |
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| |

| **35. तपाईंको वैवाहिक अवस्था के हो?** | | | |
|---|---|---|---|
| एकल | विवाहित | छोडपत्र | विधवा |

| **36. तपाईको परिवारमा कति जना सदस्य हुनु हुन्छ ?** | | |
|---|---|---|
| बच्चाहरु (-15 वर्ष): | वयस्कहरू (16-59 वर्ष): | वृद्ध (60+ वर्ष): |

| **37. कृपया संकेत गर्नुहोस्, तपाईको खेतमा कतिजना मानिसहरू काम गर्दै छन् र उनीहरूको लिंग भन्नुहोस?:** | | |
|---|---|---|
| कुल संख्या: | पुरुष कामदारहरूको संख्या: | महिला कामदारहरूको संख्या: |
| परिवारका सदस्यहरु: | पुरुष: | महिला: |
| तलबी कामदार: | पुरुष: | महिला: |

| **38. कृपया (हेक्टरमा) आफ्नो खेत को परिमाण आकार संकेत गर्नुहोस :** |
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| |

| **39. तपाईंको कुल खेतीको केवल चिया उत्पादनको लागि मात्र प्रयोग हुने जमिनको भाग (% मा) कति छ ?** |
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| **40. तपाईंको चिया खेतको जमिन कति उचाइमा छ ?(मीटर मा)** |
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| **41. तपाईं अहिले केवल चिया वा अन्य बाली (जस्तै चामल) पनि उत्पादन गर्नु हुन्छ ? यदि हो भने, कृपया कुन बालिहरू संकेत गर्नुहोस्** | |
|---|---|
| हो | होइन |
| अन्य बाली: | |